4.2 PHYSICAL ENVIRONMENT

4.2.1 Geological Resources

Introduction

As described in Sections 3.5.5 and 3.5.6, the Planning Area does not contain mineral resources (other than fluid mineral resources, oil shale, and some potential salable construction materials) that would affect or be affected by the five alternatives analyzed as part of this RMPA/EIS. Additionally, the area is not known for rockhounding because of a virtual lack of metallic minerals or gemstones. Therefore, the major geologic issues are potential geologic hazards and the Anvil Points Cave system. Issues related to the presence of paleontological resources within the Planning Area are discussed in Section 4.2.2.

Geologic hazards in the Planning Area are associated primarily with rockfall hazard along the Roan Cliffs. The combination of topographic relief in excess of 900 feet, steep slope angles, and instability associated with interbedded resistant and erosive layers contribute to rockfall. Indeed, the visual quality of the cliffs is due in large part to slope instability, which results in continual erosion and exposure of fresh bedrock and debris cones (talus and scree). Slopes steeper than 50 percent would be protected by an NGD/NSO stipulation under all four of the alternatives, but only in areas with BLM surface or mineral estate. Consequently, the rockfall hazard in the non-BLM portion of the Planning Area could be greater.

4.2.1.1 Alternative I

The rockfall hazard for potential oil and gas development and other uses of the Planning Area is greater under Alternative I than the other alternatives because the NSO stipulation for slopes steeper than 50 percent applies to 8,722 acres, compared to 16,550 acres under the other alternatives. This occurs because the stipulation under Alternative I applies only to areas that were available to oil and gas leasing under the 1999 FSEIS, while for the other alternatives it applies throughout the Planning Area.

Viewed from the opposite perspective, Alternative I would protect only about half as much of the area of steep slopes from excessive erosion due to construction of roads and drill pads as the other four alternatives. However, because road construction and other ground-disturbing activities would presumably avoid areas of obvious rockfall hazard, the impact of this lesser extent of the NSO for steep slopes under Alternative I is still expected to be negligible.

The claystone cave and karst system and associated natural arch are located within an existing oil and gas lease protected by NSO 19, which prohibits surface disturbances from oil and gas activities within 0.25 mile of the identified values (Map 11). Under Alternative I, some lands around the cave are also protected by an NSO stipulation-associated VRM Class I. Therefore, negligible negative impacts to these resources are expected from any ground-disturbing actions associated with resource management. However, risk of damage from recreational use continues.

4.2.1.2 Alternatives II through V

Impacts under these alternatives would be similar to those under Alternative I, except that portions of the steep cliffs within the no-lease area of Alternative I would instead by protected by an NGD/NSO stipulation for slopes steeper than 50 percent. Therefore, the anticipated negligible impact from rockfall hazard would be no greater than the negligible level estimated for Alternative I.

The claystone cave and karst system and associated natural arch are located within an existing oil and gas lease with NSO 19 to protect these resources from surface disturbances. Similar protection would be applied to other land uses and management activities under an analogous NGD stipulation. Lands with other SSR/CSU stipulations include areas managed for VRM Class II protection (CSU 5) and areas with slopes greater than 30 percent and erosive soils

(CSU 4). Negligible negative impacts to these resources are expected from ground-disturbing land uses or management actions in this area. The proposed Anvil Points ACEC under Alternative II (Tables 2-2a-d) provide some additional protection. However, the cave and karst system remains vulnerable to damage from unregulated recreation, and the potential for moderate to major impacts remains.

The deferral of leasing and drilling for oil and gas on top of the plateau under Alternative III, BLM's preferred alternative, would not affect the type and extent of impacts to geologic resources. For the purposes of this RMPA/EIS, it is assumed that the total number of wells and other surface facilities would not be affected by the deferral.

4.2.2 Paleontological Resources

Introduction

While high erosion rates on steep slopes in the Planning Area may be an issue in terms of rockfall hazard (see above), they have the benefit of constantly exposing subsurface materials, including new fossils. Exposed for long periods of time, these fossils erode from the confining sediments, often "float" on the ground surface, and gradually deteriorate. Cumulative impacts such as mechanical breakage and disarticulation of surface fossils due to trampling by animals and damage caused by human activities undoubtedly occurs in the Planning Area. Collecting of common invertebrates and plant fossils is a traditional and ongoing recreational activity in western Colorado. Although several fossil enthusiasts have reported vertebrate and other scientifically important fossil discoveries to land managers and BLM-permitted paleontologists, illegal collection of surface fossils still occurs and is an ongoing problem. Recreational activities such as exploring off designated roads and trails, either on foot or by mechanized means, create the need for further protective measures to preserve fossil resources.

When oil and gas activity, pipelines, and associated roads are cut into outcrops, paleontological resources are placed at risk of destruction. The ROD for the 1999 FSEIS outlines stipulations for what are now called Condition 1 and Condition 2 paleontological areas. Prior to ground-disturbing activities in a Condition 1 area (and prior to sample surveys in a Condition 2 area for larger projects), the GSFO Geologist must determine, in consultation with the BLM Regional Paleontologist, whether an inventory should be conducted by an accredited paleontologist approved by BLM. This determination is based on whether the area is likely to yield fossils of scientific importance.

Condition 1 areas (void of well-developed soils, lacking thick vegetation, and with unsafe slopes) should be recommended for a paleontological survey for all projects. Larger projects, greater than 500 acres or longer than one linear mile, should be surveyed for Condition 2 (likely to be fossiliferous). The purpose of the surveys is to add to the knowledge base of paleontological resources in the area and help in decision-making concerning actions that may affect these resources. When scientifically important paleontological resources are already known to be present or are found as the result of these surveys, the resources should be avoided, monitored, and/or mitigated as appropriate given the type of action and specific resources.

Fossil resources on BLM lands are managed under FLPMA, NEPA, specific Federal regulations, and other guidance outlined in BLM 8270 Manual and Handbook for the Management of Paleontological Resources (BLM 1998c) and in accordance with DM 411 for the Management of Museum Collections. The BLM 8270 Handbook ranks formations according to their paleontological potential, as follows:

- **Condition 1** – Areas that are known to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils. Consideration of paleontological resources will be necessary if the Field Office review of available information indicates that such fossils are present in the area.
- **Condition 2** – Areas with exposures of geologic units or settings that have high

potential to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils. The presence of geologic units from which such fossils have been recovered elsewhere may require further assessment of these same units where they are exposed in the area of consideration.

- **Condition 3** – Areas that are unlikely to produce vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils based on deep soils, surficial geology, igneous or metamorphic bedrock, and extremely young alluvium, colluvium, or aeolian deposits. However, if possible it should be noted at what depth bedrock may be expected in order to determine whether fossiliferous deposits may be uncovered during ground-disturbing activities.

Although these guidelines apply primarily to vertebrate fossils, they are designed to help protect rare plant and invertebrate fossils, especially "type" localities. Likewise, many fossils, though common and unimpressive in and of themselves, can be important indicators of paleoenvironment, depositional regime, and chronostratigraphy (i.e., temporal relationships). Based on the definitions developed using the BLM 8270 Manual, the upper member of the Wasatch Formation and the A-B groove of the Parachute Creek Member of the Green River Formation would be considered as having Condition 1 paleontological potential. Until other fossiliferous units can be identified, all other Tertiary and all Quaternary deposits in the Planning Area would be considered Condition 2.

Impacts to paleontological resources under the five alternatives are described in the following subsections. Some of the impacts may represent an irreversible and irretrievable commitment of natural resources (see Section 4.6).

4.2.2.1 Alternative I

The Condition 1 paleontological unit within existing lease areas consists of the Wasatch Formation and includes the Sharrard Park Paleontological Area (Map 11). Although current data are inadequate to quantify the extent or magnitude of the loss of scientifically significant fossil resources, areas covered by existing NSO, CSU, and LN stipulations would provide protection for the resource. However, because the Sharrard Park Paleontological Area has been specifically identified in public documents, but without the increased policing of the area that would be provided by an SRMA, an increased potential for vandalism and unauthorized fossil collecting may exist. Like CSU stipulations, all lease areas require paleontological surveys and monitoring prior to ground-disturbing activities. This minimizes the potential for moderate and major impacts to paleontological resources and benefits the paleontological resources by actively gathering scientific data.

Much of the paleontologically sensitive Wasatch Formation exists as steep slopes and bases (roughly 20 feet) within the areas of existing leases. NSO restrictions on slopes over 50 percent and in the I-70 viewshed and wildlife seclusion areas under this alternative prevent most ground-disturbing activities, although exception criteria would allow some impacts, especially in the short term. Ongoing negligible to moderate impacts on fossils could occur in the Hubbard Mesa OHV area due to the high density of routes and cross-country travel. Impacts could result not only from direct damage to fossils or to fossil-bearing rocks, but also from unauthorized collection by numerous visitors in an area with considerable bare ground and accelerated erosion.

Condition 1 paleontological units within the no-lease areas of the former NOSRs 1 and 3 consist of exposures of the Wasatch Formation on the east side of the area and the A-B groove of the Parachute Creek Member of the Green River Formation along the Roan Cliffs. The A-B horizon is also exposed in the East Fork Parachute Creek near the southwestern corner of the no-lease area. The paleontological resources of the Condition 1 units are protected from human impacts under Alternative I by the no-lease designation and the inaccessibility provided by the steep slopes where they occur.

4.2.2.2 Alternative II

Impacts under this alterative would be similar to those under Alternative I, except that Alternative II includes the larger extent of NSO stipulations for slopes steeper than 50 percent (i.e., 16,550 versus 8,722 acres). The CSU for the Sharrard Park Paleontological Area applies equally under all alternatives.

Additionally, restricting motorized or mechanized travel to designated routes throughout the Planning Area under this alternative would improve the level of protection compared to current use (Alternative I), especially in the Hubbard Mesa OHV area. Construction of any new routes should be preceded by a paleontological survey to minimize the potential for damaging a high-quality outcrop. The Hubbard Mesa SRMA could also include placement of educational signage to help minimize vandalism, although highlighting the fossil resource of the area could have the opposite effect by encouraging unauthorized collections.

Condition 1 paleontological units of the Wasatch Formation occur on the eastern side of the Northeast Cliffs and Southeast Cliffs wilderness inventory units, while those of the A-B groove of the Parachute Creek Member occur along the western edge of these units and the southwestern corner of the East Fork inventory unit. The WSR designation along East Fork Parachute Creek also adds a level of protection for Condition 1 paleontological resources under this alternative. These resource areas are protected from direct and indirect impacts associated with ground-disturbing activities by NSO stipulations and the inaccessibility from the steep slopes where they occur. However, unless special provisions can be made, the NSO stipulations hinder scientific access to paleontological resources.

Overall, Alternative II is the most restrictive due to the large areas of NSOs coincident with outcrops of Condition 1 units and designation of the Hubbard Mesa SRMA. The result would be negligible to minor impacts to paleontological resources despite greater oil and gas development than under Alternative I. The relatively small amount of land with CSU stipulations provides some additional protection, because CSU areas require a paleontological survey prior to ground-disturbing activities and monitoring during construction. Thus, CSU areas provide opportunities not only to protect the fossil resources but, just as important, to catalog and study them. Designation of the Hubbard Mesa SRMA would minimize impacts of cross-country OHV use by restricting travel to designated routes and otherwise regulating recreational activities.

4.2.2.3 Alternative III – Preferred Alternative

The Sharrard Park Paleontological area would continue to be protected under Alternative III, and all motorized or mechanized travel would be limited to designated routes, except for cross-country travel by snowmobile. The elimination of travel by OHVs would eliminate one of the most potentially serious threats to paleontological resources. This threat would be further minimized by the requirement for a fossil survey prior to ground-disturbing activities, with mitigation as required. Because the Sharrard Park area has been specifically identified in public documents, increased vandalism and illegal fossil collecting is possible.

While Alternative III provides less protection from surface disturbance than Alternatives I or II, it is generally more beneficial for fossil resources because of the large area of CSU stipulations and the accompanying requirement for paleontological clearance surveys. Consequently, Alternative III would have moderate beneficial impacts on fossil resources of the Planning Area.

The deferral of leasing and drilling for oil and gas on top of the plateau under Alternative III would not affect the type and extent of impacts to fossil resources, except to the degree that it could affect the location of wells and other facilities during the 20-year period of analysis. For the purposes of this RMPA/EIS, it is assumed that the total number of wells would not be affected.

4.2.2.4 Alternative IV

The Sharrard Park Paleontological area would continue to be protected under Alternative IV, and motorized or mechanized travel would be limited to designated routes throughout the Planning Area, except for over-snow travel by snowmobile. The restriction to designated routes would eliminate one of the most serious threats to fossil resources. This threat would be further minimized by the requirement for a fossil survey prior to ground-disturbing activities, with mitigation as required. Because the Sharrard Park area has been specifically identified in public documents, increased vandalism and illegal fossil collecting is possible.

While Alternative IV provides less protection from surface disturbance than Alternatives I or II, it is generally more beneficial for fossil resources because of the large area of CSU stipulations and the accompanying requirement for paleontological clearance surveys. Consequently, Alternative IV would have moderate beneficial impacts on fossil resources of the Planning Area.

4.2.2.5 Alternative V

This alternative would also protect the Sharrard Park Paleontological area, and OHV travel would be limited to designated routes throughout the Planning Area (except for over-snow travel by snowmobile). However, not designating the Hubbard Mesa area as an SRMA would reduce the level of restrictions imposed by BLM, such as requiring pre-disturbance fossil inventories and mitigation.

Overall, however, the large area of SSR/CSU stipulations, with the associated requirement for pre-disturbance surveys, would generally benefit paleontological resources more than the large areas of no-lease or NGD/NSO stipulations under Alternatives I and II. As described above, opening more lands to oil and gas is, perhaps ironically, paleontologically beneficial because of the lease requirements for inventorying and monitoring development in Condition 1 areas. This allows for the greatest potential for recovery of paleontological data. Thus, except for potential impacts in the Hubbard Mesa OHV area, the overall effect of Alternative V would be negligible adverse impacts on fossil resources and potentially moderate beneficial impacts.

4.2.2.6 Indirect, Offsite, and Cumulative Impacts

Indirect Impacts

As noted throughout the discussion above, decreasing levels of no-lease and NGD/NSO protection and increasing levels of oil and gas development and SSR/CSU designations from Alternatives I through V result in progressively more beneficial impacts on fossil resources by requiring paleontological surveying, monitoring, and mitigation.

Fossils are of general interest and scientific value only if discovered. Unlike plants and animals, which reside on or near the surface of an area, fossil resources extend throughout the entire volume of underlying fossiliferous rock. Thus, the paleontological value of an area is potentially greater if it is accessible and inventoried, even if subject to greater erosion, than if it is completely off limits to ground-disturbing activities. Certainly some of the most dramatic fossil discoveries throughout the U.S. have been associated with quarries or other construction projects that unearthed the remains of an ancient organism that otherwise would remain hidden.

The lone exception to this generally positive trend among the five alternatives is the lack of an SRMA designation for the Hubbard Mesa OHV area under Alternatives I and V. Keeping this area unregulated could ultimately cause problematic levels of erosion, direct and indirect damage to fossils, and an increase in unauthorized collecting due to increased levels of human activity.

