APPENDIX 13—REDUCING NONPOINT SOURCE POLLUTION WITH BEST MANAGEMENT PRACTICES

This appendix describes best management practices (BMP) used to mitigate adverse effects caused by surface disturbing activities that can contribute to nonpoint pollution. BMPs are advisory rather than regulatory. They are innovative and economically feasible mitigation measures applied on a site-specific basis to reduce, prevent, or avoid adverse environmental impacts to achieve desired outcomes for safe, environmentally sound resource development, by preventing, minimizing, or mitigating adverse impacts and reducing conflicts (Bureau of Land Management [BLM], Instruction Memorandum No. 2004-194). The BMPs identified in this appendix are extensive. However, they are not necessarily all-inclusive. As technology and management opportunities change, new BMPs will become available.

Section 303(e) of the Clean Water Act and 40 Code of Federal Regulations (CFR) 130.5 require states to maintain a water quality management continuing planning process. The process must establish procedures for adoption and appeals that, among other items, address BMPs. They are a key element in a state Nonpoint Source Management Plan, with which the Federal Government must comply under Executive Order (E.O.) 12088 and E.O. 12372, and Clean Water Act Sections 319(k) and 301(k). The practices described in this document are designed to meet the intent of the State of Wyoming's BMPs for all BLM-approved activities. The reader is encouraged to review the State of Wyoming's lists of BMPs, which address silviculture, grazing, hydrologic modification, and oil and gas among other topics (http://deq.state.wy.us/wqd/watershed/nps/npspg.htm).

It should be noted that there are multiple volumes of references for BMPs developed by government and nongovernmental agencies to reduce nonpoint sources of pollution. Many of these documents contain specific practices and design criteria. Nationwide BMPs for protecting nonpoint source pollution can be found at http://www.epa.gov/owow/nps/ and http://www.blm.gov/bmp/, among other places.

Designs can incorporate BMPs for access roads, culverts, bridges, riprap, straw bale dikes, sediment traps, etc. Depending on complexity, a structural BMP may require a detailed engineering design. In other cases, existing designs can be used or modified to fit a given situation, such as those found at the United States Department of Agriculture (USDA) website (http://www.wcc.nrcs.usda.gov/wtec/).

BMPs included in this appendix have been developed through experience working with disturbances in the Resource Management Plan Planning Area (RMPPA) from BLM-approved actions. They should be used in most cases along with Wyoming BLM mitigation guidelines. These practices are not stipulations, but represent practices that in most cases will serve to improve the design and reduce the environmental impact of proposed BLM management actions in the RMPPA. Operators are encouraged to review these practices, incorporate them where appropriate, and where possible develop better methods for achieving the same goals.

It is not possible to evaluate all the known practices and make determinations as to which are "best," nor is it advisable. What is best must be determined as the result of a site-specific investigation of the problem to be solved. These practices can be selected during project planning as part of the plan of development by the project proponent, or attached to a BLM authorization as conditions of approval for given projects, as per Instruction Memorandum (IM) 2004-194. BMPs will be applied whenever they aid in preventing unnecessary or undue degradation of the public lands, as required by Federal Land Policy and Management Act (of 1976) (FLPMA).

MANAGEMENT PLANNING PROCESS

Standard practices or BMPs may develop through the National Environmental Policy Act (of 1969) (NEPA) process into stipulations prior to lease or grant issuance. Alternately, they may serve as a basis for Conditions of Approval (COA). If these practices, including newly developed techniques, are already incorporated into plans for development submitted by a permittee, such plans may be approved. BLM considers all project proposals; however, it is the responsibility of the applicant to describe the design and construction techniques planned. If a project's design, scheduling, and construction techniques can mitigate environmental concerns, construction may be allowed without COAs. However, COAs and stipulations may be used at the request of the authorized officer to improve project designs and would then be required.

As directed by the FLPMA and bureau policy, BLM has developed a three-tiered resource management planning process to make land use planning decisions. (See Chapter 1, Section 1.3 of the RMP.) These tiers are—

- **Policy—**National and state directives and guidance
- Management Planning—RMPs
- **Activity Planning—**For specific projects (includes project decisions).

Areas of accelerated soil erosion, poor or unstable soils, eroding stream channels, and water quality of threatened or impaired stream reaches (Appendix 11) can be identified as issues during the RMP tier of the process or through stakeholder groups with local organizations on listed water bodies. Soil and water conservation practices are addressed in a general fashion during the land use planning tier and in site-specific detail during the activity planning and implementation tier.

BLM's nonpoint source strategy is to continue to—

- Provide cooperation and assistance to state agencies and conservation districts in the management of the public lands to reduce nonpoint source pollution sources

- Incorporate water quality impacts, including nonpoint sources, into land management actions planned and implemented by BLM, and identify and address nonpoint source water quality issues in BLM activity plans for specific projects

- Provide personnel and resources to identify nonpoint source pollution and control techniques through coordinated research efforts and implementation of BMPs

- Proactively implement program practices in conducting land use and land management activities to reduce or avoid water quality impacts and to improve water quality as necessary to meet management objectives and regulatory requirements.

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To protect water quality from nonpoint source pollution, as applied by the Rawlins Field Office (RFO) on BLM lands, the BMP program consists of—

- Defining practices based on the best information available, which are expected to protect water quality

- Monitoring to determine baseline conditions or ensure that practices are applied correctly

- Monitoring to determine the effectiveness of practices

- Mitigation to address unforeseen problems after the activity begins
- Adjustment of design specifications of BMPs for future activities, where appropriate (Appendix 17, Monitoring and Evaluation).

