BLM

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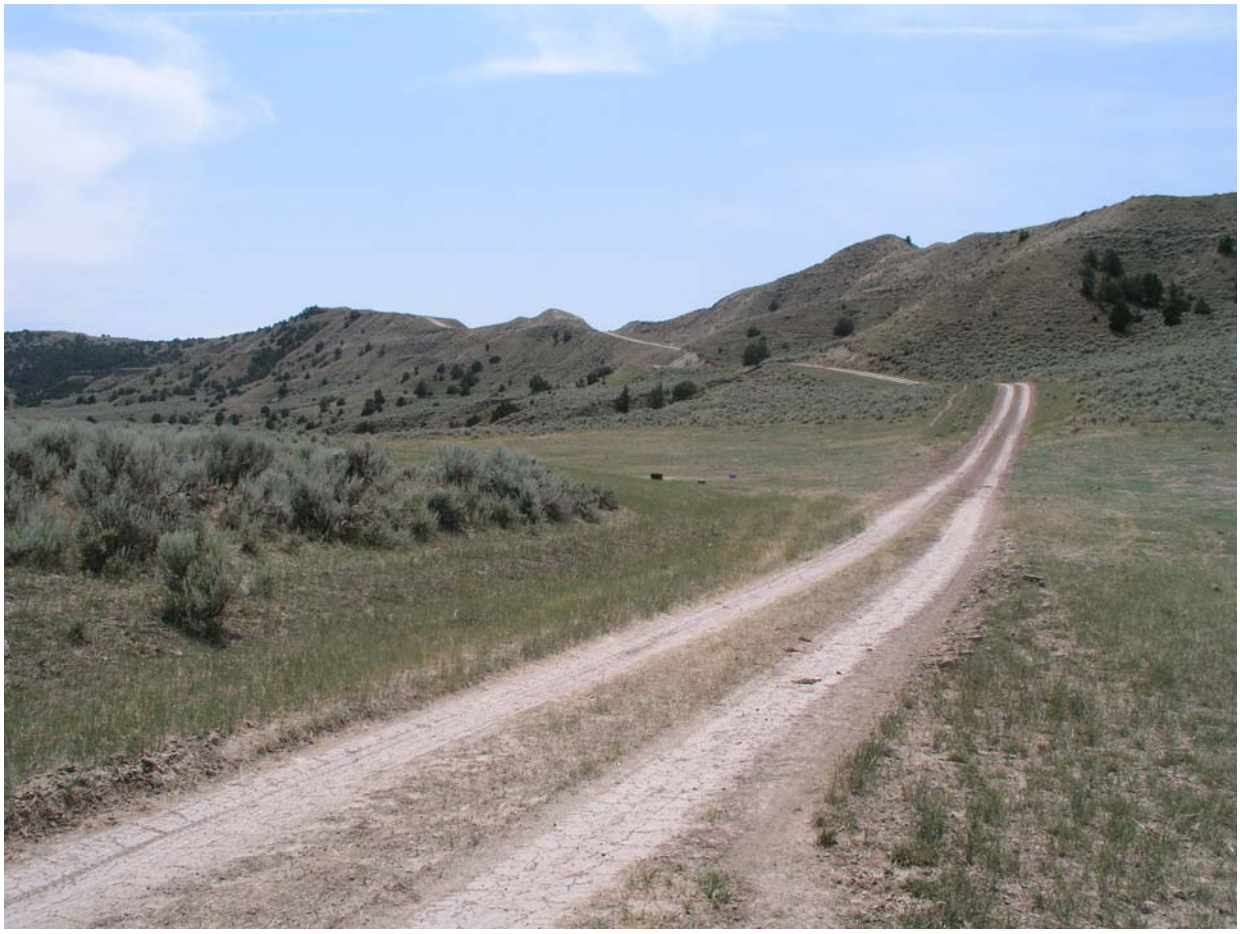
Buffalo Field Office
Oil and Gas Road Guidelines
for
Applications for Permit to Drill



INTRODUCTION

This document supersedes previous road guidance or instruction sent out by the Buffalo Field Office to the oil & gas industry. This document is intended to provide guidance to operators to help ensure that transportation planning, POD book submittals, engineering design, and road staking are such that the approval process, including onsites, proceeds as smoothly and quickly as possible. If a condition of approval (COA) for an Application for Permit to Drill (APD) requires that this document be followed, any portion of this document may be modified by a site- or project-specific COA in the APD.