Offsite Impacts

Differing levels of paleontological resource protection or discovery under the five alternatives would not be expected to have demonstrable offsite impacts. Potentially, the

increased levels of oil and gas development would make the area less suitable for fossil enthusiasts. Thus, while the Sharrard Park Paleontological Area would continue to receive CSU protection, the increased "industrialization" of nearby areas might detract from the overall fossil-hunting experience and shift some use to offsite localities. However, given the relatively small amount of this type of use compared to other recreational activities and other, non-recreation-oriented land uses, any shift to offsite areas would be negligible.

Cumulative Impacts

Long-term cumulative impacts of oil and gas development in the Planning Area are associated primarily with the fact that a considerable amount of future development would occur on private land within the Planning Area and nearby areas with the same type of fossil-bearing rock exposures. Because private landowners do not require paleontological assessments before and during construction activities, much less any mitigation of at-risk resources, some important fossil specimens or paleontological data could be lost. Additionally, private landowners may restrict access to significant fossil locations on public land that are not readily accessible except across their property. Oil and gas development both within and outside BLM lands within the Planning Area is likely to exacerbate the problem by limiting public access except on designated roads.

4.2.3 Soils

Introduction

Direct soil impacts of concern in the study area include soil erosion, compaction, mixing of horizons, changes in infiltration from fire, and chemical contamination. Some or all of these impacts can occur from recreation, OHV travel, grazing, range management, fire management, oil and gas development, and ground-disturbing activities associated with rights-of-way such as roads, pipelines, and electric transmission corridors. The physical, biological, and chemical properties of the soils can be impacted and have indirect effects on sedimentation, infiltration and permeability, soil biota, and plant productivity. The categories of impacts used in this analysis (i.e. negligible, minor, moderate, or major) are described in Section 4.1.

Soil erosion is a concern for future management of the Planning Area, particularly regarding anticipated oil and gas development. Impacts may include reduced ecological, visual, and agricultural (livestock) quality due to removal of vegetation cover, mixing of soil horizons, soil compaction, and contamination from drilling and production wastes or fuel spills. Exposed, mixed, compacted, or contaminated soils exhibit loss of productivity, decreased infiltration, increased runoff, and increased erosion. Wind erosion is not as important a factor in the Planning Area, although the combination of increased areas of bare soils and increased road traffic will increase the generation of fugitive dust (airborne particulates).

Although soil erosion is a natural process that occurs even in "pristine" areas, the rate of erosion can be greatly accelerated by anthropogenic (human-use-related) activities such as grazing, cultivation, forestry, recreation, and construction that remove vegetation cover and disturb the soil surface. Soil loss can occur as sheet, rill, or gully erosion associated with precipitation runoff, as well as from wind erosion. The most important factors affecting runoff erosion are the intensity and duration of precipitation, inherent erodibility of the soil, slope length and steepness, vegetation cover, and erosion control practices (Wischmeier and Smith 1978).

Soil erosion rates can be increased by as much as an order of magnitude (i.e., tenfold) during construction, when vegetation has been cleared, topsoils have been removed and stockpiled, and subsoils are exposed to rainfall and snowmelt, compared to undisturbed conditions. In the Universal Soil Loss Equation, input values used to represent the ameliorating effect of plant cover are 12 times as high with 60 percent grass cover, and 5 times as high with 40 percent grass cover, as for areas with zero percent grass cover (Wischmeier and Smith 1978). This increase in erosion potential is exacerbated when the

disturbance occurs in soils that are inherently more erodible (see Section 3.2.3). For example, soils with a "very severe" erosion hazard can lose 12 to 30 tons per acre per year under normal conditions, compared to only 1 to 2 tons per acre per year for soils with a "low" erosion hazard.

Surface disturbance from oil and gas development would be spread over time, with up to 40 years estimated for full development of the Planning Area, reducing the amount of new disturbance in any given year. This is important because runoff, erosion, and sedimentation associated with wells are highest initially, when soils are freshly disturbed, and decline as revegetation reduces the amount of bare soil and as compaction gradually reduces erosion loss. Runoff and erosion are likely to be greater on roads, although smaller in total area than oil and gas pads, because roads may slope and may approach or cross streams, while oil and gas pads are relatively flat and could not be located adjacent to a stream.

Because of the importance of reducing soil loss and protecting sensitive ecological resources on Federal lands in the Planning Area, BLM has established NSO 15 for areas steeper than 50 percent due to the high potential for erosion and the difficulty of rehabilitating these areas. CSU stipulations have been established for areas steeper than 30 percent having soils with a severe or very severe erosion hazard (Map 13). The application of these protective stipulations to the five alternatives considered in this RMPA/EIS is discussed in the following subsections.

Assessing the potential severity of soil erosion from oil and gas development is not as simple as comparing the amount of newly disturbed ground to the total project area. This conclusion is based on the fact that oil and gas well pads themselves will be level but will have cut-and-fill slopes proportional to the surrounding slope of the land, as well as the use of the NSO and CSU stipulations and selected special mitigation measures to avoid problematic areas and protect sensitive resources. Erosion impacts could be greatest in the areas above the rim due to the small size and limited flows in the headwater reaches of streams. However, these are also the areas with the lowest overall erosion hazard based on soils present, the best vegetation cover, and the most stringent application of protective stipulations. Below the rim, the large areas of soils that are naturally eroding at severe and very severe rates and the large size of the receiving streams (Parachute Creek and the Colorado River) may make sediment transport from oil and gas development indistinguishable from background levels.

An indirect impact of particular importance for this RMPA/EIS is the potential transport of eroded soil material to streams, where it may adversely affect water quality, riparian vegetation, and aquatic organisms, including genetically pure populations of the Colorado River cutthroat trout and other sensitive plant and animal species.

Areas of bare soil are also a source of suspended (windblown) particulates in the form of fugitive dust that may be transported into aquatic habitats and deposited on plant foliage, reducing plant vigor and affecting local air quality.

The management and expected impacts to the soil resources of the Planning Area associated with each alternative are described below. The general management of the soil resources is based on Land Heath Standards. All five alternatives would manage soils to meet or exceed Land Health Standard 1. Areas with wilderness character and areas eligible for designation as WSRs are discussed in Sections 4.5.8 and 4.5.9. Some of the soil impacts described in the following subsections may represent an irreversible and irretrievable commitment of natural resources.

4.2.3.1 Alternative I

This alternative would allow the least amount of oil and gas development on BLM lands in the Planning Area. An area of 44,267 acres would be unavailable for oil and gas leasing, and NSO 15 would protect the soil resource in 8,772 acres containing slopes greater than 50 percent. An additional 6,695 acres with slopes steeper than 30 percent and erosive soils (i.e., in the severe

and very severe erosion classes; see Table 3-1) would be protected by CSU 4. Notwithstanding the no-lease and NSO restrictions, an estimated 254 new pads would be developed during the 20-year period of analysis, resulting in 1,151 acres of long-term soil disturbance and 750 acres of temporary disturbance. The combined short- and long-term soil impacts from pads, roads, and pipelines represent 2.6 percent of BLM land in the Planning Area.

Although the limited oil and gas development under Alternative I would have negligible soil impacts overall, impacts would be more severe at a localized scale due to long-term changes in soil fertility or structure, loss of topsoil, compaction, loss of plant cover, and other changes. These areas of localized impact may create ecological and visual scars extending well beyond the end of the 20-year analysis period. Mitigation measures to minimize these impacts include requirements for salvaging and replacing topsoil.

Alternative I would allow the most unrestricted travel throughout the Planning Area, with cross-country travel permitted throughout the area and no closure of existing routes to motorized or mechanized travel. Based on current levels of OHV use in the Hubbard Mesa area and expected increases in recreational travel throughout the Planning Area, this alternative could result in increasing numbers of pioneered roads, potentially causing major localized direct impacts to soils from physical disturbance and compaction and damage to vegetation. Soil impacts could in turn result in increased sedimentation of streams.

Continuation of grazing rangeland projects (e.g., use of fences and ponds to control or direct livestock use) and administrative solutions (season-of-use revisions, stock level adjustments, pasture exclusions, and utilization stipulations) under this alternative are expected to result in gradual, minor, long-term improvements in soil conditions.

Fire management would be generally the same under all five alternatives. Fires can affect soil by removing plant cover, destroying surficial organic matter, altering the temperature and moisture regimes (by altering the amount and type of plant overstory), altering patterns of snow accumulation and snowmelt, and (if sufficiently hot) modifying soil infiltration rates by creating a "glazed" surface. Because of higher temperatures and occurrence during less favorable seasons (during summer when vegetation is drought-stressed), uncontrolled wildfires typically have a greater impact than lower-intensity prescribed fires. The latter may be used to manage forest or range health and reduce potential wildfire severity.

Overall, soil impacts under Alternative I would be minor because the limited amount of new oil and gas development and measures to improve range condition would offset the lack of restrictions on cross-country OHV travel.

4.2.3.2 Alternative II

This is the only alternative that would include designation of four ACECs: Magpie Gulch, Anvil Points, East Fork Parachute Creek, and Trapper/Northwater Creek. These ACECs are variously focused on the protection of botanical/ecological, fisheries, or visual resources, which in turn are related to some extent to soil stability and condition. Thus, measures to reduce soil (sediment) transport to streams and riparian corridors, restore areas degraded by livestock or other disturbance, minimize soil erosion in areas with sensitive plants, or avoid visual scars all involve protection of the soil resource to some degree.

Under Alternative II, the amount of no-lease land (i.e., unavailable for oil and gas leasing) would be reduced to 21,382 acres and limited to areas having wilderness character. While the remainder of the area would be open to oil and gas leasing, NGD/NSO 15 stipulation for steep slopes and other NGD stipulations would reduce the amount of surface available for oil and gas development to 21,020 acres. This would include 7,015 acres with SSR/CSU stipulations (including SSR/CSU 4 for slopes greater than 30 percent with erosive soils). The estimated new development on BLM land under this alternative would result in approximately 310 new oil and

gas pads, 1,348 acres of long-term disturbance, and 916 acres of short-term disturbance. The combined disturbance area of 2,264 acres represents 3.1 percent of BLM surface or mineral estate in the Planning Area.

In the 7,015 acres of SSR/CSU stipulations and areas with special management designations (ACECs and areas having wilderness character), ground-disturbing activities may be subject to special mitigation measures to further reduce the potential for soil damage or loss in specific locations. Examples include:

- use of erosion-control fabric to stabilize development-related bare slopes steeper than 2 to 1 (horizontal to vertical)
- construction of water bars or other erosion-control features on vehicle routes constructed or used to access oil and gas pads or roads used for grazing access and recreational travel
- testing of soil for agronomic (growth) characteristics prior to reclamation of long-term disturbances and adding organic matter, applying nutrients, or undertaking other measures to improve quality as a growth medium (not an issue for temporary impacts)
- requirements for enhanced revegetation, including use of woody plants as containerized stock to hasten soil stabilization

Travel management under this alternative would restrict OHV use to designated routes and prohibit cross-country travel, including snowmobiles. This would reduce or halt the expansion of travel routes and the soil impacts resulting from compaction, physical disturbance, and loss of vegetation. A total of 43 miles of existing routes would be closed except to administrative use, and another 43 miles would be closed to all motorized and mechanized use.

Range improvement projects would be limited to administrative actions (reduced stocking rates, pasture exclusions, season-of-use revisions, etc.). This reliance on passive processes to allow recovery of degraded sites is generally not as beneficial as active management, which can often hasten recovery. Thus, implementation of Alternative II could result in less rapid improvements to soils than the other alternatives; however, fewer structures and other anthropogenic (human-caused) features would be evident to detract from relatively pristine areas, or those having wilderness character.

Fire management would be generally the same as described for Alternative I.

Overall, soil impacts under Alternative II would be minor, based on closures and restrictions on cross-country OHV travel and relatively limited oil and gas development. Range improvement, although relying primarily on administrative solutions, would also help offset any new ground-disturbing activities.

4.2.3.3 Alternative III – Preferred Alternative

Unlike Alternatives I and II, Alternatives III, IV and V would make all of the Federal lands in the Planning Area available for oil and gas leasing. However, under Alternative III leasing and drilling on Federal lands atop the plateau would be deferred until at least 80 percent of the total wells anticipated below the rim have been drilled.

Most of the NGD/NSO stipulations applied under Alternative II would also be applied under this alternative, with a combined total area of 30,928 acres having this restriction. Much of the land made available for leasing would be protected by SSR/CSU stipulations (29,594 acres). Permit-level special mitigation (see Alternative II) could be required for specific portions of the ACECs, the Parachute Creek WMA.

The developable areas would allow an estimated 402 new oil and gas pads, resulting in 1,761 acres of long-term and 1,187 acres of temporary soil disturbance (see Table 4-2). The combined soil disturbance of 2,948 acres represents 4.0 percent of lands with BLM surface or mineral estate in the Planning Area. Fortuitously, soils in the additional lands available for oil and gas

leasing under Alternative III (compared to the two previous alternatives) tend to have low to moderate erosion hazard and good reclamation potential. Overall, impacts of oil and gas development on soils under Alternative III are expected to be negligible due to the small total area of soil disturbance and implementation of supplemental mitigation in some areas (see discussion under Alternative II).

Travel management would limit OHV use to designated routes throughout the Planning Area, except for over-snow travel by snowmobile. The Hubbard Mesa OHV area would also be designated as an SRMA under this alternative. A total of 24 miles of existing routes would be closed except to administrative use, and an additional 26 miles would be closed to all motorized or mechanized travel. These closures, and especially the prohibition against cross-country travel, would reduce the potential for soil loss associated with OHV-related disturbance.

Both range improvement projects and administrative solutions to address grazing impacts would be implemented under this alternative. The combination of tools to improve range condition is expected to result in more rapid long-term improvement to soil condition than Alternatives I and II but less than Alternative V, which also includes vegetation treatments.

Fire management would be generally the same as described for Alternative I.

Overall, soil impacts under Alternative III would be minor. This conclusion is based on the road closures, prohibition against cross-country OHV travel, and emphasis on range improvement offsetting much of the impact from oil and gas development. Additionally, the deferral of leasing and drilling for oil and gas on top of the plateau under Alternative III would result in a proportionally larger number of wells being below the rim, where more multi-well pads and reduced road lengths would reduce the total impacts.

4.2.3.4 Alternative IV

The major difference between Alternative IV and Alternative III in terms of oil and gas development is that Alternative IV would not defer development on top of the plateau. The NGD/NSO stipulations applied under Alternative III would also be applied under this alternative, with a combined total area of 30,928 acres having this restriction. Much of the land made available for leasing under this alternative would be protected by SSR/CSU stipulations (27,486 acres). These areas, as wells as the ACECs and the Trapper/Northwater Creek WMA, would be subject to permit-level special mitigation (Table 2-3).

The developable areas would allow an estimated 449 new oil and gas pads, resulting in 1,940 acres of long-term and 1,329 acres of short-term soil disturbance. The combined soil disturbance of 3,269 acres represents 4.4 percent of the BLM surface or mineral estate in the Planning Area. Fortuitously, soils in the large area of additional land available for oil and gas leasing under Alternative IV tend to have low to moderate erosion hazard and good reclamation potential. Overall, impacts of oil and gas development on soils under Alternative IV are expected to be minor due to the small total area of soil disturbance and implementation of supplemental mitigation in some areas (see discussion under Alternative II).

Travel management would limit OHV use to designated routes throughout the Planning Area, including the Hubbard Mesa SRMA but excluding over-snow travel by snowmobile. A total of 24 miles of existing routes would be closed except to administrative use, and an additional 26 miles would be closed to all motorized or mechanized travel. These closures, and especially the prohibition against cross-country travel, would reduce the potential for soil loss associated with OHV-related disturbance.

