APPENDIX 13—BEST MANAGEMENT PRACTICES FOR REDUCING NONPOINT SOURCE POLLUTION

This appendix describes best management practices (BMP) utilized to mitigate adverse effects caused by surface-disturbing activities that can contribute to nonpoint pollution. 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. The State of Wyoming Department of Environmental Quality (DEQ) publishes general BMPs for Wyoming, (http://deq.state.wy.us/wqd/watershed.asp#non). Nationwide BMPs for protecting nonpoint source pollution can be found at http://www.epa.gov/owow/nps.

BMPs have been developed through experience working with disturbances in the Rawlins Resource Management Plan Planning Area (RMPPA) from Bureau of Land Management (BLM)-approved actions and 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.

The purpose of this section is not to attempt to select certain practices or designs and require that only those be used. 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. What the RFO hopes to accomplish with this appendix section is the prescription of basic construction techniques that could be used regardless of project design or purpose.

Section 303(e) of the *Clean Water Act* and 40 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. BMPs are advisory rather than regulatory. They are a key element in a state Nonpoint Source Management Plan, with which the Federal Government must comply under *Executive Order 12088* and *Executive Order 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 BLM-approved activities. The reader is encouraged to review the State of Wyoming's lists of BMPs, which have been developed in response to the *Clean Water Act* and address silviculture, grazing, hydrology, as well as policy statement in lieu of BMPs for minerals, and oil and gas (http://deq.state.wy.us/wqd/watershed.asp#non).

MANAGEMENT PLANNING PROCESS

Standard practices or BMPs may develop through the *National Environmental Policy Act* (NEPA) process into stipulations prior to lease or grant issuance, or 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 burden 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.

As directed by the *Federal Land Policy and Management Act* (FLPMA) and bureau policy, BLM has developed a three-tiered resource management planning process to make land use planning decisions. These tiers are policy, Resource Management plans, and Activity plans.

Areas of accelerated soil erosion, poor or unstable soils, eroding stream channels, and threatened or impaired stream reaches for water quality (Water Quality within the RMPPA and River System Depletions Appendix) can be identified as issues during the Resource Management Plan 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 of the process.

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.

To protect water quality from nonpoint source pollution, as applied by the 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 ensure that the practices are applied.
- 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 (Monitoring and Evaluation Appendix).

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, and BLM would be responsible to make adjustments to the process or methods used, as needed after each project.

Wyoming BLM policy on reclamation assumes that an area can and shall be ultimately reclaimed, and requires that every surface disturbance on public lands receive attention for short-term stabilization and long-term reclamation. 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 being followed.

Watershed Protection

The entire land surface should be considered for nonpoint pollution control, with specific attention 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.
- Vegetative buffer strips should be maintained between developed recreational facilities and live water. Prior to installing toilet facilities associated with recreation, ground water protection should be provided for.
- Installation of instream structures for fisheries, watershed, or irrigation enhancement should be completely engineered if the high flow for the stream exceeds 10 cubic feet/second (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 success through surface stability, techniques to reduce wind erosion should be considered. These methods could include snow fences, soil tackifiers, and erosion control matting.

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

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 buffers provide an opportunity for concentrated flows to be dispersed before they reach a water body and 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 and may include (but are not limited to) diking, lining, screening, mulching, terracing, and diversions.

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. There is an additional concern over 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.

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 right-of-way 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.

Soil surveys are designed to update general soils information and to provide data to those areas lacking soil inventories. Allotments and areas impacted by oil and gas projects will receive priority in the soil survey process, and BLM will encourage and participate in soil surveys as opportunities arise.

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. The 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 standards applied throughout the RMPPA area 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
- Avoiding disturbance on unstable slopes or slopes 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 which 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.

Compaction or permeability testing should be used to determine pit characteristics in conjunction with BLM engineers. 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, a chemical reaction may occur between the bentonite and native soil particles. Bentonite is also subject to cracking if it is not designed properly, and the layer may be penetrated by hooves if not buried sufficiently.