Too often road (and well) locations planned by operators are found at the onsite to be improperly located or designed. The consequence of this is that BLM specialists end up performing some of the operator's planning functions during the onsite. This is not cost-effective for the operators and it stretches BLM resources, making it more difficult for the BLM to process APDs in a timely manner. With use of this guidance and good office and field planning by all of the operator's specialists (including wildlife biologists, archeologists, and civil engineers), roads (and wells) should rarely need to be moved at the onsite. Onsites should normally be a verification of the operator's good planning with few modifications to the plan by BLM specialists. The operator and the operator's road contractors (civil engineers, surveyors, and dirt contractors) should be familiar with this document.

The operator should assign experienced personnel to field locate laterals and lead-out ditches prior to or during construction (for engineered roads, these structures should be shown on drawings submitted prior to the onsite). While the primary goal for road design and construction is safety, every reasonable effort should be made to achieve the goal of minimizing disturbance. These goals can be achieved by following the *BLM Roads Manual 9113* standards. Recommended earth slopes are provided in the table in section .45, sub-section E., paragraph 4.a. of the 9113 Manual. Further, as indicated in the paragraph preceding this table, cut slopes may be steeper than recommended to reduce resource, environmental, or visual impacts as long as the angle of repose of the exposed material is not exceeded.[1] Safety concerns are sometimes cited as a reason for using flatter fill slopes on some of the steeper slopes. The flatter the fill slope, the greater the width of disturbance. However, when the 9113 Manual standards are followed, these safety concerns should be minimal if roads used as all-weather roads are constructed as all-weather roads (i.e. they are properly drained *and* surfaced with a good aggregate). An un-surfaced road composed of the soils typical in the Powder River Basin that is used during wet conditions is a much greater safety concern, even on moderately steep fill slopes, than are surfaced roads with steep fill slopes. Despite the best of intentions, there are times field personnel and the public find themselves on roads that are un-surfaced and wetter than optimum for safe travel. No matter the road grade, in steeper topography good road drainage and surfacing and, as necessary, the use of in-sloped roads is much more effective at improving safety than is the use of flatter fill slopes. Depending on the level of concern

[1] Constructing a cut slope steeper than recommended would result in a deficit of fill, assuming the fill slope would remain as recommended. How and where fill would be obtained to make up the deficit would need to be identified.

and the situation, reducing the road grade, signing, and the use of waterbars to slow down traffic can also significantly improve safety.

Scoria does not make a good surfacing material for roads. It causes a greater number of flat tires, which can result in accidents, either directly from the flat tire or when a flat is being changed and the vehicle is struck by another vehicle travelling on the road. Scoria quickly breaks down, which increases maintenance costs (e.g. more frequent replacement of the surfacing material) and dust abatement costs. If more money is not put into dust abatement on scoria roads, then the dustier conditions that result significantly decrease vehicle safety as compared to a hard durable aggregate surfacing material. The operator or the operator's road engineer should always carefully weigh the costs and benefits whenever the use of scoria is planned.

ROAD TYPES

Roads should be classified as primitive (i.e. non-constructed two-track roads or overland route corridors), improved template, and improved engineered roads. No access routes, including primitive roads, shall be flat-bladed.

Primitive Roads

Primitive roads may be existing two-track roads, two-track roads created over freshly placed utilities at locations where all of the 4 conditions for primitive roads listed below are met, two-track roads created by the operator's direct vehicle use, overland routes within a defined travel corridor leaving no defined roadway beyond crushed vegetation, or any combination of these along the route. Two-track roads created over freshly placed utilities shall be created by vehicle use on soil that has been re-contoured to near natural topography. The BLM does not have any guidance that allows the use of excavation unrelated to utility placement to create primitive roads. Excavation is used to construct improved roads. Guidance for determining when primitive road use is appropriate is given in the *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development, Fourth Edition-2007* (*Gold Book)*. The use of primitive roads shall conform to the *Gold Book*, unless indicated otherwise in this document or in project-specific conditions of approval. Primitive roads are most likely to be approved when all of the following conditions are met.

1. Road grades are 6 percent or less.
2. Side slopes are 8 percent or less.
3. Stable soils (i.e. not eroding)
4. The road services fewer than 4 wells and does not service other facilities.