Both range improvement projects and administrative solutions would be implemented to address grazing impacts under this alternative. The combination of tools to improve range

condition is expected to result in more rapid long-term improvement to soil condition than Alternatives I and II, but less than Alternative V, which also includes vegetation treatments.

Fire management would be generally the same as described for Alternative I.

Overall, soil impacts under Alternative IV would be minor due to the combination of road closures, prohibition against cross-country OHV travel except within the Hubbard Mesa SRMA, and rangeland improvements offsetting much of the impact from increased oil and gas development.

4.2.3.5 Alternative V

Alternative V would continue to include NGD/NSO stipulations along portions of sensitive streams atop the plateau, but the protected zones would be narrower than under Alternatives II through IV (compare Map 10 with Maps 4, 6, and 8). A narrower area of NGD/NSO stipulations could increase sediment delivery to the streams (see Section 4.2.4). Similarly, areas with SSR/CSU stipulations would also be reduced, giving BLM less area in which it could require that a proposed activity to be shifted by more than 200 meters.

The anticipated number of new oil and gas pads on BLM lands under this alternative is 584. Total surface disturbance during the 20-year analysis period would be 4,211 acres, of which 2,495 acres would be long-term impacts (3.4 percent of the BLM surface or mineral estate).

Travel would be restricted to designated routes, except over-snow travel by snowmobile. The prohibition of cross-country travel would reduce the incidental creation of new routes and thereby minimize the associated soil impacts, especially in comparison to full access for cross-country travel under Alternative I. The Hubbard Mesa OHV area would not be designated an SRMA but would limit travel to designated routes.

Grazing rangeland projects as well as active vegetation treatments would be emphasized to improve range condition under this alternative. These actions are expected to result in more rapid benefit than the other four alternatives for grazing areas that remain free from ground-disturbing activities associated with oil and gas development.

Fire management would be generally the same as described for Alternative I.

Overall, soil impacts under Alternative V are expected to be minor, because the road closures, restriction of travel to designated routes, and more active range improvement would offset much of the impact resulting from increased oil and gas development.

4.2.3.6 Indirect, Offsite, and Cumulative Impacts

Indirect impacts to soils associated with soil erosion have been described above and include both direct disturbance during construction of roads and drill pads or potentially from cross-country OHV use (Alternative I only), and indirect impacts from loss or reduced vigor of plant cover that stabilizes the soil. Impacts of reduced soil quality include greater erosion potential and resultant sediment transport to streams, potential entrainment as fugitive dust, visual degradation, and reduced vegetation cover due to soil instability, lower fertility, and compaction.

Especially because of the slow recovery rate of natural plant communities in semi-arid regions, the loss of vegetation associated with soil impacts would indirectly reduce wildlife carrying capacity in proportion to the amount of land taken out of forage production and no longer providing cover or, for small ground-dwelling species, habitable land.

Sediment transport to streams could affect water quality for the Colorado River cutthroat trout, as well as other aquatic species and terrestrial species that rely on water. These indirect impacts are discussed in other sections of this RMPA/EIS.

Offsite impacts would mostly be limited to offsite transport of sediments and, to a lesser

degree, offsite impacts on air quality. Considering the current conditions of sparse vegetation across much of the lower portion of the Planning Area, naturally high rates of soil erosion that would continue without changes in management and use, stipulations to reduce soil erosion loss, and the naturally high sediment load during high flow in major offsite streams and other receiving waters (including the Colorado River), these offsite impacts are expected to be negligible under all alternatives.

Private lands with private mineral rights in the Planning Area comprise 53,405 acres, with an estimated potential for long-term impacts of 2,168 acres from oil and gas development. This represents 4.1 percent of private land, a higher percentage than Federal lands under the five alternatives (1.6 to 3.4 percent), because it is assumed that resource protection would be less stringent on private lands. The exception would be slopes steeper than 50 percent, which are likely to be avoided on private as well as public lands. Combining the areas of private and Federal minerals yields potential cumulative long-term impacts to soils ranging from 3,319 acres for Alternative I to 4,653 acres for Alternative V during the 20-year period of analysis. These cumulative impact totals range from 2.6 percent to 3.7 percent of the total Planning Area of 127,007 acres.

Cumulative onsite impacts would be minor, because although the proportion of the area disturbed would be increased substantially, the number of affected acres would remain a relatively small percentage of the total area. Cumulative impacts are potentially higher if the substantial portion of total development on private land has less stringent protection in the form of avoidance of problematic areas, protection of sensitive resources, and measures to minimize long-term disturbance. Failure to avoid operations on slopes steeper than 50 percent or to implement other appropriate erosion-control practices could result in moderate cumulative impacts in portions of the Planning Area.

Assessing the potential for cumulative impacts of soil erosion assumes that urbanization of private land both inside and outside the Planning Area is likely to continue at current or accelerated rates. This has the potential to disturb much larger areas than those on BLM lands of the Planning Area. Nonetheless, the combination of increased roads and access to the Planning Area, continued population growth and resultant increase in off-road recreation, and increasing amounts of long-term disturbance associated with oil and gas development under Alternatives II through V, could result in observable negative impacts on erosion and sediment transport to streams unless applicable mitigation measures are implemented (see Section 2.4).

4.2.4 Water Resources

Introduction

This section evaluates the changes to water resources in the Planning Area from implementation of management actions for each alternative. The potential for each of the alternatives to impair water resources is discussed, as well as mitigation measures if required. The discussions for Alternatives II through V build on the information presented for Alternative I. Indirect, offsite, and cumulative impacts are identified at the end of the section.

To evaluate effects on water quality and water rights, threshold criteria were developed to differentiate the extent and intensity of impacts under each alternative. Categories of adverse impacts used in this RMPA/EIS include:

- **None** – Not likely to affect the resource.
- **Negligible** – No detectable or measurable changes to water resource quality or quantity. No exceedance of regulatory standards.
- **Minor** – Degradation of water quality, exceedance of regulatory standards, or discernible change in water quantity could occur but would last less than 48 hours (e.g., in response to a pulsatile event) and limited to the immediate area of the causal activity or discharge.

- **Moderate** – Any degradation of water quality, exceedance of regulatory standards, or discernible change in water quantity would last less than one month and be limited to the general vicinity of the causal activity or discharge.

- **Major** – Water quality would be degraded by an ongoing exceedance of regulatory standards. Changes in water quantity would be long-term and/or widespread.

The same terms are applied in a more relative sense to describe beneficial impacts. The following subsections summarize impacts to water quality and quantity under the five alternatives. Because surface water is a renewable resource (i.e., continually replenished by natural processes), and because no aspect of the proposed alternatives would represent a permanent consumptive use or depletion of surface water, none of the impacts discussed below would represent an irreversible and irretrievable commitment of natural resources.

Impacts to groundwater could be considered an irreversible and irretrievable commitment of a natural resource due to the much slower rate at which changes in water quality or quantity would be reversed by natural processes (see Section 4.6). However, the potential for contamination of usable water zones and domestic groundwater, or for adverse impacts on groundwater quantity, from oil and gas drilling on BLM lands is considered negligible under all alternatives. This is due to the requirement that operators isolate and protect usable water zones, the relatively few domestic water wells on or near public lands, and the limited water-bearing zones below the rim (TRW 1982, BLM 1998b). Atop the plateau, groundwater is more abundant but has not been significantly developed for domestic uses due to its depth and the lack of permanent residents. However, more than 40 springs have been developed by BLM for use by livestock or wildlife.

4.2.4.1 Alternative I

Alternative I would continue present management direction and activities. An estimated 855 new oil and gas wells would be developed on 254 pads, with 1,151 acres of long-term surface disturbance (1.6 percent of BLM lands in the Planning Area). All but ten of these wells would be below the rim in the current "production area" of NOSR 3. Atop the plateau, no oil and gas leasing would be allowed in NOSR 1, but small areas of existing leases in the northwestern and northeastern corners would permit new wells (Figure 1-2). A total of 44,267 acres would be closed to further leasing for oil and gas development (Table 4-1).

Onsite Impacts on Water Quality

Water quality impacts can result from a number of causes, including transport of eroded soils into streams due to livestock grazing, introduction of waste matter into streams from domestic livestock, and "low-water" crossing points of roads, routes, and ways used by motorized vehicles. While these potential impact sources exist and would continue under Alternative I, a greater source of potential impacts to water quality would result from additional oil and gas development. Potential oil and gas impacts relate to both the transport of soil eroded from roads and drill pads and the potential for release of chemical pollutants into area ponds, streams, or tributary ephemeral drainage swales.

Sedimentation – Sedimentation is the buildup of eroded soil particles in surface water channels. Erosion is a natural process; however, certain land-use activities may accelerate the process. Erosion and sedimentation can be increased by activities that move soil/sediment particles and/or activities that reduce the density or quality of vegetative cover, including livestock grazing and range manipulation, grading and clearing for roads or well pads, on- and off-road OHV use, and fire or fire management. Additionally, activities or management prescriptions that reduce the quantity or quality of ground cover can increase surface water runoff, thereby potentially increasing sedimentation of water channels.

Once soil particles have been detached and suspended in surface runoff, they can contribute

to degradation of surface water quality and aquatic habitats. Impacts to water quality due to sedimentation are highly variable. Generally, sedimentation can degrade water quality by increasing turbidity and salinity, and introduce contaminants held in the soil particles. Sediments can also bury plants and roads, and accumulate in streambeds.

In the Planning Area, streams would be protected by setback restrictions and imposition of other special mitigation measures. Nonetheless, construction of well pads, roads, pipelines, and related facilities will result in large amounts of soil being moved locally in the short term, potentially resulting in temporary decreases in water quality in nearby streams. In the portion of the Planning Area available to oil and gas development under Alternative I, which includes large areas of soils with naturally severe or very severe erosion rates (5 to 30 tons/acre/year), it is possible that any increase in sedimentation from oil and gas development during the 20-year period of analysis, or from other land-use or management activities, would not be distinguishable from natural erosion rates in the area.

The portion of a given source of sedimentation that actually reaches a stream can be near zero where an eroding slope deposits most of the soil particles at the base of a hill, to 100 percent where an eroding slope leads directly to a stream. Avoidance of, or setbacks from, streams within the Planning Area under continuation of existing NSO and CSU restrictions would reduce sediment delivery rates because of the intervening distance, intervening plant cover, and (in many areas) relatively flat run-out between the toe of slope and stream channel.

Because of the limited amount of potential oil and gas development and continuation of current management for grazing and OHV travel under Alternative I, impacts to water quality as a result of sedimentation are considered minor overall, compared to existing conditions. However, some more severe (moderate) localized impacts could occur under continuation of existing management, particularly in places where roads or pipelines cross drainages and where concentrated livestock grazing or cross-country OHV travel reduce vegetation cover on adjacent slopes.

Chemical Pollution – Each phase of oil and gas extraction can create wastestreams that, if not handled correctly, could degrade surface and ground water quality. Table 4-4 describes typical wastestreams. The severity of the effects may be highly variable, depending on the content of the waste-stream, amount and location of discharge, geologic formation and permeability of soils, and climatic conditions.

Table 4-4. Potential Wastestream Outputs from Oil and Gas Extraction Processes

Well Development	Drilling muds, organic acids, diesel oil, crankcase oils, and acidic stimulation fluids (hydrochloric and hydrofluoric acids)
Production	Heavy metals, dissolved solids, organic compounds, and high levels of salt. May also contain additives including biocides, lubricants, and corrosion inhibitors.
Maintenance	Completion fluid, well-cleaning solvents, paint, and stimulation agents. The volume of associated wastes (wastes related to maintenance) is typically very small, about one barrel per well per year.

Source: Profile of the Oil and Gas Extraction Industry (EPA 2000)

The primary wastestreams from oil and gas extraction are typically those associated with drilling wastes and produced water. During drilling, as much as 0.06 to 0.14 barrels of drill cuttings are produced for each vertical foot drilled, based on a 7.875-inch gauge bore and 12-inch washout. The drilling mud may contain bentonite clay and various contaminants (see Section 3.5.12).

Drill cuttings, including rock fragments and unsalvaged mud, typically are not removed from

the site. Up to 100 cubic yards of cuttings (for an 8,000-foot deep well and a 7.875-inch gauge bore) may be left at each drill pad per well drilled. The mud pits are typically unlined, 8 to 10 feet deep, and backfilled with the excavated soil and subsoil material after drilling is completed. Drilling mud may be reconditioned and reused. Drilling mud is typically monitored continuously (24 hours a day) during drilling operations to avoid accidental release from a site. In the event of an inadvertent discharge, its high viscosity would limit the rate of overland flow, allowing it to be contained before reaching a stream (in combination with the setback distances from streams of at least 200 meters).

According to a recent study by the EPA (2000), the primary byproduct of the production phase, and of the industry, is produced water. While disposal of produced water by underground injection is common in some regions, it is not common in the Roan Plateau area, and BLM has not approved any injection wells in the Planning Area. Use of pits or ponds to dispose of produced water by evaporation (and to a lesser extent infiltration into the soil) is also common in some areas but less so in the Planning Area. Alternative I (and the other alternatives) would specify that any drilling atop the plateau be a self-contained operation in which produced water is trucked offsite for disposal.

Table 3-33 (Section 3.5.12) summarizes the chemistry of produced water from the Black Mountain brine disposal facility in Colorado. While the data from this facility may differ slightly from the chemistry of evaporation ponds at oil and gas development sites in the Planning Area, they provide a basis for analyzing the potential impacts of disposal of contaminated produced water. At this facility, sodium, chloride, dissolved solids, iron, manganese, benzene, and toluene exceeded Colorado's Maximum Contamination Levels (MCLs) for drinking water and groundwater by a factor of 10 or more. The reported analyte concentrations presented in Table 3-33 are conservative in relation to actual produced waters at the well sites because of concentration associated with evaporation. According to Williams Production, the largest producer of oil and gas in the Planning Area, approximately 4 barrels of water are produced per well each day (Cesark 2003).

Potential regulated releases could occur from tanker trucks, onsite tanks, or evaporation ponds. The size of potential spills can vary. The average condensate tank capacity is typically 300 barrels per wellhead, and produced-water storage tanks are generally between 200 and 300 barrels per wellhead. Transport trucks range in capacity from 60 to 120 barrels. Produced water typically contains about 10 percent condensate. The tankers and/or ponds can contain more than 25 gallons of natural gas condensate at any given time. BLM requires reporting of brine releases that exceed 100 barrels.

Discharge or seepage of drilling mud or produced water, if not handled correctly, could have localized major direct impacts to surface water. The effects are highly dependent on the level of contamination, the method of disposal, and the amount disposed. However, drilling permits require operators to ensure that exploration and production waste is properly stored, handled, transported, treated, recycled, or disposed to prevent significant environmental impacts to water resources. These requirements aim to minimize or eliminate adverse impacts associated with oil and gas extraction processes.

Although the potential for new oil and gas development would be limited under Alternative I, adverse impacts to water quality could occur as a result of accidental discharges, leaks, or spills at development sites. In the case of small or one-time discharges of contaminated drilling mud or produced water, direct impacts to water quality are considered minor because effects are temporary and limited to the immediate area. However, the impacts could be major for a specific resource in a specific area. For example, a sudden accidental release from a tanker trunk — e.g., from tipping over and rupturing at a stream crossing — would cause major impacts to water quality at the site and for some distance downstream. In the small streams that characterize most of the Planning Area, a spill of up to 120 barrels of brine or other pollutant (e.g., fuel) could kill most or all of the aquatic biota, and some of the adjacent riparian

vegetation, along whatever downstream distance would be required for dilution below toxic levels. A requirement for culverted road crossings of streams, as specified for reducing stream erosion and protecting aquatic and riparian vegetation and wildlife, would probably reduce the potential for truck accidents at stream crossings, which often require a relatively steep descent to, and departure from, the crossing point. Standard operating procedures for these incidents are summarized in Section 3.5.12.