Typically a site- and/or project-specific NEPA analysis will define practices and specify monitoring needs if applicable. The project proponent would then be responsible to mitigate unforeseen problems as they arise, typically with BLM review. BLM would be responsible, as needed after each project, to make adjustments to the process or methods used.

Wyoming BLM policy on reclamation assumes that an area can and shall be ultimately reclaimed. It also requires that every surface disturbance on public lands receives attention for short-term stabilization and long-term reclamation (Appendix 36). Mitigation measures or BMPs reduce, to the extent possible, the amount of reclamation that ultimately must take place. The permit or authorization is the means provided for ensuring that mitigation measures or COAs are implemented. Compliance inspections during operations ensure that mitigation, COAs, and/or stipulations are followed.

Watershed Protection

The entire land surface should be considered for nonpoint source pollution control. Specific attention should be given to areas where the flow of water is concentrated naturally or because of construction (including roads, drainage ditches, and steam channels). Stream sediment, phosphate, and salinity load would be reduced where possible.

The following standard practices are to protect watershed function:

- Construction of ephemeral, intermittent, and perennial stream crossings associated with road and utility line construction generally would be restricted until after spring runoff and until normal flows are established.
- Adequate drainage control devices and measures would be included in the road design and maintenance (e.g., road berms and drainage ditches, diversion ditches, cross drains, culverts, out-sloping, and energy dissipaters) at sufficient intervals and intensities to adequately control and direct surface runoff above, below, and within the road environment. The aim is to avoid concentrated flows.
- Erosion control devices would also be used with the surface runoff and drainage control devices, such as temporary barriers, ditch blocks, erosion stops, mattes, mulches, and vegetative covers. A revegetation program would be implemented as soon as possible to reestablish the soil protection afforded by a vegetal cover.
- Vegetative buffer strips should be maintained between developed recreational facilities and live water.
- Installation of instream structures for fishery, watershed, or irrigation enhancement should be engineered if the high flow for the stream exceeds 10 cubic ft/sec (cfs).
- To minimize long-term surface disturbances within the vegetated sand dunes or other sensitive soils, options such as directional drilling, smaller well pads, and surface lines should be considered. To enhance reclamation through surface stability, techniques to reduce wind erosion should be considered. These methods could include snow fences, soil tackifiers, and erosion control matting.

- When an old project such as an impoundment, reservoir, dam, spreader dyke system, headcut remediation structure, well, wetland, or range improvement project on public lands needs maintenance to restore its former function, the utility of its original function based on current management goals will be considered. Alternative methods to meet the function of the project, such as providing a well or guzzler as a water source would be considered before investment of public funds and if the project is still needed to meet management goals. Restoration cost and plans will also be evaluated during the decision process, as well as impacts to the human environment.

Floodplains

Floodplain protection is required by E.O. 11988 in reference to federal real property and facilities. The E.O. states that, if facilities are to be located in a floodplain (i.e., when there is no practicable alterative), that agencies will ensure that flood protection measures are applied to new construction, or the agency can rehabilitate existing structures; agencies shall elevate structures rather than fill the land; agencies provide flood height potential markings on facilities for public use; and, when the property is proposed for lease, easement, right-of-way (ROW), or disposal, the agency must attach restriction on uses in the conveyance or withhold from such conveyance.

Identified floodplains by their very nature are unsafe locations for permanent structures. With an inundation of flood waters, soils disturbed by construction could experience a rate of erosion greater than undisturbed sites. An additional concern is the potential for flood waters to aid in the dispersal of hazardous materials that may be stored within permanent structures. Identified floodplains should have no permanent structures constructed within their boundaries, unless it can be demonstrated on a case-by-case basis that there is no physically practical alternative. In cases where identified 100-year floodplain construction is approved, additional constraints would be applied through COAs.

For the most part, standard practices to protect water quality and floodplains are to avoid surface disturbing activity in identified 100-year floodplains, within 500 feet of perennial waters and wetland/riparian areas and 100 feet from the inner gorge of ephemeral channels. These 100- and 500-foot buffers often contain the 100-year floodplains. They provide an opportunity for concentrated flows to be dispersed before they reach other water. They often preclude construction in riparian zones, except for linear features. Surface disturbing activities and permanent facilities placement avoid these buffers unless it is determined through site-specific analysis that there is no practical alternative. If such a circumstance exists, then all practical measures to mitigate possible harm to the above areas are employed. These mitigating measures would be determined case by case. They may include, but are not limited to, armoring, diking, lining, screening, mulching, terracing, and diversions.

Soils

Current objectives focus on soil conservation planning for surface disturbance actions. Soil conservation should be addressed during the initial phase of any surface disturbing action, thereby maintaining soil productivity and stability levels through the use of existing guidelines and techniques. Some areas may require more thorough soil management practices than others. However, this is dependent on the type and duration of the action and the effect on site-specific soil characteristics.

Management of the soil resource would continue to be based on the following factors: (1) evaluation and interpretation of soils in relation to project design and development, (2) identification and inventory of soils for baseline data (soil surveys), and (3) identification and implementation of methods to reduce accelerated erosion of top soil. These factors are discussed below.