Portions of a primitive road may have upgrades that do not require excavation (e.g. aggregate surface). However, no matter the type and extent of upgrades, a primitive road cannot be an all-weather road. All-weather roads must be crowned, in-sloped or out-sloped; ditched (as appropriate); and surfaced with aggregate.

A primitive road is acceptable when, among other things, drainage is not causing a problem with erosion (i.e. stable soils). Since primitive roads do not require excavation and are not used when soils are wet, the primitive road should not change the drainage characteristics. Consequently, in general, no drainage features (e.g. laterals and lead-out ditches) are required. If drainage features are required, then consideration should be given to upgrading the road to an improved template. However, when looked at on a case-by-case basis, there may be instances where it is appropriate to install a few drainage features and keep the road classification as primitive. Channel crossing upgrades may also be appropriate on a primitive road.

A section of road 300 feet or less with a grade up to 8 percent may remain primitive if there are no problems with erosion on or adjacent to the road.

Improved Template Roads

Improved template roads are constructed according to a given cross-sectional template (typical cross-section) and do not require engineering design. Construction and maintenance of improved template roads shall conform to the *Gold Book* guidance, unless indicated otherwise in this document or in project-specific conditions of approval.

Unless indicated otherwise in this document or in project-specific conditions of approval, improved template roads shall also conform to the *BLM Manual 9113* standards for turnouts, drainage elements, cattle guards, broken-back curves, horizontal curves superimposed on vertical curves, signing, and vertical and horizontal clearance. Vertical and horizontal curves should be planned and constructed to minimize the chance of the *BLM 9113 Manual* sight distance requirements being exceeded. Improved template road channel crossings shall be engineered as described in a following section titled "Engineered Channel Crossings."

Roads that are constructed through excavation and are planned to be re-vegetated should be classified as improved template or improved engineered (as appropriate), not primitive.

Improved template roads are usually in-slope with ditch, out-slope, or crown with ditch and have a running surface of 12 feet or greater with inter-visible turnouts. In-sloped templates are normally used where there is a steep uphill bank on one side and a steep downhill bank on the other. The in-sloped road helps to prevent rilling and gullying on the steep downhill bank and reduces the potential for a vehicle to slide off the downhill side of the road. Out-sloped templates are normally used when the road crosses gentle sloping terrain. The out-sloped road blends into the gentle terrain with no or little ditching or laterals and allows natural sheet flow conditions to prevail. The use of out-sloped roads in these situations prevents the creation of "dams" that concentrate the sheet flow, as can occur with crowned roads.

Improved template roads may have some segments aggregate surfaced or be entirely aggregate surfaced. If the average daily traffic (ADT) after construction is expected to be greater than 10, then the template road should be surfaced with aggregate. Un-surfaced template roads are not all-weather roads and should be used only when dry. An improved template or engineered road is required if the road services four or more wells. An

improved template road may be appropriate if (1) road grades are 8 percent or less and (2) side slopes are 20 percent or less.

If (1) the best route for a proposed template road on a hill is perpendicular to the contours of the hillside, (2) the average grade of the hill along the proposed route is 16 percent or less, and (3) the maximum grade of any 50-foot or longer segment of the proposed route is 16 percent or less, the road may remain template without engineering, no matter the total length of the road on the hill. After construction, all segments of the road must have a grade of 16 percent or less, including all 50 foot or shorter segments where the natural topography is greater than 16 percent. The dirt contractor shall be provided a centerline profile of the natural topography where the road will be constructed if any portion of the proposed route exceeds 16 percent in order to identify the segments 50 foot or shorter that need to be cut to bring the grade down to 16 percent or less and to help the dirt contractor identify where the cut material can be placed without causing the grade to exceed 16 percent. As on all roads, the *BLM 9113 Manual* standards for turnouts apply.

The exception to the previous paragraph is when a well pad, stop sign, road intersection, or other situation exists that could or would cause a sudden reduction in speed of vehicles is within 100 feet of a portion of the proposed road that exceeds 8 percent grade. In these cases, if the operator wishes to keep the same road alignment, engineering should be performed to reduce the grade to 8 percent within 100 feet of the situation that could or would cause a sudden reduction in speed of vehicles. This may require stockpiling excess cut or finding other uses for the excess cut. Alternatively, the operator may align the road at an angle up the hill to maintain a template road at a grade of 8 percent or less or engineer the road with grades of 16 percent or less.