Overall, adverse impacts on surface water quality under Alternative I are expected to be negligible, assuming that the recommended mitigation measures are applied. However, more severe (minor) localized impacts could occur.

Onsite Impacts on Water Quantity

Water yield is dependent on both natural factors and land management. Natural factors include climate, geology and soils, slope, channel conditions, and vegetation type and density. Land use or management activities that result in alteration of these natural factors plays a role in altering water yield, including grading or compaction of soils for new roads or well pads, and management prescriptions that alter the type or density of vegetation.

Reductions in water flow can have adverse impacts on the ecology of a watershed, recreational potential, the availability of drinking water and water for other uses, and groundwater quality and quantity (EPA 1999). Discernible reductions in flow associated with oil and gas development are not anticipated because of a planned LN (lease notice) requiring that all water used for drilling or other purposes (e.g., dust suppression on roads) be trucked in from outside the drainage basins of the Planning Area.

Some minor additional water development for grazing or wildlife enhancement is possible, but the amount of any related depletions due to increased evaporative loss from stockponds or "guzzlers" would be trivial at the scale of the Planning Area. Additionally, successful enhancement of areas not meeting land health standards due to livestock use could decrease runoff due to increased vegetation cover. However, the result of this impact is generally beneficial, because contributions of runoff as shallow subsurface flow following infiltration into a vegetated hillside are less "flashy" and more protracted than in poorly vegetated situations, even if actual flow to the stream is reduced. The 1988 GSRA RMP allows for enhancing water yield by vegetation manipulation, which alters the timing, duration, and intensity of runoff. Treatments could include thinning of brush, prescribed fires, and timber harvests.

Changes to water quantity under Alternative I are considered negligible.

4.2.4.2 Alternative II

Alternative II would increase the amount of oil and gas development, with an estimated 905 wells on 310 pads and an associated 1,348 acres of long-term surface disturbance (1.8 percent of BLM lands in the Planning Area). The increased drilling would be associated with new wells on top of the plateau (87, versus 10 under Alternative I). The three areas having wilderness character would be closed to oil and gas leasing under this alternative, and the WSR-eligible streams and other important resource areas would be protected by NGD/NSO stipulations. Other watershed areas would have SSR/CSU stipulations or be designated as special mitigation areas. The special mitigation measures, which would also be applicable in SSR/CSU areas, could include culverting of stream crossings, use of biodegradable erosion mats in areas of disturbed soil, and enhanced revegetation requirements.

No areas would remain open to cross-country travel, and 86 miles of existing routes would be closed to all motorized or mechanized travel or limited to administrative use. Administrative measures such as stock level adjustments, pasture exclusions, and reduced utilization rates would be used to improve areas not currently meeting land health standards.

Onsite Impacts on Water Quality

Designating East Fork Parachute Creek and Trapper/Northwater Creek ACECs under this alternative would benefit water quality by protecting watershed function and condition in these ecologically, visually, and recreationally important areas. The establishment of NGD/NSO stipulations for WSR-eligible streams and the no-lease designation for areas having wilderness character would further protect the important streams and associated basins atop the plateau. Because these designations and protections are beyond the current levels of protection, Alternative II would have beneficial impacts on water quality.

Sedimentation — Alternative II establishes extensive NGD/NSOs and special mitigation areas to protect the watersheds and associated resources for physical disturbance of stream channels and transport of eroded soils from adjacent slopes. Alternative II also restricts OHV use to designated routes, thereby causing less direct disturbance to soils and damage to vegetation cover during cross-country travel, and includes measures to improve range condition.

Impacts to water quality as a result of sedimentation under Alternative II are considered minor overall due to a combination of the factors described above, mitigation measures to be required throughout the area atop the plateau (e.g., use of culverts for all stream crossings), and supplemental mitigation requirements that may be applied in SSR/CSU and special management areas (e.g., the entire top of the plateau is in a WMA to protect the watersheds for direct and indirectd impacts). Examples of supplemental mitigation measures include use of a biodegradable erosion mat to stabilize disturbed soil and requirements for enhanced revegetation. Thus, while some localized sedimentation impacts could occur, these are expected to be less than under current management (Alternative I).

Chemical Pollution — Additional oil and gas development would increase the likelihood of spills or discharges of contaminated drilling mud, produced water, or other pollutants by approximately 6 percent (based on the number of wells under Alternative II versus Alternative I), although the impacts from such an occurrence would remain the same as under Alternative I. An exception to this generalization is for activities on top of the plateau. Because of the ecological and visual/recreational importance of these streams (many segments of which support genetically pure populations of the Colorado River cutthroat trout), consequences of a spill or other release, such as from a ruptured tanker truck, could be locally catastrophic until remedial measures are implemented and have sufficient time to become effective (e.g., removing contaminated sediment, replanting damaged vegetation, restocking trout killed by physical or chemical trauma).

As in Alternative I, the potential for contamination of usable groundwater zones from oil and gas drilling on BLM lands is considered to be negligible due to the requirement that operators isolate and protect usable water zones, the relatively few domestic water wells on or near public lands, and the limited water-bearing zones below the rim (TRW 1982, BLM 1998b). Groundwater atop the plateau is more abundant but has not been significantly developed for domestic uses due to its depth and the lack of permanent residents.

Overall, adverse impacts on water quality are expected to be negligible, assuming that the recommended mitigation measures are applied. However, more severe (minor) localized impacts could occur.

Onsite Impacts on Water Quantity

Protective measures to be established under this alternative — including extensive areas of NGD/NSOs, SSR/CSUs, and special mitigation requirements — would generally protect water yield as well as water quality. The restriction against using water collected onsite for drilling operations or dust suppression on roads would also be applied under this alternative.

As described for Alternative I, successful enhancement of areas degraded by livestock use

could decrease runoff due to increased vegetation cover. However, the result of this impact is generally beneficial, because contributions of runoff as shallow subsurface flow following infiltration into a vegetated hillside occur more gradually and are more protracted, even if actual flow to the stream is reduced. Although minor additional stockponds or water sources for wildlife are possible as management tools, the overall impact of these measures on water quantity would be negligible.

Although Alternative II would result in more oil and gas development atop the plateau than Alternative I, the increase in amount of long-term barren areas associated with roads and well pads would represent only 0.7 percent of the upper area. Therefore, impacts to water quantity are considered negligible under this alternative.

4.2.4.3 Alternative III – Preferred Alternative

Alternative III would allow a higher level of oil and gas development than either Alternatives I or II, with an estimated 1,324 new wells on 402 new pads and an associated 1,761 acres of long-term surface disturbance (2.4 percent of BLM lands in the Planning Area). Of the new wells, 51 would be on top of the plateau. WSR-eligible streams would continue to have NGD/NSO stipulations, but other stream segments and portions of the watershed would have more limited amounts of SSR/CSUs and special mitigation protection. However, special mitigation and other management prescriptions related to protection of streams would be applied throughout the Trapper/Northwater Creek WMA (see Table 2-3).

No areas would be open to cross-country travel, and 50 miles of existing routes would be closed or restricted to administrative use. Livestock management would use a combination of administrative and more active range management tools to reduce grazing impacts and help meet land health standards.

Onsite Impacts on Water Quality

Designating the East Fork Parachute Creek and Trapper/Northwater Creek ACECs under this alternative, including the Trapper/Northwater Creek WMA, would benefit water quality by reducing the potential for adverse impacts in these ecologically, visually, and recreationally important areas. Retention of the WSR-eligible stream segments would also benefit water quality in these stream segments and downstream reaches. .

Sedimentation — Impacts of sedimentation in surface waters as a result of soil erosion are expected to be minor under Alternative III due to the extensive NGD/NSO, SSR/CSU, and special mitigation areas — including the Trapper/Northwater Creek WMA — to protect area streams from ground-disturbing activities and transport of eroded soil. Some localized more severe (moderate) impacts could occur during episodes of severe runoff.

Cross-country OHV travel throuthgout the Planning Area (except for snowmobiles) and active range management measures to improve areas degraded by livestock would help redcue sediment transport associated with these recreation and grazing.

Impacts to water quality as a result of sedimentation under Alternative III are considered minor overall due to a combination of the factors described above, mitigation measures to be required throughout the area atop the plateau (e.g., use of culverts for all stream crossings), and supplemental mitigation requirements that may be applied in SSR/CSU and special management areas (e.g., the WMA). Examples of supplemental mitigation measures include use of a biodegradable erosion mat to stabilize disturbed soil and requirements for enhanced revegetation. Thus, while some localized sedimentation impacts could occur, these are expected to be less than under current management (Alternative I).

Chemical Pollution — Additional oil and gas development would increase the potential for accidental spills or other discharges of contaminated drilling mud or produced water over time, but the impacts from such an occurrence would remain the same as under Alternatives I and II. With 55 percent more wells than Alternative I, the potential for a pollutant spill would increase proportionately but remain low.

In the case of small or one-time discharges of contaminated drilling mud, produced water, or other pollutants, direct adverse impacts are considered minor overall. However, as described for Alternative II, impacts of a catastrophic release such as spillage of a tanker truckload into a sensitive stream segment could be major for localized resources. Potentially affected resources could include the Colorado River cutthroat trout and other sensitive aquatic or terrestrial receptors exposed to the water. Impacts could extend a considerable distance downstream, depending on the volume and rate of pollutant release, the volume and flow velocity of the receiving water, and the toxicity and dispersal behavior of the specific pollutant (highly viscous mud versus soluble contaminants versus an immiscible surface sheen resulting from the inability of oil and water to mix).

As in Alternatives I and II, the potential for contamination of usable groundwater zones from oil and gas operations is negligible. This conclusion is based on the requirement that operators isolate and protect usable water zones, the relatively few domestic water wells on or near public lands, and the limited amount of water-bearing zones on public lands below the rim (TRW 1982, BLM 1998b). Although four significant water-bearing zones occur on top of the plateau, these have not been developed for domestic use due to their depth and the lack of permanent residents.

Onsite Impacts on Water Quantity

Under Alternative III, no areas would be closed to oil and gas leasing. However, previously described stipulations and mitigation measures would specifically address protection of aquatic and riparian resources, including large portions of watersheds. These measures would tend to reduce impacts to water quantity as well as to water quality.

Although the greater amount of long-term barren area associated with the road and well pad construction under this alternative would tend to increase runoff and hence water yield, any increases are likely to be imperceptible due to the required setback distance from streams. Furthermore, the amount of long-term surface disturbance represents only 2.4 percent of BLM lands in the Planning Area, of which 1.6 percent would also occur under Alternative I. Overall, therefore, impacts to water quantity under Alternative III are considered negligible.

The deferral of leasing and drilling for oil and gas on top of the plateau under Alternative III would not affect water resources, except to the degree that it affects the location of wells and other facilities during the 20-year period of analysis. For the purposes of this RMPA/EIS, it is assumed that the total number of wells would not be affected.

4.2.4.4 Alternative IV

Alternative IV would allow a higher level of oil and gas development than either Alternatives I or II, with an estimated 1,324 new wells on 449 new pads and an associated 1,940 acres of long-term surface disturbance (2.6 percent of BLM lands in the Planning Area). Of the new wells, 168 would be on top of the plateau. WSR-eligible streams would continue to have NGD/NSO stipulations, but other stream segments and portions of the watershed would have a more limited area of SSR/CSUs protection. However, special mitigation and other management prescriptions related to protection of streams could be applied throughout the Trapper/Northwater Creek WMA (see Table 2-3).

No areas would be open to cross-country travel, and 50 miles of existing routes would be closed or restricted to administrative use. Livestock management would use a combination of

administrative and more active range management tools to reduce grazing impacts and help meet land health standards.

Onsite Impacts on Water Quality

Designating the East Fork Parachute Creek and Trapper/Northwater Creek ACECs under this alternative, including the Trapper/Northwater Creek WMA, would benefit water quality by reducing the potential for adverse impacts in these ecologically, visually, and recreationally important areas. Retention of the WSR-eligible stream segments would also benefit water quality in these stream segments and downstream reaches. .

Sedimentation — Impacts of sedimentation in surface waters as a result of soil erosion is expected to be minor under Alternative IV due to the extensive NGD/NSO, SSR/CSU, and special mitigation designations — including the Trapper/Northwater Creek WMA — to protect area streams from ground-disturbing activities and transport of eroded soil. However, some localized more severe (moderate) impacts could occur during episodes of severe runoff.

Cross-country OHV travel would be restricted to the Hubbard Mesa area, and active range management measures would be implemented to improve areas degraded by livestock.

Impacts to water quality as a result of sedimentation under Alternative III are considered minor overall due to a combination of the factors described above, mitigation measures to be required throughout the area atop the plateau (e.g., use of culverts for all stream crossings), and supplemental mitigation requirements that may be applied in SSR/CSU and special management areas (e.g., the WSR areas). Examples of supplemental mitigation measures include use of a biodegradable erosion mat to stabilize disturbed soil and requirements for enhanced revegetation. Thus, while some localized sedimentation impacts could occur, these are expected to be less than under current management (Alternative I).

Chemical Pollution — Additional oil and gas development would increase the potential for accidental spills or other discharges of contaminated drilling mud or produced water over time, but the impacts from such an occurrence would remain the same as under Alternatives I through III. With 55 percent more wells than Alternative I, the potential for a pollutant spill would increase proportionately but remain low.

In the case of small or one-time discharges of contaminated drilling mud, produced water, or other pollutants, direct adverse impacts are considered minor overall. However, as described for Alternatives II and III, impacts of a catastrophic release such as spillage of a tanker truckload into a sensitive stream segment could be major for localized resources. Potentially affected resources could include the Colorado River cutthroat trout and other sensitive aquatic or terrestrial receptors exposed to the water. Impacts could extend a considerable distance downstream, depending on the volume and rate of pollutant release, the volume and flow velocity of the receiving water, and the toxicity and dispersal behavior of the specific pollutant (highly viscous mud versus soluble contaminants versus an immiscible surface sheen).

As in the previous alternatives, the potential for contamination of usable groundwater zones from oil and gas operations is negligible. This conclusion is based on the requirement that operators isolate and protect usable water zones, the relatively few domestic water wells on or near public lands, and the limited amount of water-bearing zones on public lands below the rim (TRW 1982, BLM 1998b). Although four significant water-bearing zones occur on top of the plateau, these have not been developed for domestic use due to their depth and the lack of permanent residents.

Onsite Impacts on Water Quantity

Under Alternative IV, no areas would be closed to oil and gas leasing. However, previously described stipulations and mitigation measures would specifically address protection of aquatic

and riparian resources, including large portions of watersheds. These measures would tend to reduce impacts to water quantity as well as to water quality.

Although the greater amount of long-term barren area associated with the road and well pad construction under this alternative would tend to increase runoff and hence water yield, any increases are likely to be imperceptible due to the required setback distances from streams. Furthermore, the amount of long-term surface disturbance represents only 2.6 percent of BLM lands in the Planning Area, of which 1.6 percent would also occur under Alternative I. Overall, therefore, impacts to water quantity under Alternative IV are considered negligible.