In general, emphasis should continue to be placed on the reduction of soil erosion and sediment. Of particular importance would be those 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 DEQ, Air Quality Division (DEQ-AQD), during the process of analysis. This coordination results in technical review of applications for permits and/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 or chemicals to control dust in the demolition of structures, construction operations, grading of roads, or clearing of land.
- The use of water for dust abatement 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. Only the water needed for abating dust should be applied; this method should not be used as a water disposal option under any circumstances. There should be no traces of oil or solvents in water used for dust abatement.
- 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.

Prescribed Fire Emissions:

Emissions that may be created directly by BLM activities are mitigated for. Prescribed fires are conducted to reduce emissions by burning only at appropriate fuel moistures and wind speeds (among other factors), which reduces as much as possible the smoke created in locations near populated areas. All BLM activities that may potentially cause undesirable air quality impacts are also coordinated with Wyoming DEQ-AQD. Permits to conduct these activities are secured (where necessary) before the activity begins to ensure compliance with all Federal, state, and local air quality laws.

Pipelines and Communication Lines

Existing roads would be used for access to utility lines where possible 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 construction and backfilling are completed. Vegetation removed from the right-of-way would also be required to be respread to provide protection, nutrient recycling, and a seed source.

On ditches exceeding 36 inches in width, 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 (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. Instream protection structures (e.g., drop structures) may be required in drainages crossed by a pipeline to prevent erosion.

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

Grazing BMPs

Proper grazing is the practice of managing forage harvest by all grazing animals including domestic livestock at a sustainable yield that does not accelerate erosion and sedimentation above acceptable levels for the receiving waters. Proper grazing will maintain or increase plant cover including residue, which should in turn slow down or reduce runoff and increase water infiltration. Allotment Management plans, Conservation plans, or similar documents should contain a list of the BMPs most appropriate for the area. Management plans must be developed with reasonable goals and objectives, and progress toward goals and objectives must be monitored. Monitoring must include measures of actual changes in resource conditions as well as measurements of completion of objectives and tasks. BMPs have been developed for domestic animals, wildlife (big game, small game, and nongame), wild horses, grazing in wetland/riparian areas, fencing, livestock herding, access roads, water development both instream and offstream, biological and mechanical land treatment, weed and pest management, and windbreaks (Wyoming DEQ, 1997).

BLM *Healthy Rangelands Standards and Guidelines* (Monitoring Methods to Assess Wyoming Standards and Guidelines for Healthy Rangelands Appendix) will be used for assessment of water quality issues associated with BLM activities. Allotments are evaluated based on these criteria, and BMPs can be developed within Allotment Plans to improve or maintain these standards. Included in these assessments are an evaluation of water quality, wetland/riparian areas, and upland conditions, among other factors. These serve as the guidance and goals for Allotment Plans and would be used to evaluate monitoring (Monitoring and Evaluation Appendix). These BMPs are developed at the site-specific level of planning to account for local constraints and conditions.

Many grazing systems exist, and there is no single system for all vegetation types. The proper system or combination of systems must be selected to fit any given site. Consideration must be given to season of use, soil type, precipitation, range condition, stocking rates, type of livestock, plant growth rates, and ecological site potential. The numbers of all grazing animals should be maintained in balance with their

habitat. Options for developing a grazing management system at a particular location include but are not limited to the following factors:

- Livestock stocking rates
- Wild horse and/or wildlife densities
- Livestock, wild horse, or wildlife distribution
- Timing and duration of each rest (including complete rest) and grazing period
- Livestock kind and class
- Forage allocation for livestock, wildlife, and wild horses
- Water developments to improve distribution
- Salt/mineral supplements (these should be located away from water sources)
- Livestock access control
- Rehabilitation measures.

Well Pads and Facilities

Site-specific reclamation procedures would be developed in each Application for Permit to Drill (APD), right-of-way (ROW) application, or Sundry Notice submitted to BLM for review and approval prior to the authorization of surface-disturbing activities, upon which mitigation measures 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 and should consider soil permeability, water quality, and depth to ground water. Oil-based muds would be allowed in closed drilling systems. Drill cuttings and any remaining oil-based 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.