Segments of road that do not run perpendicular to the contours may have a grade greater than 8 percent for 600 feet or less and remain a template road with BLM approval. The BLM may approve the use of a template road in these situations if (1) the grade along this section of road varies little and is less than 12 percent, (2) there is little or no active erosion along the proposed road alignment, (3) no crossings require a culvert larger than 18 inches, and (4) side slopes are 20 percent or less.

Improved Engineered Roads

Engineering design is required is some situations to ensure a safe design and/or to ensure that the potential for erosion caused by improperly constructed roads is kept to a minimum. Given the same road width and cut and fill slopes, the difference in width of disturbance between an engineered road and a template road is minimal.

Often the operator's field staff stakes out the general route of a road that is to be engineered. Then the operator's road engineer designs the road, adjusting as necessary the general route laid out by the operator's field staff. This may work fine in many cases. However, in areas of difficult access, the operator may be much better served by their engineer if they instead ask the engineer to find the route(s) to the well that have the greatest potential for reclamation and least amount of disturbance.

Improved engineered roads should conform to the road standards in the *BLM Manual 9113 (Roads), Wyoming BLM Manual 9113 Supplement, BLM Manual Handbook H-9113-1 (Guidelines for Determination of Curve Widening), and BLM Manual 9112 (Bridges and Major Culverts),* unless indicated otherwise in this document or in project-specific conditions of approval. The *BLM Manual 9113, Wyoming BLM Manual 9113 Supplement,* and *BLM Manual Handbook H-9113-1* are appendixes A, B, and C to these road specifications. Improved engineered roads are entirely surfaced with aggregate.

Engineering of improved roads will generally be required when any of the following conditions are met.

1. Road grades exceed 8 percent.
2. Side slopes are greater than 20 percent.
3. Significant use is expected (e.g. ADT expected to be >20).

POD BOOK SUBMITTALS

POD book submittals should provide sufficient information that, when out in the field with the information, a person can tell exactly what is planned at any given location on all roads (primitive, improved template, and improved engineered). This includes the exact planned cut and fill slopes. Consequently, cut and fill slopes on typicals should not include qualifiers such as “MAX” or “MIN” and each typical should show only one cut slope and one fill slope. The following should be submitted.

General

1. Completed Surface Use Data Summary Form, showing number of miles of primitive, improved template, and improved engineered roads and acres of disturbance.
2. Locations of fence crossings and cattle guards.
3. Road maintenance plan.
4. Locations of upgrades on maps or line diagrams with a unique identifier (on the map is preferable, unless this clutters up the transportation map too much). A table should be submitted listing all upgrades by the unique identifier and a description of each upgrade.
5. Turnout locations for improved template and engineered roads on plan view drawings, maps, or line diagrams.
6. State the compaction requirements for embankments (e.g. lift height and how compaction will be obtained).
7. An extra 11”x17” set of road drawings for BLM engineering field use, if legible at this size.
8. The operator must submit a reclamation plan for roads that includes interim (during production) and final reclamation. The plan must include configuration of the reshaped topography (e.g. a statement saying the road will be reclaimed back to near natural topography), seeding or other steps to reestablish vegetation, weed control, and other practices necessary to reclaim the road.

9. Narrow ridge tops, locations that would require removal of much or all of hill tops, channel crossings that would require deep cuts on the approaches, alkali flats, badlands, dunes, rock outcrops, and other areas of low reclamation potential should be avoided (see *Wyoming Reclamation Policy* which applies to all surface disturbing actions authorized, conducted, or funded by the BLM). It is better to avoid these areas as it is unlikely that roads will be permitted at these types of locations if they are on public land or if the private landowner wants the road to be reclaimed. If the operator wishes a road to be considered at a location with low reclamation potential, then a site specific reclamation plan needs to be submitted of sufficient detail that the BLM soil scientist and civil engineer can determine that the road can reasonably be reclaimed to the reclamation standards identified in the *Wyoming Reclamation Policy*. The components of a site specific reclamation plan will depend on each unique situation. On narrow ridge tops the plan may require cross-section drawings showing the amount of cut accompanied by text explaining how soil will not be lost down the slopes during construction and how soil will be replaced and contoured on the ridge top during reclamation. Or a design that will show how a road will be constructed without removing a hilltop may be required (e.g. retaining walls). Site specific reclamation plans will be needed where large cuts are planned at channel crossings and crossing approaches. The reclamation plan and/or design must provide assurance that reclamation can and will take place.
10. If pipe/utility line installation increases the average width of disturbance required for road construction, provide a cross-section drawing(s) and text that explain how and why the pipe/utility line installation increases this width.