Evaluation and interpretation of soils involve identification of soil properties that would influence their use, and recommendations for development while minimizing soil loss. Projects would be examined on a site-specific basis, evaluating the potential for soil loss and the compatibility of soil properties with project design. Stipulations and mitigating measures are provided on a case-by-case basis to ensure soil conservation and practical management.

Projects requiring soil interpretations include construction of linear ROW facilities (i.e., pipelines, roads, railroads, and power transmission lines); construction of water impoundments; rangeland manipulation through fire or mechanical treatments; construction of plant site facilities, pump stations, well pads, and associated disturbances; and reclamation projects.

Before a surface disturbing activity is authorized, topsoil depth would be determined. The amount of topsoil to be removed, along with topsoil placement areas, would be specified in the authorization. Uniform distribution of topsoil over the area to be reclaimed would be required unless conditions warrant a varying depth. On large surface disturbing projects (e.g., gas processing plants), topsoil would be stockpiled and seeded to reduce erosion. Where feasible, topsoil stockpiles would be designed to maximize surface area to reduce impacts to soil microorganisms. Stockpiles remaining less than 2 years are best for soil microorganism survival and native seed viability. It is recommended that stockpiles be no more than 3 to 4 feet high. Areas used for spoil storage would be stripped of topsoil before spoil placement. The replacement of topsoil after spoil removal would be required.

Some examples of BMPs applied throughout the RMPPA based on soil management criteria are as follows:

- Individual road closures due to saturated soil conditions when soil resource damage would occur due to wheel rutting or compaction of wet soils
- Salvage and subsequent replacement of topsoil whenever possible on surface disturbing activities
- Avoidance of disturbance on unstable slopes or slopes with angles greater than 25 percent
- Identification of critical erosion condition areas during site-specific project analysis, and activity plan development for the purpose of avoidance and special management
- Temporary disturbances that do not require major excavation (e.g., small pipelines and communication lines) may be stripped of vegetation to ground level using mechanical treatment, leaving topsoil intact and root mass relatively undisturbed.
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Compaction or permeability testing in conjunction with BLM engineers should be used to determine pit characteristics. If clay soils are used as stock pond lining, they should have a liquid limit greater than 30 and a Plasticity Index of at least 20. Assuming that bentonite would sufficiently seal a pit is not a good procedure, because the bentonite must be adequately compacted, with uniform coverage and density. If not so compacted, a chemical reaction may occur between the bentonite and native soil particles. Bentonite is also subject to cracking if the seal is not designed properly. Further, hooves may penetrate the layer if it is not buried sufficiently.

In general, emphasis should continue to be placed on the reduction of soil erosion and sediment. Of particular importance are areas with saline soils or with highly erodible geology and soils.

Airborne Dust and Air Quality

BLM actions must comply with all applicable air quality laws, regulations, and standards. As projects are proposed that include possible major sources of air pollutant emissions, air quality protection-related stipulations are added to BLM permits and rights-of-way grants. In addition, BLM coordinates with Department of Environmental Quality, Air Quality Division (DEQ-AQD), during the process of analysis. This coordination results in technical review of applications for permits or identification of additional stipulations to be applied to these permits.

Dust Control

The following standard practices limit the emission of fugitive dust:

- The use of water for dust abatement on roads may be considered on a case-by-case basis. The water should meet state standards for this use and be permitted by the Wyoming State Engineers Office. There should be no traces of oil or solvents in water used for dust abatement. Only the water needed for abating dust should be applied; this method should not be used as a water disposal option under any circumstances.
- All-weather surfacing of roads using gravel or asphalt paving and the application of water or suitable chemicals to keep dust in place on roads or materials stockpiles.
- Appropriate road design, including shape, drainage, and surface material, to protect the roadbed from being eroded.

Pipelines and Communication Lines

Existing roads would be used where possible for access to utility lines to minimize surface disturbances. Where possible, clearing of pipeline and communication line rights-of-way would be accomplished with the least degree of disturbance to topsoil. Where topsoil removal is necessary, it would be stockpiled (wind-rowed) and respread over the disturbance after completion of construction and backfilling. Vegetation removed from the ROW would also be required to be spread again. This will provide protection, nutrient recycling, and a seed source.

On ditches wider than 36 inches, 6 to 12 inches of surface soil should be salvaged where possible from disturbed sites. When pipelines and communication lines are buried, there should be at least 48 inches of backfill on top of the pipe. Backfill should not extend above the original ground level after the fill has settled. Bladed surface materials would be respread on the cleared route once construction is completed.

To promote soil stability, the compaction of backfill over the trench would be required. (It is not to extend above the original ground level after the fill has settled.) Water bars, mulching, and terracing would be required as needed to minimize erosion. To prevent erosion, instream protection structures (e.g., drop structures) may be required in drainages crossed by a pipeline.

For communication lines or other small lines, such as plastic water lines that do not require trenching, a ditch witch or similar trenching machine should be used to reduce disturbance and reclamation.

Livestock Grazing BMPs

BMPs which reduce non-point source water pollution due to livestock grazing are described in Appendix 19, in the Grazing Management Prescriptions section.

Well Pads and Facilities

Site-specific reclamation procedures would be developed in each Application for Permit to Drill (APD), ROW application, or Sundry Notice submitted to BLM for review and approval prior to the authorization of surface disturbing activities, on which mitigation measures or COAs can be applied.