4.2.4.5 Alternative V

Alternative V would allow the highest degree of oil and gas development of the five alternatives analyzed, with an estimated 1,582 wells on 584 pads and 2,495 acres of long-term surface disturbance (3.4 percent of BLM lands the Planning Area). Of this total, 234 wells would be on top of the plateau. No special resource use or management designations focused on protecting water resources or associated values are included, except for an NGD/NSO stipulation for stream segments designated as WSR-eligible under Alternatives II through IV (but without the actual designation) and some areas of SSR/CSU on lower sideslopes along these and other stream segments.

OHV travel would be limited to designated routes throughout the Planning Area, but no existing routes would be closed. Livestock management would emphasize land treatments and rangeland management to improve areas degraded by grazing.

Onsite Impacts on Water Quality

The reduced level of protection for streams and watersheds compared to Alternatives II through IV would be expected to increase the potential for adverse impacts on water quality. However, the retained stipulations are sufficient to protect most of the significant streams from impacts associated with ground-disturbing activities on adjacent hillsides of the watershed. Use of some of the key mitigation measures proposed for Alternatives II through IV (including a requirement for culverted road crossings and use of a biodegradable erosion mat and enhanced revegetation in areas of erodible soil) would further reduce the impact potential.

Chemical Pollution — Because of the higher degree of oil and gas development, this alternative would increase the potential for an accidental spill or other discharge of contaminated drilling mud, produced water, or other pollutant. Based on the number of anticipated wells, the risk of a pollutant release is approximately 85 percent greater than for Alternative I, although still low. Actual impacts from such an occurrence remain the same for the other alternatives.

While overall impacts from a small or one-time discharge of a chemical pollutant would be negligible, the localized impacts at and downstream from the discharge could be major, depending on the chemical's volume, release rate, toxicity, and dispersal characteristics and the volume and velocity, channel morphology, and other characteristics of the receiving stream. Requiring a culvert at all stream crossing points would reduce this hazard by creating a safer condition for trucks.

As in the previous alternatives, the potential for contamination of usable groundwater zones from oil and gas development is negligible based on the requirement that operators isolate and protect usable water zones, the relatively few domestic water wells on or near public lands, and the limited amount of water-bearing zones on public lands below the rim (TRW 1982, BLM 1998b). While water-bearing zones are present on top of the plateau, they have not been developed due to their depth and the lack of permanent residents.

Sedimentation — The combination of increased roads and access to the Planning Area, increased population and the resulting increase in off-road recreation, and the significant increase in long-term disturbed areas is likely to have observable, direct, and adverse impacts on sediment

delivered to surface streams under this alternative.

Offsetting this to some extent is the more aggressive range improvement under Alternative V and the restriction of OHV travel to designated routes throughout the Planning Area. Nonetheless, the smaller areas of NGD/NSO and SSR/CSU stipulations and other special resource management designations and the increased area of long-term disturbance are expected to result in moderate impacts from sedimentation rather than minor impacts as under the previous alternatives discussed. More severe (major) localized impacts could also occur, with potentially more such events due to the greater amount of oil and gas development.

Onsite Impacts on Water Quantity

Under Alternative V, no lands would be closed to oil and gas leasing. NGD/NSO and SSR/CSU stipulations would be applied to smaller areas than under the other alternatives, and no areas would be designated for special management. However, management objectives for this and the other alternatives include a provision for BLM to meet all land health standards. This includes a requirement that all water bodies achieve the quality standards set by the State of Colorado.

While this standard does not address water quantity specifically, management activities to reduce sedimentation and maintain healthy vegetation and/or riparian habitat to help meet this goal will indirectly aid in maintaining water yield. Areas of good vegetation cover are typically characterized by retardation of overland flow and infiltration of precipitation, resulting in a more protracted surface and subsurface contribution to streams than the flashy runoff of more barren areas. Although the greater amount of long-term barren area associated with the road and well pad construction under this alternative would tend to increase runoff and hence water yield, any increases are likely to be imperceptible due to the required setback distance from streams and the fact that the long-term disturbance represents only 3.4 percent of BLM lands in the Planning Area (of which 1.6 percent would also occur under Alternative I).

Based on these considerations, and assuming that the mitigation measures precluding use of onsite surface water for drilling or dust suppression purposes, impacts to water quantity under this alternative are considered negligible.

4.2.4.6 Indirect, Offsite, and Cumulative Impacts

Indirect Impacts

Indirect impacts on water resources include changes in channel morphology and stability. Land-use changes may increase runoff by decreasing infiltration and evapotranspiration (e.g., due to reduction in vegetation cover) and increasing the amount of impermeable surface (roads, structures, compacted soil). Generally, channel area increases to accommodate the increased discharge would lead to channel deepening, widening, or both. Large quantities of sediment introduced directly to the channel or riparian zone can aggrade channels, fill pools, and choke channel substrates with fine sediment.

None of the anticipated land uses or management activities under the five alternatives is expected to reduce water quantity, particularly in light of restrictions against using water collected onsite for dust suppression or other applications in oil and gas development. As described previously, oil and gas activities throughout BLM portions of the Planning Area would operate as self-contained operations that use offsite water rather than onsite surface water or shallow groundwater. Some additional stockponds could be built under any of the alternatives, but the amount of depletion from evaporation or consumption by livestock or wildlife would probably be negligible on a sitewide scale. Consequently, reduced flows probably would not occur, thereby avoiding the potential for increased concentrations of suspended solids, dissolved solids, and metals or other chemical constituents that affect water quality.

Under Alternative I, present land management activities would mostly be retained. However, increased use of the Planning Area for a variety of purposes that may have indirect impacts on streams, including OHV travel, has the potential to increase surface runoff and sediment delivery rates without the benefit of some of the protective stipulations and mitigation measures under Alternatives II through V. Therefore, minor indirect impacts to stream channels would be likely even for the No Action alternative.

Under Alternatives II through V, surface runoff and sediment delivery to streams would be addressed by a variety of NGD, SSR, restrictions on cross-country recreational travel, and (in some areas) special mitigation and range improvement measures. Therefore, likely indirect impacts to stream channels under these alternatives are considered negligible or, if minor, less than for Alternative I.

Under Alternative V, reduced no-lease areas, reduced extent of NGD/NSO and SSR/CSU stipulations, and no special management designations, combined with the larger area of long-term surface disturbance, create increased potential for indirect impacts to streams, especially in areas of currently unstable channels. However, proper placement of well pads, roads, and pipelines, and satisfactory implementation of measures to stabilize and revegetate areas of temporary disturbance are expected to keep indirect impacts to streams at a minor level.

Offsite Impacts

Offsite impacts to water resources include transport of sediments or contaminants through surface runoff or stream flow to downgradient receptors, including Parachute Creek and the Colorado River. The impact of sediments and chemical pollutants in offsite streams, lakes, or ponds from land use and management activities in the Planning Area is expected to be negligible compared to the various land uses and management actions in the offsite areas. The exception to this generalization would be if a chemical pollutant were discharged in sufficient quantities to be transported to offsite waters at concentrations that adversely affect water quality for aquatic life, livestock watering, recreation, or other uses.

Cumulative Impacts

Cumulative impacts include impacts from other projects occurring onsite or offsite that, when combined with impacts from activities regulated by BLM in the Planning Area, represent a different level of impact than indicated by only the site-specific analysis. Regarding water resources, cumulative effects include urbanization of private lands in and near the Planning Area. Urbanization typically increases impervious surfaces, thereby increasing surface runoff and potentially increasing sediments and contaminants in local surface waters. Urbanization of private land is anticipated to continue at current rates and has the potential to disturb larger areas than the projected oil and gas development.

4.2.5 Climate and Air Quality

Introduction

The burning of fossil fuels (natural gas, crude oil, coal, etc.) produces various emissions, including so-called greenhouse gases (GHGs). These GHGs (primarily carbon dioxide, CO_2) are widely believed to cause global warming but, at a minimum, contribute to air pollution. The continued or increased production and combustion of natural gas from resources underlying the Planning Area, which would occur under any of the five alternatives, would produce GHGs. However, the amount of GHGs potentially produced from Planning Area resources is an extremely small fraction of global emissions and lower than it would be if other fuels (coal, oil, etc.) were being used instead. Therefore, no significant adverse impacts to climate are anticipated from implementation of any of the alternatives, because they would not add to the demand or consumption of fossil fuels.

This section of the RMPA/EIS is predicated on conservative assumptions and information available at the time of the analysis. Additional

information, including comments from the public, may result in changes in the analysis presented in the Final RMPA/EIS. Where specific data or procedures were not available, appropriate assumptions were incorporated. For example, the far-field ("regional") air quality impact assessment of Alternative V assumed that an additional 3,055 wells would go into production (no "dry holes") within 20 years, then operate at full production (no "shut-ins").

Potential air quality impacts were analyzed to determine maximum near-field ("local") ambient air pollutant concentrations and hazardous air pollutant impacts, as well as to determine maximum far-field impacts on ambient air pollutant concentrations, visibility, and atmospheric deposition (acid rain).

Air pollution impacts are limited by State and Federal regulations, standards, and implementation plans established under the Clean Air Act and administered by CDPHE-APCD. Colorado regulations require that proposed air pollutant emission sources — including dehydrators, separators, and natural gas compressors — undergo a permitting review. Therefore, CDPHE-APCD has the authority to review emission permit applications and to require emission permits, fees, and control devices prior to construction and/or operation. In addition, Section 116 of the Clean Air Act authorizes Tribal, State, and local air quality regulatory agencies to establish air pollution control requirements more (but not less) stringent than Federal requirements. Additional site-specific air quality analysis would be performed, and additional emission control measures, including Best Available Control Technology (BACT), may be required to protect air quality resources.

Under FLPMA and the Clean Air Act, BLM cannot conduct or authorize any activity that does not conform to all applicable Federal, Tribal, State, and local air quality laws, statutes, regulations, standards, and implementation plans. An extensive Air Quality Impact Assessment was prepared to analyze the potential impacts and is available for review (Trinity 2004).

Finally, a word regarding dispersion modeling analyses and their use in planning and decision-making: All dispersion models, regardless of their level of complexity, are mathematical approximations (based largely on fluid dynamics) of the behavior of the atmosphere. Therefore, particularly given the uncertain nature of the number and placement of sources under the five alternatives used in this analysis, the results need to be viewed appropriately as estimates of possible future concentrations and not exact predictions in time and space.

Because of this, dispersion modeling is generally conducted conservatively to ensure that the modeled results do not underestimate actual future impacts so that appropriate planning decisions can be made. For example, sources may be assumed to operate for longer periods or emit more pollutants than actual conditions to ensure that health-based standards are protected. On the other hand, analyses are not conducted assuming "worst-case" conditions across the board, because this typically leads to unreasonable results — i.e., beyond conservative to a level that is unrealistic. Hence, dispersion modeling uses the best available information and methods (EPA-approved models, emission factors, etc.) when possible, and the best scientific and professional judgment in attempting to ensure that projections of future air quality are neither under-predicted nor unrealistically over-predicted.

Impacts Common to All Alternatives (Near-Field Analysis)

Results of the near-field air quality analysis are presented in the following section. A more detailed description of the near-field modeling methodology and results is presented in the Air Quality Technical Support Document (TSD) (Trinity 2004). Individual tables showing results for each year and pollutant, including the location of each maximum impact, are provided in Appendix E of the TSD (Trinity 2004). Plots showing the location of each maximum impact and the wind roses for each year of meteorological data for both stations are provided in Figures A-34 through A-85 of Appendix A of the TSD (Trinity 2004). The

input and output files for the post-processing are provided on CD in Appendix F of the TSD (Trinity 2004).

A separate screening model analysis was conducted to estimate potential impacts from flaring associated with natural gas production. This is presented at the end of this section.

Modeling Methodology. The following describes the methodology used for conducting the near-field dispersion modeling for the Planning Area air quality analysis, as performed by the BLM's National Science and Technology Center. The near-field modeling methodology generally follows that used in a previous modeling analysis for the Glenwood Springs area performed by the National Park Service (NPS 1998). Trinity Consultants, the primary modeling contractor for the far-field analysis, was also consulted to ensure that, where applicable, the two methodologies (near-field and far-field) were consistent. Finally, further details were developed in response to comments from EPA Region 8 (EPA 2003b) on Trinity's protocol for far-field modeling (Trinity 2003b) and subsequent meetings with EPA's NEPA and Air Quality staffs.

The ISCST3 model, as contained in Lakes Environmental ISC-AERMOD View software (Lakes 2002) package, was used for all near-field modeling. Unless stated otherwise, the regulatory default options built into the model were used. All modeling assumed flat terrain, rural dispersion conditions, and building down-wash effects for a hypothetical compressor building.

The near-field modeling was performed in flat terrain because the exact location of any group of wells, as modeled here, is unknown. It would not be possible to conduct this type of modeling exercise with a hypothetical arrangement of sources in complex (mountainous) terrain, because the choice of terrain features would be completely arbitrary. While placing the arrangement of modeled sources in a complex terrain environment might produce higher resultant concentrations, the results of such an effort would be of little value due to the sensitivity of the model to the location and orientation of the terrain selected.

A hypothetical grouping of sources was used that provides an estimate of potential near-field pollutant impacts. These sources include well pads, glycol dehydrators, natural gas compressors, and an unpaved road traversing the source area. Details of the source types and configurations are discussed in Section 3.11 of the TSD (Trinity 2004). Appropriate operating parameters were used for each source, and were in all cases, unless otherwise stated, the same as those used in the CALPUFF modeling performed by Trinity.

Only the following sources were included in the near-field modeling (inventory and RFD sources are not included in the near-field analysis):

- 25 well pads arranged in a 5 x 5 matrix, with 300-meter spacing between the centers of adjacent pads, which is approximately equivalent to a 20-acre well spacing with 1.9 acres disturbed per pad.
- A glycol dehydrator collocated at the center of each well pad.
- A total of six natural gas compressors, modeled as point sources, equally spaced within the 5 x 5 well matrix.
- An unpaved road (approximately 1,700 meters long) diagonally traversing the source area.

Meteorological data for the period 1987-1991 from Grand Junction, Colorado, were used in the modeling. The raw surface and upper air data were processed using the EPA-approved PCRAMMET meteorological processing software to combine the surface and upper-air data into a model-ready format.

Wind roses for the 5-year period from each location are presented in the TSD. Individual wind roses for each year can be seen in Appendix A of the TSD (Trinity 2004).

Model receptors (points at which the model estimates concentrations) were placed according to the scheme outlined in Table 4-5 below. This

receptor spacing differs somewhat from that used in the 1998 Glenwood Springs analysis, but in all cases the changes meant including more receptors and/or closer spacing to ensure that the maximum modeled concentration was captured and occurred within the receptor domain. A graphic representation of the source configurations and model receptors is presented in Figures 3-1 and 3-2 of the TSD.

Table 4-5. Receptor Spacing for Near-Field Modeling

Pollutant(s)	Source Type(s)	Receptor Ranges (m)	Receptor Spacing (m)
PM_{10}, $PM_{2.5}$	Roads	50 – 1, 500	50
	Pad Construction	50 – 1,700	50
All other Criteria Pollutants	Pad Construction	100 – 4,000	100
	Compressors, and Glycol Dehydrators	4,000 – 10,000	2,000
Hazardous Air Pollutants (HAPs)	Compressors	100 – 4,000	100
	Glycol Dehydrators	4,000 – 10,000	2,000

Criteria Pollutants. The following paragraphs present the results of the ISCST3 near-field modeling for Glenwood Springs.