If upgrades, turnout locations, or other information cannot be clearly depicted on the transportation map, provide line diagrams or narrative that show what work is to be done by stationing along the road. When preparing line diagrams, show intersections with other roads and section lines. On the line diagrams, provide the Township, Range, and sections the road is in and, if needed for clarity on long roads, provide a description of the road route starting from station 0+00.

Primitive Roads

If the road is part of a proposed pipe or utility line corridor, drawings of a typical detail(s) should be submitted that shows the disturbed width required for pipe/utility line installation and the location of the road within the disturbed width.

Improved Template Roads

The following shall be submitted for improved template roads.

1. Centerline profile of the natural topography of road segments where the average slope of the proposed route exceeds 12 percent or where the slope of any portion of the proposed route exceeds 16 percent, regardless of length. These data are to ensure that no portion of the proposed template road will exceed 16 percent and to provide the dirt contractor data for construction of the road in cases where short segments exceed 16 percent (see last two paragraphs of the “Road Types” section;

sub-section “Improved Template Roads”). The vertical accuracy of the centerline profile data shall be survey quality.

2. A drawing of each typical road cross-section used.
3. On maps and/or line diagrams, indicate which typical road cross-section was used for each road or road segment. There will of course be one or more short transitions when more than one typical cross-section is used on a road. No drawings are needed for these transitions.
4. A template drawing for each type of crossing (e.g. low water crossings, straight culverts, broke-back culverts, etc.) and lateral (e.g. culvert, drainage dip, waterbar).

Improved Engineered Roads

The operator shall document in the POD book all locations that do not meet a road standard in any of the BLM manuals referenced earlier in this document (e.g. road standards for horizontal curves, vertical curves, etc.) or specification set forth in this document. An explanation shall also be provided as to why each unmet standard or specification was not met. Generally, this information should be consolidated in a table in the section containing the engineering designs. Drawings and other documentation should be submitted as described in the section titled “Engineering Design Procedures.”

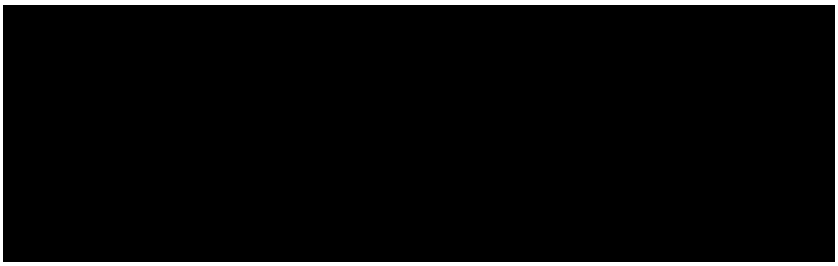
GENERAL CONSTRUCTION, DESIGN, & MAINTENANCE SPECIFICATIONS

The following applies to all road types (primitive, improved template, and improved engineered). Some of the following specifications relate to the timing of road completion. These specifications are needed because drilling traffic and other traffic on uncompleted roads poses a significant safety hazard. Erosion from uncompleted roads can also degrade the environment. The longer the road remains uncompleted, the greater the erosion potential. Due to safety and environmental concerns, drilling a well using an uncompleted road is not usually an acceptable practice. If drilling traffic damages the road, the road should be promptly repaired upon drilling completion.