Both produced water and reserve pits should be constructed to ensure protection of surface water and ground water. The review to determine the need for installing lining material should be performed on a case-by-case basis. It should consider soil permeability, water quality, and depth to ground water. Oil-based muds would be allowed only in closed drilling systems. Drill cuttings and any remaining drilling fluids would be disposed of in an environmentally acceptable manner. Pits will be lined if there is not sufficient clay in the subsurface to protect building material, for preventing infiltration of fluids into shallow ground water.

Unlined reserve pits would not be located in areas where ground water is less than 50 feet from the surface and soil permeability is greater than 107 cm/hr. If ground water is encountered during setting of the conductor, a closed drilling system may be used and freshwater may be required for drilling. All reserve pits would be fenced, as specified in individual authorizations, to restrict livestock and wildlife use. Any pits with harmful fluids in them shall be maintained in a manner that would prevent migratory bird mortality.

Abandoned sites must be satisfactorily rehabilitated in accordance with a plan approved by BLM (see the Headcut Structures and Channel Restoration section of this appendix). Soil samples may be analyzed to determine reclamation potential, appropriate reseeding species, and nutrient deficits. Tests may include pH, mechanical analysis, electrical conductivity, and sodium content, among others. Terraces or elongated water breaks would be constructed after slope reduction. Disturbances should be reclaimed or managed for zero runoff from the location until the area is stabilized. All excavations and pits should be closed by backfilling and contouring to conform to surrounding terrain. On well pads and larger locations, the surface use plan would include objectives for successful reclamation, including soil stabilization, plant community composition, and desired vegetation density and diversity.

On producing locations, operators would be required to reduce slopes to original contours (not to exceed 3:1 slopes). Areas not used for production purposes should be backfilled and blended into the surrounding terrain, and reseeded. Erosion control measures should be installed, as they would be required after slope reduction. Facilities would be required in order to approach zero runoff from the location to avoid contamination and water quality degradation downstream. Mulching, erosion control measures, and fertilization may be required to achieve acceptable stabilization.

Any produced water or reserve pits that show indications of containing hazardous wastes would be tested for the Toxicity Characteristic Leaching Procedure constituents. If analysis proves positive, the fluids would be disposed of in an approved manner. The potentially responsible party would bear the cost of the testing and disposal.

No surface disturbance is recommended on slopes exceeding 25 percent, unless erosion controls can be ensured and adequate revegetation is expected. Engineering proposals and revegetation and restoration plans would be required in these areas.

Oil and Gas Drilling

All federally approved drilling activities must conform to Onshore Oil and Gas Operations, Federal and Indian Oil and Gas Leases requirements (43 CFR), Wyoming Oil and Gas Commission requirements (http://wogcc.state.wy.us/), and Wyoming BLM requirements (http://www.wy.blm.gov/minerals/og/). A good description of typical oil and gas development activities can be found at Environmental Protection Agency's (EPA) industrial process description for oil and gas extraction (http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/oil.html). Casing, cementing, well completion and other practices, if done incorrectly, may impact surface or groundwater resources. Drilling fluids used to cool and lubricate the drill bit, remove rock fragments, and counterbalance pressures to keep fluids and gases from entering the well bore prematurely may migrate into groundwater. It is important for operators to notify the BLM with concerns, especially if a large loss of fluids occurs. Drilling fluid additives and well completion additives should be disclosed per NEPA for projects, and potential impacts described (see Chapter 4, Section 4.17 of the RMP). Produced water is the most common waste stream from oil and gas activity. More than 90 percent of onshore produced water is disposed of through injection wells (API 1997). Projects may consider surface discharge as an option for produced water (see the Surface Discharge of Water Section).

Reclamation

Current BLM policy recognizes there may be more than one correct way to achieve successful reclamation, and a variety of methods may be appropriate to the varying circumstances (Appendix 36). BLM will continue to allow applicants to use their own expertise in recommending and implementing construction and reclamation projects. These allowances still hold the applicant responsible for final reclamation standards of performance. All reclamation needs to conform to BLM reclamation policy.

BLM reclamation goals emphasize—

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

All reclamation should accomplished as soon as possible after the disturbance occurs, with efforts continuing until a satisfactory revegetation cover is established and the site is stabilized (3 to 5 years). Only areas needed for construction would be allowed to be disturbed.

On all areas to be reclaimed, seed mixtures would be required to be weed-free and site-specific, composed of native species, and would be required to include species-promoting soil stability. A predisturbance species composition list must be developed for each site if the project encompasses an area where several different plant communities are present. Livestock palatability and wildlife habitat needs would be given consideration in seed mix formulation. Guidance for native seed use is in BLM Manual 1745 (Introduction, Transplant, Augmentation, and Reestablishment of Fish, Wildlife, and Plants), and E.O. 13112 (Invasive Species).

Interseeding, secondary seeding, or staggered seeding may be required to accomplish revegetation objectives. During rehabilitation of areas in important wildlife habitat, provision would be made for the establishment of native browse and forb species if they are determined to be beneficial to the affected habitat. Follow-up seeding or corrective erosion control measures may be required on areas of surface disturbance which experience reclamation failure.

Trees, shrubs, and ground cover (not to be cleared from ROWs) would require protection from construction damage. Backfilling to preconstruction condition (in a similar sequence and density) would be required. Restoration of normal surface drainage would also be required.

Any mulch used would be free from mold, fungi, or noxious or invasive weed seeds. Mulch may include native hay, small-grain straw, wood fiber, live mulch, cotton, jute, synthetic netting, and rock. Straw mulch should contain fibers long enough to facilitate crimping and provide the greatest cover.