Carbon Monoxide (CO). Maximum potential CO emissions from natural gas-fired compressors (units were assumed to run 8,760 hours without stopping) were used to determine the maximum potential 1-hour and 8-hour average CO concentrations. The maximum modeled concentrations were 32.5 $\mu g/m^3$ (1-hour) and 11.8 $\mu g/m^3$ (8-hour).

When background concentrations were added (8,000 $\mu g/m^3$ [1-hour]; 4,444 $\mu g/m^3$ [1-hour]), the total concentrations were 8,032 $\mu g/m^3$ (1-hour) and 4,456 $\mu g/m^3$ (8-hour). These concentrations are well below the applicable Colorado and National AAQS for CO of 40,000 $\mu g/m^3$ (1-hour) and 10,000 $\mu g/m^3$ (8-hour).

Particulate Matter. To address the concerns of some stakeholders and cooperating agencies, the modeling analysis for particulate matter (PM_{10} and $PM_{2.5}$) was divided into two parts: (1) analysis of a hypothetical road diagonally crossing the area of the well pads by itself; and (2) analysis of all particulate matter sources grouped together. It should be noted that different receptor configurations were used for the two analyses (Trinity 2004) and that all particulate matter sources were modeled with emissions limited to the hours from 0700 to 1900, the period when these sources are generally active. Also, since most of these sources are temporary in nature, PSD increments would not apply.

- **PM_{10}** – For the road-only analysis, the maximum modeled potential PM_{10} concentrations were 11.0 $\mu g/m^3$ (24-hour) and 1.9 $\mu g/m^3$ (annual). When background concentrations were added (54 $\mu g/m^3$ [24-hour]; 24 $\mu g/m^3$ [annual]), the total concentrations were 65 $\mu g/m^3$ for the 24-hour average and 26 $\mu g/m^3$ for the annual average. These concentrations are well below the applicable Colorado and National AAQS of 150 $\mu g/m^3$ (24-hour) and 50 $\mu g/m^3$ (annual).

  For all sources (well pads [construction, traffic], compressors, roads), the maximum modeled potential PM_{10} concentrations were 7.2 $\mu g/m^3$ (24-hour) and 0.8 $\mu g/m^3$ (annual). When background concentrations were added (54 $\mu g/m^3$ [24-hour]; 24 $\mu g/m^3$ [annual]), the total concentrations were 61 $\mu g/m^3$ for the 24-hour average and 25 $\mu g/m^3$ for the annual average. These concentrations are well below the applicable Colorado and National AAQS of 150 $\mu g/m^3$ (24-hour) and 50 $\mu g/m^3$ (annual).

- **$PM_{2.5}$** – For the road-only analysis, the maximum modeled potential $PM_{2.5}$ concentrations were 1.7 µg/m^3 (24-hour) and 0.29 µg/m^3 (annual). When background concentrations were added (19 µg/m^3 [24-hour]; 7 µg/m^3 [annual]), the total concentrations were 21 µg/m^3 for the 24-hour average and 7.3 µg/m^3 for the annual average. These concentrations are well below the proposed National AAQS for $PM_{2.5}$ of 65 µg/m^3 (24-hour) and 15 µg/m^3 (annual).

  For all sources (well pads [construction, traffic], compressors, road), the maximum modeled potential $PM_{2.5}$ concentrations were 1.1 µg/m^3 (24-hour) and 0.13 µg/m^3 (annual). When background concentrations were added (19 µg/m^3 [24-hour]; 7 µg/m^3 [annual]), the total concentrations were 20 µg/m^3 for the 24-hour average and 7.1 µg/m^3 for the annual average. These concentrations are well below the proposed National AAQS of 65 µg/m^3 (24-hour) and 15 µg/m^3 (annual).

Again, it should be noted that the two particulate matter analyses used different receptor configurations due to the arrangement of sources; therefore, the all-sources analysis does not automatically show higher modeled concentrations.

Sulfur Dioxide (SO_2). The maximum short-term (3-hour and 24-hour) and long-term (annual average) SO_2 emissions would occur from compressors used to move the gas through the pipelines (well drilling engines were screened out of the analysis as insignificant). The maximum modeled concentrations (including representative background values) would be 110 µg/m^3 (3-hour), 39 µg/m^3 (24-hour), and 11 µg/m^3 (annual). Therefore, all predicted short-term and long-term SO_2 concentrations comply with the Colorado SO_2 Ambient Air Quality Standards (3-hour) of 700 µg/m^3, as well as the NAAQS of 365 µg/m^3 and 80 µg/m^3 (24-hour and annual average), respectively. The 3-hour State standard is more stringent than the National AAQS.

Nitrogen Oxides (NO_2). Maximum NO_2 impacts during operations were predicted using "reasonably foreseeable" compressor NO_x emission rates. The maximum potential near-field NO_2 concentrations were determined by multiplying maximum NO_x concentrations by 0.75, in accordance with standard EPA methodology (EPA 1995a). The maximum predicted annual potential NO_2 concentration was 5.4 µg/m^3. When this value is added to the assumed representative background concentration (34 µg/m^3), the resulting predicted maximum total impact is 39.4 µg/m^3, which is also below the applicable Colorado and National AAQS of 100 µg/m^3 (annual).

Hazardous Air Pollutants (HAPs). The following section describes the results of the near-field modeling for hazardous air pollutants. Maximum HAPs impacts during operations were predicted for the hypothetical arrangement of sources as described above. The emissions sources include 6 compressors (benzene, ethylbenzene, formaldehyde, toluene, and xylene) and 25 individual glycol dehydrators (benzene, toluene, ethyl benzene, hydrogen sulfide, and xylene). Since neither Colorado nor EPA has established HAP standards, 24-hour and annual HAP concentrations were predicted using the ISCST3 model and compared to a range of State Acceptable Ambient Concentration Levels and/or EPA Reference Concentrations (RfCs). These thresholds are presented in Table 4-6. The results of the modeling follow the table.

The results of the near-field HAPs modeling show that the annual benzene concentration (12.1 µg/m^3) and the annual formaldehyde concentration (0.086 µg/m^3) exceed the low end of the range of acceptable air concentration limits (AACLs).

Because one or more of the AACLs or reference concentrations (RfCs) were exceeded, an incremental cancer risk analysis was performed for the two carcinogenic compounds emitted from the proposed sources modeled.

Table 4-6. Summary of Hazardous Air Pollutant Levels

Benzene ($\mu g/m^3$)	Ethylbenzene ($\mu g/m^3$)	Formaldehyde ($\mu g/m^3$)	Hydrogen Sulfide ($\mu g/m^3$)	Toluene ($\mu g/m^3$)	Xylenes ($\mu g/m^3$)	Agency
0.12 (annual)	1,000 (24-hour)	0.077 (annual)	0.9 (24-hour)	400 (24-hour)	1,500 (24-hour)	Washington Department of Ecology, WAC 176-460-150
53 (24-hour)	14,467 (24-hour)	-	467 (24-hour)	6,267 (24-hour)	14,467 (24-hour)	Utah DEQ Toxic Screening Level [2]
-	-	-	140 (24-hour)	-	-	North Dakota Department of Health, Division of Environmental Engineering, 33-15-02 or Air Toxics Policy
13 - 45 [3] (annual)	-	8 [3] (annual)	-	-	-	EPA IRIS Database 1/10,000 (1 x 10^{-4}) Risk Level
-	1,000 (24-hour)	-	1.0 (24-hour)	400 (24-hour)	100 (24-hour)	EPA IRIS Database RfC [1]

[1] *EPA's Integrated Risk Information System (IRIS) contains information on reference concentration for chronic inhalation exposure (RfC)(EPA 1997, per Trinity 2003a).*

[2] *The Toxic Screening Level (TSL) for Utah can be found in Utah Administrative Code R307-401(1)(d).*

[3] *The range of values shown here represents the air unit risk of 1 in 10,000 (1 x 10^{-4}) taken from EPA's IRIS database.*

Two estimates of cancer risk were made: one that corresponds to a most likely exposure (MLE) condition, and one reflective of the maximally exposed individual (MEI). The estimated cancer risks were adjusted to account for duration of exposure and time spent at home.

Under the MLE scenario, the estimated individual cancer risks associated with long-term exposure to benzene (compressors, dehydrators) and formaldehyde (dehydrators) are below 1.0 x10^{-4} (2.0 x 10^{-5} to 5.6 x 10^{-6} and 2.4 x 10^{-7}, respectively). Under the MEI analysis, the individual cancer risks for benzene (2.7 x 10^{-5} to 7.6 x 10^{-6}) and formaldehyde (3.4 x 10^{-7}) and the total cancer risk for the inhalation pathway (2.7 x 10^{-5} to 7.9 x 10^{-6}) fall toward the lower end of the threshold range of presumptively acceptable risks of 1.0 x 10^{-6} to 1.0 x 10^{-4} (one excess cancer per 1 million people to one excess cancer per 10,000 people, respectively)(EPA 1998). Therefore, the long-term cancer risk analyses indicate no basis for concern.

It should be noted that the risk calculations are based on the maximum modeled concentration found anywhere in the vicinity of the hypothetical arrangement of sources. These maximum concentrations occurred within a few hundred meters of the edge of the sources and dropped off quickly with increasing distance from the sources. It is unlikely that any individual would be living this close to the sources. Therefore, the risk values calculated above should be viewed as an upper bound on the range of possible risks associated with near-field impacts, with risks to actual residents likely being lower.

Natural Gas Flare. As mentioned above, a separate modeling exercise was conducted for potential natural gas flaring emissions. As suggested at a meeting of the air quality stakeholders for this project (BLM 2003c), the flare modeling was performed with the SCREEN3 model (EPA 1995c). The SCREEN3 model is a simple single-source screening model that assumes a constant wind direction for an entire hour, and reports a 1-hour concentration.

A predetermined matrix of wind speeds and atmospheric stabilities are processed to find the maximum concentration. These results show that all modeled concentrations are well below the National AAQS. Detailed results are presented in the Technical Support Document.

Far-Field Analysis

Results of air quality analysis for each alternative are presented the following sections. Detailed modeling results, including the location and date of each maximum impact, are provided in the TSD (Trinity 2004). Plots showing the receptor grid, terrain, and location of each maximum impact are provided in Figures A-8 through A-29 of Appendix A of the TSD. Output, input, and list files are provided on CD in Appendix F of the TSD.

Modeling Methodology. The following describes the methodology used for conducting the far-field dispersion modeling for the Planning Area air quality analysis, as performed by Trinity Consultants and BLM National Science and Technology Air Quality (NSTC-AQ) staff.

This modeling analysis followed a general modeling procedure used in previous NEPA assessments and Clean Air Act New Source Review (NSR) permit applications and, specifically, the modeling protocol and subsequent addendum developed for this project (Trinity 2003a, b). The CALPUFF model was used to estimate potential impacts on air quality and AQRVs from proposed and other "reasonably foreseeable" sources in the modeling domain. The CALPUFF modeling domain included the entire Vernal Field Office (VFO) and GSFO areas, several mandatory Federal Class I areas, and other sensitive Class II areas specified by BLM and the States. This modeling domain covers most of northeastern Utah and western Colorado and portions of southwestern Wyoming.

The CALPUFF modeling system consists of three main component models:

- CALMET – A meteorological model that develops hourly wind and temperature fields on a three-dimensional modeling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also include in the CALMET output.

- CALPUFF – A transport and dispersion model that moves puffs of emitted material from modeled sources, simulating dispersion and transformation processes along the way. The movement of these puffs is dictated by the meteorological fields generated by CALMET.

- CALPOST – Processes the CALPUFF output files to produce tables that summarize the results. Separate CALPOST runs are needed for individual pollutants and for each AQRV scenario

Outputs from the air quality modeling are used to assess potential impacts on near- and far-field air quality and AQRVs. The following assessments were conducted:

- Prediction of the potential direct and cumulative air quality impacts of emissions from existing and foreseeable oil, gas, and mineral development scenarios (five alternative scenarios).
- Comparison of potential direct and cumulative air quality impacts plus the existing background concentration to the applicable National AAQS and State AAQS that are more stringent.
- Visibility assessment impacts within mandatory Federal Class I areas and specific Class II areas of concern.
- Atmospheric deposition of total sulfur and nitrogen within mandatory Federal Class I areas and specific Class II areas of concern.

For the CALMET inputs, a search of meteorological stations using Trinity's proprietary database showed that 28 surface and 68 precipitation meteorological stations were within the modeling domain or near the domain boundary. From these stations, 14 surface

stations and 38 precipitation stations were selected based on data counts of at least 6,000 and their distance from the RMP areas. Data from four upper air stations were used. These data, combined with MM5 data for 1996, were processed to produce a single year of meteorological data for input to CALPUFF.

To develop the sources to be included in the CALPUFF modeling, Trinity conducted a review of all sources provided in the Utah and Colorado source inventory and all Title V permits available on the UDEQ and CDPHE websites. The review was conducted on a per-pollutant basis since each pollutant had a different monitoring baseline date.

Subsequent to Trinity's review of Colorado State permits, BLM NSTC-AQ staff undertook a review of a small portion (based on a screening procedure developed by NSTC-AQ staff; see Section 3.3.1.3 of the TSD for details) of the approximately 250 inventory sources to determine if all the information provided by the States was correct.

Approximately 10 facilities (26 sources) were selected for detailed review. Approximately 20 sources were removed or had some of their source parameters changed. At the request of CDPHE, the American Soda facility (17 sources) was added.

As discussed in Section 3.4 of the TSD (Trinity 2004), the modeling domain was set such that it extends 50 km beyond all sources and Class I receptors. Therefore, only sources inside 50 km of the modeling domain boundary are modeled. Figure A-1 in the TSD (Trinity 2004) shows the modeling domain boundary.

Receptor locations were placed at 3-km intervals within the two BLM resource areas. No receptors were placed within 4 km of a source (see near-field analysis). For each Class I and Class II area, a grid of receptors was placed at 2-km spacing within the area. Figures A-4 through A-27 in Appendix A of the TSD (Trinity 2004) show the receptor grid for each sensitive area and the RMP areas.

For the criteria pollutant (NAAQS) and HAPs results, background concentrations were added to produce the total modeled concentrations (Tables 4-7 and 4-8).