1. Adequate drainage control (e.g. laterals, lead-out ditches, etc.) shall be in place before operator use of the roads begins. This includes all road types.
2. A minimum of 4 inches of aggregate shall be placed where grades exceed 8%, where average daily traffic (ADT) is expected to be greater than 10, on roads that will be used as all-weather roads, and on loop roads. These roads shall be surfaced before being put into use.
3. Scoria shall not be used for culvert bedding and fill or in low water crossings.
4. Roads shall be completed prior to drilling. If utilities are placed before road construction, all rills, gullies, and other surface defects shall be ripped to the full depth of erosion across the entire width of the roadway prior to final grading and surfacing. Thick-walled plastic SDR9 pipe 9 inches or larger in diameter may be used for temporary drainage control when a road is completed but utilities have not yet been placed. Utility placement after the road has been constructed should not normally disturb area outside of the area disturbed by the road construction. If this requires temporary removal of road structures (e.g. culverts, laterals, lead-out ditches, etc.), the

operator shall provide monitoring to ensure that the utility contractors correctly replace or re-build the structures. If the utility placement interrupts the flow of traffic on the completed road, the operator shall require that the utility contractor provide flaggers, signing, or other measures to ensure safe travel on the road. If utility placement after road construction requires disturbing area outside the area disturbed by road construction, the reason additional disturbance is required should be explained as described in item 10 of the "POD Book Submittal" section "General" sub-section of this document. To avoid disturbing a constructed road is not normally a valid reason for increasing the disturbance width for utility placement.

5. Maximum design speed on all operator-constructed and maintained roads shall not exceed 25 miles per hour.
6. On cut-slope sections of road and other sections of road where topography on one side of the road does not allow the use of lead-out (wing) ditches to relieve road ditch flow, laterals in the form of culverts, water bars, or drainage dips shall be placed according to the following minimum spacing:[2]



7. Laterals shall be constructed with a durable ditch block just downstream of the inlet and the flow through laterals shall be discharged into a lead-out ditch as soon as is practicable. For culverts used as laterals, thick-walled plastic SDR9 pipe (or pipe with similar crushing resistance characteristics) 12 inches or larger in diameter may be used in-lieu of 18-inch CMP. Minimum cover for these pipes shall be 6 inches (minimum cover for CMP is 12 inches or one-half the diameter, whichever is greater).
8. To the extent that is beneficial and feasible, lead-out ditches shall be placed between laterals and uphill of the most uphill lateral in order to reduce flow in the road ditch at the exit of the next downhill lateral, especially on steeper slopes.
9. Where laterals are not needed, the road shall be constructed to ensure that flow does not concentrate and water does not pond next to the road. As is necessary,

[2] Sometimes laterals and lead-out ditches are constructed following spacing guidelines without regard to best placement of these structures. For this reason, experienced personnel who see how the road operates for years after construction or, preferably, road design engineers, should direct the placement of these structures to ensure that a sufficient number are constructed and that they are placed in locations that do not worsen hillside erosion below the discharge point. Over about the last 5-7 years, laterals and lead-out ditches have often been inadequately utilized, with contractors instead relying on coir logs to slow down ditch flow to non-erosive velocities. Coir logs should only be used in addition to properly placed laterals and lead-out ditches to help vegetation to get established. Significant ditch erosion has been low recently due to a period of low precipitation. However, in 2008, a normal to above normal precipitation year, significant ditch erosion began to develop along many roads due to inadequate use of laterals and lead-out ditches. This situation will increasingly worsen if the area returns to near normal or above normal precipitation, unless additional laterals and lead-out ditches are constructed.

lead-out ditches shall be constructed to ensure that water is dispersed away from the road according to the minimum spacing given for laterals.