The grantee or lessee would be responsible for the control of all noxious and invasive weed infestations on project-disturbed areas as well as native areas infested as a direct result of the project. Aerial application of chemicals would be prohibited within 1/4-mile of Special Status plant locations. Control measures would adhere to those allowed in the RMPPA Noxious Weed Control and Commercial Site Vegetation Control EA (WY-037-EA6-122), and the Vegetation Treatment on BLM Lands in Thirteen Western States Environmental Impact Statement (EIS) and Record of Decision (ROD) (1991). The BLM Authorized Officer would monitor herbicide application.

Surface Discharge of Water

The largest by volume byproduct of the oil and gas extraction process is water. According to the American Petroleum Institute, about eight barrels of water are produced for every barrel of oil, while conventional natural gas wells yield much less water volumes, but are still significant (API 1997). Coalbed Natural Gas (CBNG) development typically produces large volumes of water relative to oil and conventional gas. If surface discharge is proposed, NEPA will consider impacts from approved Wyoming Pollutant Discharge Elimination System (WYPDES) permits (see Chapter 4, Section 4.17 of the RMP). Industry also uses water for hydrostatic testing of pipelines. Although injection wells dispose of most waters, project proponents often consider surface discharge of these waters.

The water quality of any potential surface discharge of waters should be known. If the water is used for some purpose, such as hydrostatic testing of pipelines, potential contaminants should be tested for. Hydrostatic test water will be discharged in a controlled manner onto an energy dissipater and within existing ROWs. Prior to discharge, water should be tested and treated or filtered if necessary to reduce pollutant levels or to settle out suspended particles if necessary. Coordinate all discharge to test water with the State Engineers Office (SEO), WDEQ, and the BLM. Discharge permits should be obtained from the State of Wyoming when necessary; adhere to conditions outlined in the permit.

Temporary discharge (less than 1 to 4 days) of waters into upland sites should be done using energy dissipation structures such as temporary hay bail ponds, gated pipe to disperse flow, or other designs to increase infiltration and to reduce the potential for concentrated overland flow. Rilling (formation of small gullies about 4 to 6 inches deep) should not occur during discharge, and discharge should be monitored to ensure concentrated overland flow does not occur. Volumes below 1 cfs would be manageable for these types of temporary structures; larger discharges may require BLM-approved engineered designs.

Temporary discharge (less than 1 to 4 days) into drainages should include the armoring of discharge point into a stable channel reach. Stable channel reaches should not have any erosional features that would indicate the channel is not in equilibrium to the sediment and flow supplied. They should have indications that the amount and duration of discharge proposed commonly occurs within the channel. Discharge should be monitored for erosion, and armoring could include fabric with angular rock, gabion wire baskets with riprap or other designs that would reduce the energy of the discharged water. Volumes below 1 cfs would be manageable for these types of temporary structures; larger discharges may require engineered designs.

Continuous discharges into off-channel reservoirs (for months or years) should consider and provide for infiltration if required, by including groundwater monitoring or evaluation, or should be suitably lined to prevent shallow groundwater contamination. Designs should maximize evaporation by being shallow and potentially providing for aeration or atomization.

Continuous discharges into drainages for months or years would require water management plans that would include detailed drainage surveys with mitigation plans for potential erosional problems on lands downstream. These types of discharges should not occur above active headcutting (active headcutting would include vertical streambed adjustments of greater than 1 foot). They should be done within volumes, durations, and at times that are within the natural variation and patterns of the receiving system.

Headcut Structures and Channel Restoration

The headward erosion in stream channels (headcuts) would be stabilized in and estimated for 10 locations during the plan. Further, some channel restoration work (25 miles) would be needed on public lands to meet maintain or improve water and soil resources to meet rangeland standards (Appendix 33). No heavy equipment use is expected for the stream channel restoration projects. However, for headcut remediation, heavy equipment may be needed to adequately key in structures and to properly design any structures to withstand normal flow levels and periodic flooding.

When possible, minimal impact techniques would be used. For example, “beaver seeding” provides good-quality building material (aspen logs) for beavers to construct their dams. Similarly, channel restoration work would use “channel gardening” techniques, such as providing rock or wood at strategic positions in channels to encourage meander bends and point bars to form or provide controlled vertical changes in the channel bed (drop structures). All projects would solicit multi-disciplinary input during activity and project decision planning.

Road Design and Maintenance

Roads would be constructed as described in BLM Roads Manual 9113. Bureau roads are for use, development, and administration of public lands and resources. They are generally open to public use; however, roads can be closed or their use restricted to fulfill resource management objectives. All permanent roads constructed by nongovernmental entities across public lands must be designed by or under the direction of a licensed professional engineer. Roads crossing public lands must be located, designed, constructed, and maintained to protect and preserve watershed, water quality, natural, historical, cultural, and scenic values.

Bureau roads that no longer support a management objective (timber sale, range improvement, etc.) are obliterated and revegetated. BLM Manual 9113 classifies roads as collector, local, or resource roads. Collector roads provide primary access to large blocks of land, or connect different road systems. They are designed for user safety, comfort, and travel time. Local roads serve smaller areas and would have lower volume. User comfort and travel times are secondary to maintenance and construction costs. Resource roads are spur roads that generally access one or two types of use. They would carry a very low volume of traffic.