Table 4-7. Background Criteria Air Pollutant Concentrations for GSRA

Pollutant	Annual ($\mu g/m^3$)	24-Hour ($\mu g/m^3$)	8-Hour ($\mu g/m^3$)	3-Hour ($\mu g/m^3$)	1-Hour ($\mu g/m^3$)	Monitoring Station Location Description
PM_{10}	24	54	-	-	-	Rifle, Garfield Co (1998-2000 data collected by CDPHE) [1]
$PM_{2.5}$	7	19	-	-	-	Grand Junction, Mesa Co. (1999-2001 data collected by CPHE) [1]
NO_2 [2]	34	-	-	-	-	Woodmen and Colorado College stations, Colorado Springs, El Paso Co. (1998-2000 data) [1]
CO [3]	-	-	4,444	-	8,000	Grand Junction, Mesa Co. (Average of 1999-2001) [1]
SO_2 [4]	11	39	-	110	-	Colorado College, Colorado Springs, El Paso Co. (1998-2000) [1]

[1] *Background concentration recommended by CDPHE in the review comments provided by Nancy Chick, dated on December 20, 2002 (Chick 2002, per Trinity 2003a).*

[2] *The NO_2 concentration recommended by CDPHE is originally stated in 0.018 ppm, annual average (Chick 2002, per Trinity 2003a).*

[3] *The CO concentrations recommended by CDPHE are based on 3 years average and are originally stated in ppm, as follows: 8-hr, 3.74 ppm; 1-hr, 6.1 ppm.7 ppm (Chick 2002, per Trinity 2003a).*

[4] *The SO_2 concentrations recommended by CDPHE are originally stated in ppm: annual, 0.004 ppm; 3-hour, 0.042 ppm; 24-hour, 0.015 ppm (Chick 2002, per Trinity 2003a).*

Table 4-8. Recommended Hazardous Air Pollutant Background Concentrations

Agency	Benzene	Ethylbenzene	Formaldehyde	Toluene	Xylenes
Annual Mean (ppbv) [1]	0.90	0.84	5.78	3.70	3.63 [2]
24-hour Maximum (ppbv)	2.72	10.68	14.00	33.26	43.66 [2]
Annual Mean (μg/m^3)	2.87	3.65	7.11	13.95	15.75
24-hour Maximum (μg/m^3)	8.68	46.35	17.22	125.39	189.48

[1] *ppbv = parts per billion, by volume*

[2] *The xylene concentration represents the sum of m,p-xylene and o-xylene.*

4.2.5.1 Alternative I

The following subsections present the CALPUFF modeling results for Alternative I for criteria pollutants (NAAQS and PSD increments), HAPs, visibility, deposition, and Acid Neutralizing Capacity (ANC) from BLM sources only.

Criteria Pollutants

The modeling results show no exceedances of the NAAQS for any pollutant, nor were any potential concentrations predicted that could exceed the Class I or Class II increments for BLM sources only.

Hazardous Air Pollutants

The results of the near-field HAPs modeling show no concentration values (excluding background concentrations) that exceeded any of the AACLs/RfCs for BLM sources only. However, when background concentrations are included, the annual concentrations for benzene (2.87 μg/m^3) and formaldehyde (7.14 μg/m^3) as well as the 24-hour concentration for xylenes (189.5 μg/m^3) exceed their respective AACLs. BLM sources contribute, at most, 0.6% to these concentrations, meaning that at least 99.4% percent are due to assumed background concentrations. The background HAPs concentrations provided by CDPHE represent monitored urban concentrations and likely are overestimates of existing conditions in the Glenwood Springs area.

Because one or more of the AACLs/RfCs was exceeded (when background concentrations are included), an incremental cancer risk analysis was performed for benzene and formaldehyde emitted from the proposed sources modeled (xylenes are not considered carcinogenic). Two estimates of cancer risk were made: one that corresponds to a most likely exposure (MLE) condition and one that reflects the maximally exposed individual (MEI). The estimated cancer risks were adjusted to account for duration of exposure and time spent at home. Background concentrations are not included in the concentrations used for risk assessment calculations because only the incremental cancer risk due to BLM sources is the focus of this portion of the analysis.

Under the MLE scenario, the range of estimated individual cancer risks associated with long-term exposure to benzene from BLM GSRA sources only is 1.8×10^{-10} to 6.5×10^{-10}. For formaldehyde, the MLE risk is 9.3×10^{-8}. All of these values are well below the lower end of the threshold range (1×10^{-4} to 1×10^{-6}) of presumptively acceptable risks (EPA 1998).

Under the MEI analysis, the range of individual cancer risks for benzene is 2.5×10^{-10} to 8.9×10^{-10}. For formaldehyde, the MEI risk is 1.3×10^{-7}. These values are also well below the lower end of the threshold range of presumptively acceptable risks. Therefore, these very low estimated risk values pose no concern for residents.

It should be noted that these risk calculations are based on the maximum modeled concentration found anywhere in the vicinity of the hypothetical arrangement of sources. It is unlikely that an individual is residing at this exact location for the entire length of time assumed in the calculations. Therefore, the risk

values calculated above should be viewed as an upper bound on the range of possible risks associated with near-field impacts, with actual risks to residents likely being lower.

Visibility

Screening-Level Analysis. Since the proposed emissions constitute many small sources spread over a very large area, discrete visible plumes are not likely to impact PSD Class I or other wilderness areas, but the potential for cumulative visibility impacts (increased regional haze) is a concern. Regional haze (visibility) degradation is caused by fine particles and gases scattering and absorbing light. Changes to regional haze are measured in terms of perceptible visibility (1.0 deciview [dv]) differences from existing ambient background conditions.

Visibility can be affected by plume impairment (heterogeneous) or regional haze (homogeneous). Given the dispersed nature of potential emission sources, and because the GSFO area is not within 10 kilometers (6.2 miles) of any mandatory Federal Class I area, plume impairment will not be a factor. Since the potential air pollutant emission sources constitute many small sources spread over a very large area, discrete visible plumes are not likely to impact the distant sensitive areas.

Regional haze occurs at distances where air pollutants have become dispersed into the atmosphere, with no definable plume. The primary causes of regional haze are secondary sulfate and nitrate particulate matter (typically as ammonium salts), which are formed from SO_2 and NO_x gases through chemical transformation in the atmosphere. These reactions take time, such that near a source little NO_x or SO_2 will have formed nitrate or sulfate, whereas far from a source nearly all SO_2 will have formed SO_4 and much of the NO_x will have formed NO_3. A lesser contributor to regional haze is primary inhalable (PM_{10}) particulate matter emissions. This analysis consists of sources that do not have a defined location.

In addition, implementation of the Clean Air Act (including the determination of "visual impacts of plumes from present and future coal-fired power plants in the coalbed methane [natural gas] emphasis area") has been delegated to applicable local, State, and Tribal air quality regulatory agencies (with EPA oversight). The regulatory agencies will be able to determine the visual impact of the plume from individual emission sources during the new source review process. Therefore, this analysis does not evaluate the near-field visibility impact of the sources at the resource planning stage.

Potential changes to regional haze are calculated in terms of a perceptible or "just noticeable" change (1.0 dv) in visibility when compared to background conditions. A 1.0-dv change is considered potentially significant in mandatory Federal PSD Class I areas as described in the EPA Regional Haze Regulations (EPA 1999) and originally presented in Pitchford and Malm (1994). A 1.0-dv change corresponds to a 10-percent change in the extinction coefficient and a 2- to 5-percent change in contrast (for black target against a clear sky at the most optically sensitive distance from an observer). This represents a small but noticeable change in haziness under most circumstances when viewing in mandatory Federal Class I areas.

The screening-level analysis procedure for visibility is to follow the recommendations in the FLAG (2000) guideline document. Specifically, this analysis compares daily modeled primary (PM_{10}) and secondary (sulfate and nitrate) particulate matter concentrations to "natural" background conditions and seasonal relative humidity [f(RH)] values. From this comparison, a potential change in visibility is calculated. FLAG has identified a 0.5-dv (5-percent change in extinction) threshold as the "Limit of Acceptable Change" (LAC) for single-source impacts and a 1.0-dv (10-percent change in extinction) threshold for cumulative impacts.

The results of the screening visibility analysis for Alternative I as performed by Trinity (2004) are shown in Table 4-9. The results indicate that operations of proposed GSRA BLM sources do not result in a perceptible (1.0-dv reduction)

impact on visibility at any of the PSD Class I Wilderness Areas under Alternative I.

In addition, the USFS and other members of the stakeholders group requested that a separate analysis be completed, comparing the screening visibility results to the USFS 0.5-dv Limit of Acceptable Change threshold to evaluate potential significant visibility impacts at the PSD Class I Areas. The results of this analysis may be found in the TSD (Trinity 2004). BLM performed the analysis of potential visibility impacts at the 0.5-dv level at the request of the USFS and other stakeholders, not based on any legal requirement, and any predicted visibility impacts below the 1.0-dv "just noticeable change" threshold would not be perceptible.

This screening-level regional haze analysis was conducted using conservative assumptions (as is the case with any sort of screening analysis) regarding emissions, plume transport time, humidity, and the conversion of NO_x to ammonium nitrate. It was assumed that 75 percent of the NO_x would convert to NO_2 and that all the NO_2 would convert to nitrate particles. In all likelihood, the amount of NO_x that converts to ammonium nitrate particles would be less. Even using these "reasonable, but conservative" analysis assumptions in the analyses, no perceptible visibility impact (>1.0-dv reduction) would occur at any Class I areas.

Table 4-9. Results of Screening-Level Visibility Analysis for Alternatives I through V
(BLM Sources Only, Glenwood Springs, CO Resource Areas)

PSD Class	Name of Class I or Class II Area	Days >1.0 Deciview Change	
		Screening-Level Modeling	
		Minimum	Maximum
I	Black Canyon of the Gunnison National Park	0	0
I	Eagle's Nest Wilderness	0	0
I	Flat Tops Wilderness	0	0
I	La Garita Wilderness	0	0
I	Maroon Bells-Snowmass Wilderness	0	0
I	Mt. Zirkel Wilderness	0	0
I	Rawah Wilderness	0	0
I	Weminuche Wilderness	0	0
I	West Elk Wilderness	0	0
II	Colorado National Monument	0	0
II	Dinosaur National Monument	0	0
II	Holy Cross Wilderness	0	0
II	Hunter-Frying Pan Wilderness	0	0
II	Raggeds Wilderness	0	0

Table 4-9 also presents screening visibility results for a number of Class II areas. These areas were added at the request of various members of the stakeholder group and are presented for disclosure purposes only. These Class II areas have no visibility protection under State or Federal law at this time and hence are not required to be included in the visibility analysis. However, inclusion in the analysis provides the BLM decision maker with a more complete picture of potential impacts throughout the region.

Because the results of the screening visibility analysis showed no potential impacts above the 1.0-dv level due to GSRA BLM sources only, no refined visibility analysis was conducted for Alternative I.

Deposition

All calculated potential values of sulfur and nitrogen deposition from BLM sources were well below the applicable thresholds of 3 kilograms per hectare per year (kg/ha/yr) for total sulfur and 5 kg/ha/yr for total nitrogen.

Acid Neutralizing Capacity

Where background lake chemistry data were available, an analysis of potential changes to Acid Neutralizing Capacity (ANC) was performed using the procedure recommended by the USFS (2000). This screening methodology takes deposition values of sulfur and nitrogen estimated by CALPUFF and converts these values into a potential change in the ability of a given lake to neutralize acid precipitation.

These values were compared to a 10-percent change in ANC for lakes with background ANC values equal to or above 25 microequivalents per liter (μeq/L). For lakes with background ANC values less than 25 μeq/L, the threshold is no more than 1.0 μeq/L total change in ANC. The results indicate that all lakes considered in the modeling analysis are well below their respective levels of concern for GSRA sources only.

4.2.5.2 Alternative II

The following subsections present the CALPUFF modeling results for Alternative II for criteria pollutants (NAAQS and PSD increments), HAPs, visibility, deposition, and ANC from BLM sources only.

Criteria Pollutants

As with Alternative I, the modeling results show no exceedances of the NAAQS for any pollutant, nor were any potential concentrations predicted that could exceed the Class I or Class II increments for BLM sources only.

Hazardous Air Pollutants

The results of the near-field HAPs modeling show no concentration values (excluding background concentrations) that exceeded any of the AACLs/RfCs for BLM sources. However, when background concentrations are included, the annual concentrations for benzene (2.87 $\mu g/m^3$) and formaldehyde (7.14 $\mu g/m^3$) as well as the 24-hour concentration for xylenes (189.5 $\mu g/m^3$) exceed their respective AACLs. As with Alternative I, BLM sources contribute less than 1% to the total modeled concentrations.

An incremental cancer risk analysis (excluding background concentrations) for benzene under the MLE scenario yielded individual risks of 1.8×10^{-10} to 6.5×10^{-10} for long-term exposure to benzene, while the results for formaldehyde show a risk value of 9.3×10^{-8}. All of the MLE risks are well below the lower end of the range of presumptively acceptable risks (1×10^{-6}; EPA 1998).

Under the MEI analysis, the individual cancer risk for benzene was 2.5×10^{-10} to 8.9×10^{-10}, while formaldehyde showed a maximum individual risk of 1.3×10^{-7}. These risks values are also below the range of presumptively acceptable risks.

As described previously, the risk calculations are based on the maximum modeled concentration found anywhere in the vicinity of the hypothetically located sources; the calculated risk values should be viewed as an upper boundary on the range of possible risks associated with far-field impacts, with actual risks likely being lower.

Screening-Level Analysis. Results of the screening visibility analysis for Alternative II are the same as for Alternative I (Table 4-9). These indicate that operations of proposed GSRA BLM sources would not result in a perceptible visibility impact (1.0-dv reduction) at any of the PSD Class I Wilderness Areas analyzed. Results using the 0.5-dv threshold

requested by USFS are provided in the TSD (Trinity 2004). As noted previously, Class II areas have no visibility protection under State or Federal law at this time, but selected areas were included in the analysis to provide decision-makers with a more complete picture of potential regional impacts.

Deposition

All calculated potential values of sulfur and nitrogen deposition for BLM sources were well below the applicable thresholds of 3 kg/ha/yr for total sulfur and 5 kg/ha/yr for total nitrogen. Methods are as described previously.

Acid Neutralizing Capacity

Results of this analysis indicate that impacts to all lakes considered in the modeling would be well below the thresholds of 10-percent change for lakes with background ANC values equal to or above 25 µeq/L, or a total change of less than 1.0 µeq/L for lakes below 25 µeq/L.

4.2.5.3 Alternative III – Preferred Alternative

The following subsections present the CALPUFF modeling results for Alternative III for criteria pollutants (NAAQS and PSD increments), HAPs, visibility, deposition, and ANC from BLM sources only. Note that the modeling and data analyses for this alternative do not reflect the proposed deferral of leasing for oil and gas on top of the plateau. As described previously, this would result in no oil and gas activities above the rim until 80 percent of the anticipated wells below the rim have been drilled. The deferral would result in a higher percentage of wells below the rim.

The modeling results and analyses described below for Alternative III conservatively used the same distribution of wells — i.e., above versus below the rim — as for Alternative IV, which has the same number of wells, area available for oil and gas development, and annual drilling rate but without the deferral. Thus, the projected air quality impacts are the same for Alternatives III and IV, while in reality the deferral is expected to lead to less impact. This is because the higher proportion of wells below the rim under Alternative III results in more multi-well pads and hence fewer pads, fewer miles of new or widened roads, and fewer vehicular trips for the same number of wells.

Criteria Pollutants

Results of the modeling show no exceedances of the NAAQS for any pollutant, nor would any predicted potential concentrations exceed the Class I or Class II increments for emissions from BLM sources.

Hazardous Air Pollutants

As with the previous alternatives, the modeled concentrations, excluding background concentrations, showed no values that exceeded the low end of the range of the AACLs/RfCs for BLM sources. However, when background concentrations are included, the annual concentrations for benzene (2.87 $\mu g/m^3$) and formaldehyde (7.15 $\mu g/m^3$) as well as the 24-hour concentration for xylenes (189.5 $\mu g/m^3$) exceed their respective AACLs. BLM sources contribute, at most, 0.5%; at least 99.5% percent of these concentrations are due to assumed background concentrations. Background HAPs concentrations provided by CDPHE represent monitored urban concentrations and likely are overestimates of existing conditions in the Glenwood Springs area.