10. If feasible, road runoff shall **not** be directed into pre-existing eroded features (including small steep hillside channels with no discernable floodplain or riparian vegetation), but instead will be put to beneficial use by routing lead-out ditches away from eroded features and onto stable soils. Lead-out ditches and laterals shall be constructed as close as practicable to crossings (e.g. on the crossing approaches or just before the approach) in order to reduce the amount of ditch water and sediment directly entering drainages.
11. Channel crossing culverts **on roads that are planned to be reclaimed** will be appropriately sized in accordance with standards in *BLM Manual 9113* (including no development of static head at the culvert entrance for the 10-year discharge and no serious head or velocity damage at the 25-year discharge). The minimum diameter for channel crossing culverts will be 18 inches. Small hillside channels with no discernable floodplain or riparian vegetation do not require a culvert if the flow in the channel can be re-routed and dispersed in a non-erosive manner (see previous paragraph). Culverts shall be aligned parallel with the channel. Backfill shall be thoroughly compacted.
12. **For culvert embankments 6 feet or greater** (as measured from the downstream channel invert), the culvert(s) shall be sized per *Gold Book* standards (i.e. no development of static head at the culvert entrance for the 25-year discharge.
13. Channel crossing culverts **on roads that are planned to be permanent** shall be sized to pass the 50-year discharge without development of static head at the culvert entrance. For permanent road crossings of large drainages or permanent road crossings with high embankments, a site-specific COA should be considered that requires the channel crossing culvert be sized to pass the 100-year discharge without development of static head.
14. Filter fabric shall be placed at low water crossings, unless approved otherwise by the BLM. Culverts used in low water crossings shall not significantly constrict flow in the defined channel and shall be armored to prevent culvert embankment failure when the capacity of the culvert is exceeded. Cuts on low water crossings shall be armored as necessary to prevent erosion from high flow events.
15. On roads that service 4 or more wells, culverts 48 inches and smaller used for channel crossings shall be placed on compacted cohesionless (5 percent fines or less and maximum particle size of ¾-inch) material of 4-inch depth or greater. This same material, or native material with rocks greater than 4 inches removed, shall be compacted under the haunches of the culvert. Compaction shall continue to the top of road in 6-inch lifts. For culverts larger than 54 inches, the cohesionless bedding shall be 6 inches deep or greater. Culverts 36 inches and larger shall be placed with camber as specified by a registered professional engineer. On roads that service fewer than 4 wells, channel crossing culverts 48 inches and smaller may be placed on native materials with rocks larger than 1 inch removed. All lateral culverts may be placed on native materials with rocks larger than 1 inch removed.
16. In uniformly well-vegetated (i.e. well-grassed and riparian) swales and drainages with no defined channel, porous rock fill below the road subgrade but above the natural topography, a suitable energy dissipater at the culvert exit, or multiple culverts with energy dissipaters shall be used to maintain sheet flow and prevent channel development.

17. On primitive roads, rutting, other road damage, and adjacent surface damage, including erosion from road runoff, shall be promptly repaired. If needed in low spots to prevent further damage, fill shall be placed. If road damage or adjacent surface erosion from road runoff is caused or worsened by inadequate drainage, additional drainage shall be promptly constructed. New construction will require a Sundry. If road damage is chronic or extensive, the operator shall request a Sundry to upgrade to an improved road.
18. On improved roads (template and engineered), if erosion occurs during the life of the project, the company shall promptly repair it and control it through maintenance of existing structures, construction of additional culverts, lead-out ditches, or other modifications as necessary. New construction will require a Sundry.
19. Road surfacing material will be from a permitted pit. The parent material (rock) must be crushed and screened to meet road grade W standards as set forth in the Wyoming Supplement to *BLM Manual 9113*.
20. When crossing perennial streams containing fish, bottomless culverts or bridges shall be used to allow fish passage.

ENGINEERING DESIGN SPECIFICATIONS

The following describes the engineering design and documentation that is required. These designs and documentation should also be submitted in the POD book. If a type of design (or elements of a design) is selected that is different than agreed to at the onsite inspection, a justification should be included in the design documents. All designs and documentation within their control should be stamped by a registered Professional Engineer. Describe the soils and the assumptions used for the design (e.g., as applicable, loadings, functional classification, design speed, etc.).

Drawings

On the first page of approved final engineering drawings, A BLM civil engineer should sign and stamp “Approved.” This is in addition to the stamp and signature of a professional engineer registered in the State of Wyoming that is required of the operator’s design engineer. A plan and profile drawing and typical cross-section drawings shall be submitted (an extra 11”x17” set of drawings for BLM engineering field use should also be provided). The plan and profile drawings should indicate the Township and Range and show section lines. The plan drawing will show topographic contours. The plan and profile and typical cross-section drawings will show ***all*** engineering elements of the design including, but not limited to, energy dissipation structure layout, rock size and gradation, curve widening, vertical and horizontal curve design parameters, crossings, laterals (culverts, drainage dips, and water bars), and lead-out (wing) ditches. The plan view shall show the width of excavation and fill. For engineer designed channel or drainage crossing drawings, the length and elevation information on the drawings should be based on channel and overbank survey data and be to scale.

Show on the plans the dirt balance, including the assumed shrinkage factor and the volume of assumed shrinkage. Plan for disposal of excess cut or borrow for excess fill. Indicate on the plans what will be done with excess cut (e.g. use on other roads, stockpile, etc.). Show

on the plans stockpile and borrow locations. Indicate the average width of disturbance for each engineered road or road segment on the drawings.