Road easements are a minimum of 50 feet or the width of construction plus 10 feet on each side (whichever is greater). Easement widths should be as narrow as possible to allow for a good road design. Less initial disturbance is in the best interest of all the BLM management resources. Therefore, minimizing the construction width to what is needed for a well-designed road is highly recommended. Structure widths must have a width of 14 feet for single-lane roads and 24 feet for double-lane roads, but in all cases not less than the nominal width of the adjacent travelway as measured at right angles to the travelway centerline (BLM Manual 9113).

Road shape for crowned roads in most cases should not have side ditches steeper than 3:1, and a taper slope no flatter than 4:1. Recommended slopes for a typical crown shape is—

- Earth Surface 0.03–0.05 ft/ft
- Aggregate Surface 0.02–0.04 ft/ft
- Paved Surface 0.02–0.03 ft/ft

Inslope and outslope road designs can be considered for roads that have less than 20-mph design speed (Table A13-1). This inslope or outslope grade should not exceed 6 percent (BLM Manual 9113).

Culverts should be installed in road crossings for small ephemeral channels. All drainage and erosion mitigation should be designed for at least a 10-year event with no static head at the entrance. (Static head is the height of the water column above the top of the culvert.) This will avoid serious head and velocity damage during 25-year discharge events (BLM Manual 9113). All drainage and erosion mitigation also should also use at minimum 18-inch culverts, with armored entrances and exits as necessary. Minimum fill on top of a culvert should be 12 inches. Waterbars, waddles or hay bales, and silt fences can be used as needed to reduce surface runoff velocity and deposit sediment in the uplands to protect riparian areas, wetlands, and surface waters.

New collector and local roads would be designed and constructed to reduce sediment loading to surface waters. Running surfaces would be graveled to achieve an all-weather surface. Resource roads will be graveled if the site is accessed in the winter, and if the base does not already contain sufficient aggregate, or if the road is in sensitive soils. Cut and fill slopes more than 10 feet high should be structurally stable, and slopes should not be steeper than 2:1 on level or rolling terrain and 1-1/2:1 on mountainous terrain (BLM Manual 9113). In clayey or silty soils common in the RMPPA, maximum slope should be limited to 2:1 or less, regardless of the height of the fill. All collector, local, and resource roads are considered developed roads. Undeveloped vehicle routes are an important consideration for resource management and used as access routes.

Off-road vehicle travel for necessary tasks would use all-terrain vehicles to reduce impacts whenever possible. If these tasks can be done without the use of vehicles, tasks off-road should be done by walking or by horseback whenever possible to reduce impacts to soils and vegetation.

Designing Roads

Access roads are improved roads designed for minimal access; typically, they go into only one well or a small group of wells. Access roads should be kept to a minimum and used when dry or when they are all-weather surfaced. Road design should incorporate adequate drainage and erosion minimization. Roads design should encourage the shedding of water from the surface before the water gains enough concentration or velocity to cause erosion. After water is shed from the road surface, energy dissipation structures should be designed, again with the goal of reducing the concentration and velocity of water. Table A13-1 outlines the geometric standards for BLM roads.

Table A13-1. Geometric Standards for Bureau Roads from BLM Manual 9113

Functional Classification	Est. 20 Yr. Average Daily Traffic	Terrain	Design Speed[1]		Travelway Width[1]		Maximum Grade[1]	
			Pref.	Min.	Pref.	Min.	Pref.	Max.
Resource	Less than 20	Level & Rolling	30	*	14	*	8	10
		Mountainous	15	*	14	*	8	16
Local	Less than 100	Level & Rolling	40	30	20	20	6	10
		Mountainous	20	15	14	12	8	15
	More than 75	Level & Rolling	50	40	24	20	6	10
		Mountainous	30	15	24	20	8	14
Collector	50–150	Level & Rolling	50	30	24	20	6	8
		Mountainous	30	20	20	20	8	12
	More than 100	Level & Rolling	50	40	24	20	6	8
		Mountainous	30	20	24	20	8	12

* If the preferred design speed and travelway width are not feasible for specific resource roads, alternate values can be determined by the State BLM office.

[1] Design speeds and surface widths chosen are limited to values shown, except that greater widths are allowed when oversize traffic justifies wider widths. Maximum acceptable grade must never be exceeded. Maximum preferred grade should be exceeded only when preferred value is not feasible.

Source, BLM Manual 9113 – Roads, Release 9-247

Preplanning road construction activities to reduce water quality impacts is important. The following should be included in good planning:

- Construct roads a safe distance from a waterbody.
- Minimize the number of stream crossings.
- Carefully design stream crossings with bridges, culverts, rip-rap, etc.
- Construct stream crossings during periods of low streamflow.
- Fit upland roads to the topography using culverts, waterbars, stabilized slopes, etc.
- Route road runoff to a filter strip and not directly into a waterbody.
- Provide energy dissipaters (bales, rocks, logs, etc.) to reduce the erosive force of runoff.
- Carefully locate, and properly reclaim, borrow pits and gravel sources.
- Seed or otherwise stabilize disturbed areas as soon as possible.
- Complete road construction prior to the main runoff season to minimize exposure of unfinished roads to heavy runoff.

All roads should be designed and maintained to preserve some type of surface shape to reduce water concentration, surface flow, ponding, and resulting safety and maintenance problems. All construction activities should occur during no- or low-flow periods to reduce impacts. Two commonly accepted surface shape designs are crowned roads, where the center of the road is at the highest elevation and the sides are lower, allowing for the shedding of water off the road surface; and outsloped roads, which shed water to the downslope side of the road. Insloping should only be used when outsloping or crowning is infeasible because of safety considerations, or erosion on the outslope is a great concern, as drainage on the inslope will require ditches and cross-drainage. Outsloped or insloped roads should only be used on roads with less than 6 percent grade (USDI, BLM 1982).