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 10^{-7}cm/hr. If ground water is encountered during setting of the conductor, a closed drilling system will be used. Pits would be fenced as specified in individual authorizations. Any pits with harmful fluids in them shall be maintained in a manner that would prevent migratory bird mortality. Drilling pits are exempt from hazardous waste regulations as long as they are covered with 5 feet of soil after use.

Abandoned sites must be satisfactorily rehabilitated in accordance with a plan approved by BLM (see Restoration section). 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. 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 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 pit that shows 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 cost of the testing and disposal would be borne by the potentially responsible party.

No surface disturbance is recommended on slopes in excess of 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.

Reclamation

Current BLM policy recognizes that there may be more than one correct way to achieve successful reclamation, and a variety of methods may be appropriate to the varying circumstances. BLM should 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, 1990a)

BLM reclamation goals emphasize (1) protection of existing native vegetation, (2) minimal disturbance of existing environment, (3) soil stabilization through establishment of ground cover, (4) establishment of native vegetation consistent with land use planning, and (5) monitoring and management of the reclamation sites to evaluate reclamation success.

All reclamation is expected to be 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 there are several different plant communities present. Livestock palatability and wildlife habitat needs would be given consideration in seed mix formulation. BLM guidance for native seed use is BLM Manual 1745 (Introduction, Transplant, Augmentation, and Reestablishment of Fish, Wildlife, and Plants), and *Executive Order 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 determined to be beneficial to the habitat affected. 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 surface disturbances. 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 Environmental Assessment (EA) (WY-037-EA6-122), and Vegetation Treatment on BLM Lands in Thirteen Western States Environmental Impact Statement (EIS) and Record of Decision (ROD) (1991). Herbicide application would be monitored by the BLM Authorized Officer.

Types of Roads

Access Roads:

Access roads should be kept to a minimum and used when dry or when all-weather surfaced. Adequate drainage and erosion minimization should be incorporated into road design. Roads should be designed to encourage the shedding of water from the surface before it 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 to reduce the concentration and velocity of water. There are two types of roads throughout the RMPPA: this discussion will address both two-track undeveloped access roads, and designed and maintained surfaced roads.

Undeveloped Two-Track Roads:

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

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

Developed or Designed Roads:

Roads would be constructed as described in BLM Manual 9113. New main artery roads would be designed to reduce sediment loading to surface waters. Where necessary, running surfaces of the roads would be graveled if the base does not already contain sufficient aggregate. Developed roads would be upgraded to an all-weather surface if access will occur during winter months or if the road is in sensitive soils.

All developed 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. 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 that 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 (BLM, 1982).

On surfaced road with grades greater than 8 percent, surface shape alone will probably not be enough to protect the road surface, and cross-drainage systems should be considered (USDA, 1997). The two most common approaches are waterbars that shed water from the surface of the road, and drainage ditches or

culverts to transport water from the road surface to a location where concentrated flow is dispersed. BLM manual section 9113 should be used for accepted specifications.

To control or reduce sediment from roads, guidance involving proper road placement and buffer strips to stream channels; surfacing; proper drainage; and in some cases redesign or closure of old roads, or seasonal closures, would be developed when necessary. Construction may also be prohibited during periods when soil material is saturated, frozen, or 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.

Reclamation of abandoned roads would include requirements for reshaping, recontouring, 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.

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.

Methods for Shedding Water From Road Surfaces:

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 necessary 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 (BLM Manual 9113).

Methods for Designing Road Crossings:

Active streams are those that maintain aquatic vegetation, animal or fish populations. Other stream crossings should follow BLM Manual 9113 specifications. The majority of active streams are intermittent or perennial, however there may be some portions of ephemeral systems that meet this definition. All 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.

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 and 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 aquatic species presence.

Where new or replacement culvert designs are chosen for crossings of active streams, 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 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 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 3 percent or culvert length would exceed 100 feet, additional consideration should be given to alternate design options such as bridges or low-water crossings because of the difficulty of providing for the passage of aquatic species through culverts installed at these sites.

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