Submit a typical drawing for each cross-section planned (each typical shall show only one cut or fill slope at any point on the cross-section). The plan view and/or line diagrams shall indicate which typical was used for each road or road segment. There will of course be one or more short transitions when more than one typical cross-section is used on a road. No drawings are needed for these transitions.

Submit a typical drawing for each type of crossing (e.g. low water crossings, straight culverts, broke-back culverts, etc.) and lateral (e.g. culvert, drainage dip, and waterbar) planned. These crossing and lateral typicals may reference the improved template road typicals for these structures if they are the same (or vice-versa). For crossings that require a culvert larger than 36 inches (or would if just one culvert were used) and crossings with embankments higher than six feet (as measured from the downstream channel invert), submit information as described in the following section.

Engineered Channel Crossings

Channel crossings should be sized following the criteria given in the *BLM Manual 9113*. The methodology[3] used to obtain the design flow(s) will be identified, the design flow given, and the values of the variables used for the design flow calculation listed.

The culvert analysis method used (e.g. FHWA culvert hydraulic analysis methodology) and the values of the variables used for the culvert analysis (e.g. roughness coefficient, culvert shape, length and slope, entrance conditions, etc.), will be provided. Multiple culvert hydraulic methods will be used when more than one culvert is used. Minimum velocity of the 10-year discharge through culverts is 2 feet per second.

Acceptable maximum culvert velocities of the 25-year discharge if an energy dissipation structure is not used are shown in the table below for various channel materials (Handbook of Steel Drainage & Highway Construction Products, April 1987)

Material	Velocity ft/sec
Fine Sand Colloidal	2.5
Alluvial silts noncolloidal	3.5
Stiff clay very colloidal	5.0
Alluvial silts colloidal	5.0
Shales and hardpans	6.0
Fine gravel	5.0
Graded loam to cobbles when non-colloidal	5.0
Graded silts to cobbles when colloidal	5.5
Coarse gravel noncolloidal	6.0

[3] Some potential methods include the Corps of Engineers rainfall/runoff model HEC-HMS, Natural Resources Conservation Service (NRCS) TR-20 program (http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-tr20.html), the rational method (Dunne and Leopold, 1978), and the USGS Peak Flow Method (Miller, 2003). Note that Lowham's regression equations for peak flow(1988) using physical and climatic basin characteristics have been superseded by those in WRIR 03-4107 (Miller, 2003)

If the preceding velocities cannot be maintained for the 25-year discharge, then an energy dissipation structure will be required (e.g. rip-rap, gabion mattress, etc.) to dissipate the energy or a larger culvert or culverts spaced across the width of the channel should be used in order to decrease exit flow velocity to acceptable levels.

Filter fabric is required at low water crossings. The filter fabric should be keyed in well to above the expected high water elevation. Rock should be sized to withstand the velocity of the 25-year discharge.

ROAD STAKING SPECIFICATIONS

Road Staking Specifications for the first Onsite

Proposed primitive and improved template roads shall be clearly staked and flagged along the centerline (or offset a set distance in one direction from the centerline) with staking at 300-foot intervals or within line of sight, whichever is less. The start and end of upgrades shall be staked. Upgraded areas include, but are not limited to placing aggregate, drainage structures, constructing a short template section, etc. Channel and fence crossings shall be staked on primitive and improved template roads (cattle guards and type and size of channel crossing shall be identified on the staking).

On engineered roads, the location of all structures (e.g. culverts, LWC's, lead-out ditches, cattle guards, etc.) shall be staked (cattle guards, type and size of channel crossing, and type and size of lateral shall be identified on the staking). Engineered roads with 0-2 feet of cut or fill shall have the centerline staked at 100-foot intervals. Engineered roads with 2-5 feet of cut or fill shall have the centerline and limits of disturbance staked at 100-foot intervals. Engineered roads shall be slope staked at 50-foot intervals or less when the following conditions are met.

1. Cut or fill at any point on a cross-section exceeds 5 feet.
2. Any depth of cut or fill where material moved during the construction process may inadvertently end up outside the planned disturbance area (e.g. on top of narrow, steep ridges).
3. Where the centerline of the road is 100 feet or less from a headcut or channel.

Road Staking Specifications for Construction

Construction staking shall be in place prior to construction or, if scheduled, prior to the pre-construction onsite and shall meet the staking procedures for the first onsite.