On surfaced road with grades greater than 8 percent, surface shape alone will probably not be enough to protect the road surface; therefore cross-drainage systems should be used (USDA, 1997). The two most common approaches are waterbars that shed water from the surface of the road, and drainage ditches, wing ditches, and culverts to transport water from the road surface to a location where concentrated flow is dispersed. Wing ditches should be used to direct concentrated flow to a non-erosive location; culverts can be used to bring water from one side of the road to the other for better dissipation (cross-drainage). BLM manual section 9113 should be used for accepted specifications.

To control or reduce sediment from roads, proper road placement, buffer strips, surfacing, proper drainage design, permanent closure of old roads or two tracks, and/or seasonal closures will be used as conditions of approval when necessary to reduce impacts from new roads. Road and well pad construction may also be prohibited during periods when soil material is saturated or frozen, and when watershed damage is likely to occur.

On newly constructed, permanent roads, the placement of topsoil, seeding, and stabilization would be required on all cut and fill slopes unless conditions (e.g., rock) prohibit it. No unnecessary sidecasting of material (e.g., maintenance) on steep slopes would be allowed. Snow removal plans may be required so that snow removal does not adversely affect reclamation efforts or resources adjacent to the road.

Shedding water from road surfaces can be performed by installing water bars on steep sections and not allowing ruts to develop in others. Wear on access roads can be significantly reduced by minimizing use when the roads are wet. Good design on access roads with a significant amount of traffic can include surfacing, installation of road drainage, such as wing ditches and culverts, and proper maintenance.

As needed for erosion control and energy dissipation, structures such as wing ditches, riprap, and culverts should be part of the road design. Riprap should be placed around outlets of culverts and the inlets of drainage structures where possible. All riprap should be angular rock, and should be placed on geotextile fabric. Culverts should be considered for cross-drainage when travel is expected to exceed 10 to 15 vehicles per day, regardless of surface design, and culverts should be 18 inches or greater in diameter. Culverts used for cross-drainage or laterals should be placed to form an entrance angle of 45 to 60 degrees. They also should have a gradient equal or slightly greater than the approach ditch gradient. A design gradient of 0.5 percent is recommended for wing ditches so that the ditch does not erode. Outlets for wing ditches should avoid natural channels when possible or use riprap (BLM Manual 9113). Spacing of lateral drainage features such as wing ditches should follow the recommendation in Table A13-2 below.

Table A13-2. Spacing for Lateral Drains (Wing Ditches or Cross Drainage)

Gradient in percent	Recommended Spacing in Feet [1]									
	Erosion Index[2]									
	10	20	30	40	50	60	70	80	90	100
2	900	1225								
3	600	815	1070	1205						
4	450	610	800	905	1015					
5	360	490	640	725	810	865	1000			
6	300	410	535	605	675	720	835	1010		
7	255	350	455	515	580	620	715	865	1030	1210
8	225	305	400	450	505	540	625	755	900	1055

Gradient in percent	Recommended Spacing in Feet [1]									
	Erosion Index[2]									
	10	20	30	40	50	60	70	80	90	100
9	200	270	355	400	450	480	555	670	800	940
10	180	245	320	360	405	435	500	605	720	845
11	165	220	290	330	370	395	455	550	655	770
12	150	205	265	305	340	360	415	505	600	705
13	140	190	245	280	310	335	385	465	555	650
14	130	175	230	260	290	310	355	430	515	605
15	120	165	215	240	270	300	335	405	480	565
16	115	155	200	225	255	280	310	380	450	530

[1] Based on rainfall intensities of 1 to 2 in/hour storms with a 25-year return interval

[2] Erosion Index	Soil Types
10–20	Silty sands, sand-silt mixtures, inorganic silts and very fine sands, silty or clayey fine sands
30–40	Inorganic silts, micaneous or datomaceous fine sandy or silty soils, elastic silts, organic silts and organic silty clays or low plasticity, inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays
50–60	Organic clays with medium to high plasticity, organic silts, inorganic clays of high plasticity, fat clays, clayey sands, sand-clay mixtures, silty-gravels, gravel-sand-silt mixtures
70	Clayey gravels, gravel-sand-clay mixtures
80–90	Clean sands or clean, gravelly sands
100	Clean gravels or sand-gravel mixtures

Source: Road Standards, Excerpts from BLM Manual Section 9113

Undeveloped Vehicle Routes

Use of undeveloped vehicle routes should be kept to a minimum, and they should only be used during dry conditions, if possible. If areas are identified with multiple vehicle routes with the same destination, brush barriers or signing should be used to identify the best quality route to discourage use of other unnecessary vehicle routes. As funding is available, these unnecessary vehicle routes should be reclaimed.

The road should be considered for a designed surface road if erosional features are present on necessary vehicle routes, including but not limited to excessive rutting, with evidence of concentrated flow during storm events, sediment deposition adjacent to the vehicle routes, ponding in ruts, or ruts greater than 6 inches in depth. If the road is not improved, improve drainage by the installation of water bars, culverts, or wing ditches to reduce concentrated flows.