Using the MLE scenario, an incremental cancer risk analysis for BLM sources yielded individual risks associated with long-term exposure of 1.8 x 10^{-10} to 6.5 x 10^{-10} for benzene, while the formaldehyde individual long-term risk was 1.0 x 10^{-7}. All of these risks are well below the EPA (1998) range of presumptively acceptable risks of 1 x 10^{-4} to 1 x 10^{-6}. (Xylenes are not considered carcinogenic).

Using the MEI analysis, the individual cancer risks for benzene were 2.5 x 10^{-10} to 8.9 x 10^{-10}, while the formaldehyde individual risk was 1.4 x 10^{-7}. These values are also below the lower end of the range of presumptively acceptable risks.

Visibility

Screening-Level Analysis. The results of the visibility analysis for Alternative III are the same as those for Alternatives I and II (Table 4-9). These indicate that potential BLM sources would result in no perceptible visibility impact (1.0-dv reduction) at any of the PSD Class I Wilderness Areas. Results using the USFS 0.5-dv threshold are presented in the TSD (Trinity 2004). Again, note that inclusion of sensitive Class II areas in the analysis is not required but is intended to provide decision-makers with a more complete picture of potential regional impacts. Therefore, no refined visibility analysis was conducted.

Deposition

All calculated potential values of sulfur and nitrogen deposition for BLM sources were well below the applicable thresholds of 3 kg/ha/yr for total sulfur and 5 kg/ha/yr for total nitrogen.

Acid Neutralizing Capacity

Results of this analysis indicate that impacts to all lakes considered in the modeling would be well below the thresholds of 10-percent change for lakes with background ANC values equal to or above 25 µeq/L, or a total change of less than 1.0 µeq/L for lakes below 25 µeq/L.

4.2.5.4 Alternative IV

The following subsections present the CALPUFF modeling results for Alternative IV for criteria pollutants (NAAQS and PSD increments), HAPs, visibility, deposition, and ANC from BLM sources only.

Criteria Pollutants

Results of the modeling show no exceedances of the NAAQS for any pollutant, nor would any predicted potential concentrations exceed the Class I or Class II increments for emissions from BLM sources.

Hazardous Air Pollutants

As with the previous alternatives, the modeled concentrations, excluding background concentrations, showed that there were no values that exceeded the low end of the range of the AACLs/RfCs for BLM sources. However, when background concentrations are included, the annual concentrations for benzene (2.87 $\mu g/m^3$) and formaldehyde (7.15 $\mu g/m^3$), as well as the 24-hour concentration for xylenes (189.5 $\mu g/m^3$), exceed their respective AACLs. BLM sources contribute, at most, 0.5% to these concentrations; at least 99.5% percent are due to assumed background concentrations. Background HAPs concentrations provided by CDPHE represent monitored urban concentrations and likely are overestimates of existing conditions in the Glenwood Springs area.

Using the MLE scenario, an incremental cancer risk analysis for BLM sources yielded individual risks associated with long-term exposure of 1.3×10^{-10} to 6.5×10^{-10} for benzene, while the formaldehyde individual long-term risk was 1.0×10^{-7}. All of these risks are well below the EPA (1998) range of presumptively acceptable risks of 1×10^{-4} to 1×10^{-6}.

Using the MEI analysis, the individual cancer risks for benzene were 2.5×10^{-10} to 8.9×10^{-10}, while the formaldehyde individual risk was 1.4×10^{-7}. These values are also below the lower end of the range of presumptively acceptable risks.

Visibility

Screening-Level Analysis. The results of the visibility analysis for Alternative IV are the same as for Alternatives I, II, and III (4-9). These indicate that potential BLM sources would result in no perceptible visibility impact (1.0-dv reduction) at any of the PSD Class I Wilderness Areas. Results using the USFS 0.5-dv threshold are presented in the TSD (Trinity 2004). Again, note that inclusion of sensitive Class II areas in the analysis is not required but is intended to provide decision maker with a more complete picture of potential regional impacts.

Deposition

All calculated potential values of sulfur and nitrogen deposition for BLM sources only were well below the applicable thresholds of 3 kg/ha/yr for total sulfur and 5 kg/ha/yr for total nitrogen.

Acid Neutralizing Capacity

Results of this analysis indicate that impacts to all lakes considered in the modeling would be well below the thresholds of 10-percent change level for lakes with background ANC values equal to or above 25 µeq/L, or a total change of less than 1.0 µeq/L for lakes below 25 µeq/L.

4.2.5.5 Alternative V

The following subsections present the CALPUFF modeling results for Alternative V for criteria pollutants (NAAQS and PSD increments), HAPs, visibility, deposition, and ANC from BLM sources only.

Criteria Pollutants

Modeling shows no exceedances of the NAAQS for any pollutant, nor were any predicted potential concentrations found that could exceed the Class I or Class II increments for emissions from BLM sources.

Hazardous Air Pollutants

The results of the near-field HAPs modeling show no concentration values (excluding background concentrations) that exceeded any of the AACLs/RfCs for BLM sources only. However, when background concentrations are included, the annual concentrations for benzene (2.87 $\mu g/m^3$) and formaldehyde (7.15 $\mu g/m^3$) as well as the 24-hour concentration for xylenes (189.5 $\mu g/m^3$) exceed their respective AACLs. As with previous Alternatives, BLM sources contribute less than 1% to the total modeled concentrations.

An incremental cancer risk analysis (excluding background concentrations) for benzene under the MLE scenario yielded individual risks of 1.8 x 10^{-10} to 6.5 x 10^{-10} for long-term exposure to benzene, while the results for formaldehyde showed a risk value of 1.1 x 10^{-7}. All MLE risks are well below the lower end of the range of presumptively acceptable risks (1 x 10^{-6}; EPA 1998).

Under the MEI analysis, the individual cancer risk for benzene was 2.5 x 10^{-10} to 8.9 x 10^{-10}, while formaldehyde showed a maximum individual risk of 1.5 x 10^{-7}. These risks values are also below the range of presumptively acceptable risks.

As described previously, the risk calculations are based on the maximum modeled concentration found anywhere in the vicinity of the hypothetically located sources; the calculated risk values should be viewed as an upper boundary on the range of possible risks associated with far-field impacts, with actual risks likely being lower.

Visibility

Screening-Level Analysis. Results of the screening visibility analysis for Alternative V are the same as for Alternatives I through IV; there were no modeled impacts that exceeded the 1.0 deciview threshold for any of the Class I areas. Results of an analysis using the USFS threshold of 0.5-dv change are available in the TSD (Trinity 2004).

As noted previously, Class II areas have no visibility protection under State or Federal law at this time but were included in the analysis to provide decision-makers with a more complete picture of potential regional impacts.

Deposition

All calculated potential values of sulfur and nitrogen deposition for BLM sources were well below the applicable thresholds of 3 kg/ha/yr for total sulfur and 5 kg/ha/yr for total nitrogen.

Acid Neutralizing Capacity

Results of this analysis indicate that impacts to all lakes considered in the modeling would be

well below the thresholds of 10-percent change level for lakes with background ANC values equal to or above 25 μeq/L, or a total change of less than 1.0 μeq/L for lakes below 25 μeq/L.

4.2.5.6 Discussion of Air Quality Impacts under Alternatives I through V

The above analysis shows that the proposed BLM sources in the GSRA are not projected to cause an exceedance of any applicable standard or threshold.

It should also be noted that the multiple conservative assumptions used throughout the modeling further underscore that actual air quality impacts are likely to be less than the modeled values. For example, some pollutant sources were assumed to operate 100 percent of the time throughout the modeled period. The maximum modeled concentration was used for health risk calculations, although it is unlikely that anyone resides at the maximum location. Fugitive dust sources were conglomerated into area sources, likely increasing local $PM_{2.5}$ and PM_{10} concentrations. Roads are assumed to emit dust equally throughout the year; in actuality, dust emissions are reduced or eliminated when roads are frozen or wet. After considering these factors, it is reasonable to conclude that impacts on air quality of implementation of one of the five alternatives would be as follows compared to existing conditions (terms are defined in the introduction to Chapter 4):

- Hazardous Air Pollutants – none to negligible (benzene, formaldehyde)
- Priority Pollutants – none
- Visibility – none to negligible
- Deposition of Sulfur and Nitrogen – none
- Acid Neutralizing Capacity – none

These qualitative impact level values recognize that the calculated values are likely higher than actual conditions, based on the multiple conservative assumptions used in the modeling and described above.

As discussed previously, regulation of oil and gas development activities by State and Federal authorities would be expected to avoid or minimize the potential for violations of applicable standards. For example, if monitoring indicates that fugitive dust emissions are leading to exceedances of PSD increments or NAAQS standards, more restrictive operational constraints or more stringent mitigation measures would be required.

4.2.5.7 Cumulative Impacts

The CALMET/CALPUFF dispersion model was used with MM5 meteorological data from 1996 plus numerous surface, precipitation, and upper-air data to predict maximum potential far-field cumulative air quality impacts at downwind PSD Class I Wilderness Areas. The results were used to (1) determine if PSD Class I increments and NAAQS might be exceeded, (2) calculate potential nitrate and sulfate deposition (and their related impacts) in sensitive lakes, and (3) predict potential impacts to regional visibility. Concentrations were also predicted in the impact analysis area to determine compliance with the NAAQS and Class II increments.

Potential emissions from other "reasonably foreseeable" facilities not represented by the measured background values were combined with those resulting from implementation of Alternative V (representing the greatest degree of oil and gas development) to determine potential cumulative air quality impacts. The results discussed below therefore represent the highest cumulative impact from the five alternatives. Detailed information on the sources outside the Planning Area is presented in the TSD (Trinity 2004).

Criteria Pollutants

The modeling results show no exceedances of the NAAQS for any pollutant. Predicted potential concentrations were also compared to the applicable Class I and Class II PSD increments. No modeled concentrations exceeded any PSD increment for any criteria pollutant.

Hazardous Air Pollutants

The results of the far-field HAPs modeling show that the annual benzene and formaldehyde concentrations (2.93 µg/m^3 and 7.18 µg/m^3 respectively, including background concentrations) and the 24-hour concentration of xylenes (191 µg/m^3, including background) were the only values that exceeded any of the AACLs. An incremental cancer risk analysis was performed for benzene and formaldehyde emitted from the proposed sources modeled (xylenes are not considered carcinogenic).

Under the MLE scenario, the estimated individual cancer risks associated with long-term exposure to benzene range from 1.4 x 10^{-6} to 4.8 x 10^{-6}, while the formaldehyde risk was estimated to be 2.0 x 10^{-5}. These values are within the EPA (1998) range of presumptively acceptable risks of 1.0 x 10^{-4} to 1.0 x 10^{-6}.

Under the MEI analysis, individual cancer risks for benzene were 1.8 x 10^{-6} to 6.5 x 10^{-6}, while the risk for formaldehyde was 2.8 x 10^{-5}. Again, the values are within the range of presumptively acceptable risks.

As described for the five alternatives, risk calculations are based on the maximum modeled concentration found anywhere in the vicinity of the hypothetical arrangement of sources. Therefore, the calculated risk levels should be viewed as an upper bound on the range of possible risks associated with far-field impacts, with risks to actual residents likely being lower.

Visibility Screening-Level Analysis. Results of the visibility analysis performed by Trinity (2004) for BLM sources and all sources are presented in Table 4-10.

Table 4-10. Results of Screening-Level and Refined Modeling of Cumulative Visibility Impacts
All Sources, Vernal, UT and Glenwood Springs, CO Resource Areas [1]

PSD Class	Name of Class I or Class II Area	Days >1.0 Deciview Change		
		Screening-Level Modeling	Refined Modeling	
			Minimum	Maximum
I	Black Canyon of the Gunnison National Park	2 (0)	0	1(0)
I	Eagle's Nest Wilderness	0	--	--
I	Flat Tops Wilderness	1 (0)	0	0
I	La Garita Wilderness	0	--	--
I	Maroon Bells-Snowmass Wilderness	0	--	--
I	Mt. Zirkel Wilderness	1 (0)	0	1(0)
I	Rawah Wilderness	0	--	--
I	Weminuche Wilderness	0	--	--
I	West Elk Wilderness	1 (0)	0	0
II	Colorado National Monument	3 (0)	--	--
II	Dinosaur National Monument	3 (0)	--	--
II	Holy Cross Wilderness	0	--	--
II	Hunter-Frying Pan Wilderness	0	--	--
II	Raggeds Wilderness	0	--	--

[1] *BLM sources of emissions shown in parentheses. Class II areas and Class I areas with no impact in screening analysis did not have a refined analysis conducted.*

The results shown in Table 4-10 indicate that potential BLM sources, along with existing inventory sources, could result in a perceptible or "just noticeable" impact (1.0-dv reduction) on visibility at several of the PSD Class I areas in the study domain. Results of an analysis using the USFS threshold of 0.5-dv change may be found in the TSD (Trinity 2004). As with the five alternatives analyzed, the Class II areas have no visibility protection under existing State or Federal laws but are included to provide decision-makers with a more complete picture of potential impacts throughout the region.

Refined Analysis. Because the screening visibility showed potential impacts at one or more Class I areas, a daily refined analysis was conducted based on hourly IMPROVE (2002) optical monitoring data measured at Canyonlands National Park for the years 1986-2002. Daily optical values were calculated based on at least 6 hours of valid data each day (Archer 2002, per Trinity 2004). Also, the maximum relative humidity was limited to no more than 90 percent. The basis for limiting aerosol growth at 90 percent relative humidity is that direct optical monitoring devices are not reliable at humidity values above this level, and measurements above 90 percent were not reported as "valid" by the IMPROVE data contractor.

Air Resource Specialists, Inc. (2002, per Trinity 2004) states that these data are not labeled as valid because "…small random temperature or absolute humidity fluctuations along the path can lead to condensation of water vapor causing meteorological interferences. Thus, in accordance with the philosophy expressed above [viz., of ensuring that impacts are not underestimated], the 90 [percent] relative humidity limit was selected for this test." Therefore, the maximum relative humidity was limited at 90 percent for optical data comparison. Again, the FLAG 1.0-dv (10 percent change in extinction) "just noticeable change" cumulative source threshold was used to assess the significance of potential impacts. The results of the refined modeling analysis are also presented in Table 4-10.

Note that the refined visibility results show that operations of proposed BLM and Inventory sources could result in a "just noticeable" (1.0-dv reduction) impact on visibility at only one Class I area (the Black Canyon of the Gunnison; maximum potential impact is 1 day). No BLM sources (Vernal and Glenwood Springs) cause significant impacts to this, or any, Class I area.

Acid Neutralizing Capacity. Where background lake chemistry data were available, an analysis of potential changes to ANC was performed using the procedure recommended by the USFS (2000). This screening methodology takes deposition values of sulfur and nitrogen estimated by CALPUFF and converts these values into a potential change in the ability of a given lake to neutralize acid precipitation. These values were compared to a 10-percent change in ANC for lakes with background ANC values equal to, or above, 25 μeq/L. For lakes with background ANC values less than 25 μeq/L, the threshold is no more than 1.0 μeq/L total change in ANC.

The results indicate that none of the lakes analyzed would be adversely affected by modeled sources.

4.3 BIOLOGICAL ENVIRONMENT

4.3.1 Upland Vegetation and Riparian/Wetland Areas

Introduction

A number of management actions proposed for incorporation into the RMP have the potential to impact native vegetation. Two categories of actions are described and assessed by alternative below. The first category includes management actions directed at vegetation resources. The second category includes other proposed management actions such as oil and gas development, livestock grazing and range management, and travel management.

Native vegetation in the Planning Area is conceptually subdivided into the general