Road and/or Pad Closure and Reclamation

Road closures may be implemented during crucial periods (e.g., wildlife winter periods, spring runoff, and calving and fawning seasons). These would require signing or the areas being designated in a publicly available map.

Reclamation of abandoned roads or closed roads would include requirements for reshaping, recontouring, ripping (increasing infiltration, reducing compaction, and increasing effective precipitation by dragging 18-inch or greater blades through the old road surface), resurfacing with topsoil, installing water bars, and seeding on the contour. Removal of structures such as bridges, culverts, cattleguards, and signs usually would be required. Stripped vegetation would be spread over the disturbance for nutrient recycling where practical. Fertilization or fencing of these disturbances would not normally be required. Additional erosion control measures (e.g., fiber matting) and road barriers to discourage travel may be required in addition to signing.

On gentle slopes, minimal treatment (rip and drain with a partial outslope) may be effective, but steeper terrain or close-to-stream channels may require water bars, pitting and/or restoring the original topography with reclamation.

It is important to note, that the roughness of the seedbed is increased with ripping and other disturbance to increase porosity. However, increases in porosity are slight enough that only very hardy plants may initially take advantage of improved surface. Soil settlement and surface sealing highlight the fact that freshly tilled road soils are generally sterile and poorly structured. Luce (1997) found that ripping alone provides only temporary and marginal improvements. The author recommended organic matter (mulch) along with ripping to enhance both the short-term effectiveness and durability of gains in porosity and infiltration capacity. Seeding can also greatly increase restoration success by capitalizing on the temporary increases in porosity and beginning to form new topsoil by fixing nitrogen, reducing rains plash erosion, and providing organic litter.

Methods for Designing Road Crossings

Active streams are those that maintain aquatic vegetation, animal, or fish populations. The majority of active streams are intermittent or perennial. However, some portions of ephemeral systems may meet this definition. Bridges and major culverts are to be designed, constructed, and maintained to maintain the natural stream channel to the greatest extent feasible to support fish species in active streams. All active streams should have bridges and major culverts (opening of 35 square feet or greater, i.e., a 7- foot or greater culvert diameter). These should be located, designed, constructed, and maintained according to standards that preserve or improve streambed gradients and velocities to allow fish passage and that minimize erosion and sediment damage. Open-bottomed culverts could be used to accomplish channel conditions important for fish passage. The design for permanent bridges is for a minimum of a 50-year storm. Major culverts should be designed to pass a 25-year flow with no head and not to fail during a 50-year storm. Bridges and major culverts should be designed under the direct supervision of a professional engineer with experience in designing these types of facilities. These designs should be submitted to the BLM. They must have a register professional engineer’s stamp or seal affixed to plans, specifications, drawings, and other documents (BLM Manual 9112).

All stream crossings should consider the failure of the crossing during flows beyond the design capacity. This can be accomplished by allowing the road fill to be breached in predetermined locations during storm events greater than the design capacity, and by not diverting the water to a new pathway causing gullying, erosion, and formation of a new channel. Other drainage crossings (minor culverts on non active streams) should follow BLM Manual 9113 specifications (see the Road Design and Maintenance section).

The goal of any design should be to maintain current fluvial processes for moving sediment and flow in the active channel. This results in designs that do not confine flows to only one portion of the channel or flood plain. They also do not result in a grade change through the crossing. Channel dimensions are a good indicator of the range of water, debris, and sediment yields in the channel. The active stream bed width or annual scour can be used as an estimate of the area required for the crossing to pass typical (1.5-

to 2-year reoccurrence) flows. Similarly, the eroded area with temporary vegetation and flood terracing can be used as indicators of extreme events for reoccurrence intervals greater than 2 years. These field measurements, along with peak flow events (Miller 2003) and other empirical methods, should be used to determine design criteria for crossings.

In general, crossings designed to pass 100-year storm events would in most cases allow for unrestricted passage of flow and sediment from smaller storms. Crossing designs that simulate natural stream processes and provide unrestricted passage of flow and sediment can include bridges, low-water crossings, culverts, and bottomless culverts. The appropriate design should be chosen after careful consideration of local conditions, including hydrologic conditions, soil erodibility, road utilization, and presence of aquatic species.

Fill failures on drainage crossings can be a major source of sediment. Drainage crossings should include a backup design that will handle flood flows in excess of the design flow or in the case of culvert failure. These backup drainage designs should direct overflow to areas of least impact and protect the road fill in the drainage. Also, construction of critical fills (i.e., in the drainage) should include subexcavation of weak foundation materials, armoring, or adequate compaction to improve fill stability and to resist erosion

Where new or replacement culvert designs are chosen for crossings of active streams and a bridge is infeasible, the active channel design option should be followed if the channel slope is less than 3 percent, the culvert is less than 100 feet in length, or a passage is required for aquatic species.

Design criteria specific to the active channel design option include the following:

- **Culvert Width**—The minimum culvert width shall be equal to or greater than 1.5 times the active channel width.
- **Culvert Slope—**The culvert shall be placed level (0 percent slope).
- **Embedment—**The bottom of the culvert shall be buried into the streambed at not less than 20 percent of the culvert height at the outlet, and not more than 40 percent of the culvert height at the inlet. Embedment does not apply to bottomless culverts.

At sites where the channel slope is greater than 3 percent or the culvert length exceeds 100 feet, additional consideration should be given to alternate design options such as bridges or low-water crossings. This is because of the difficulty of providing for the passage of aquatic species through culverts installed at these sites.

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