Appendix 7: MFWF – Parachute Ranch Stormwater Management Plan

encana™ natural gas

Permit Area	Permit Number
North Parachute Ranch	COR-037689

SWMP REVISIONS

Date	Description	Initials
12/14/2010	Update Legal and Local Contacts	KK
12/14/2010	Updated company name from EnCana to Encana	KK
12/14/2010	Inserted Oil and Gas Construction Field Permit Certification NOTICE OF AMENDMENT OF PERMIT COVERAGE as an option in addition to the Final Stabilization Certification - Appendix F	KK
09/06/2011	Updated Permitted SWMP Area and Map	KV
01/30/2012	Updated Legal and Local Contacts	KV
01/30/2012	Updated BMP Manual	KV
01/30/2012	Updated Stormwater Inspection Form	KV
01/30/2012	Updated Supplemental Form to reflect BMP Manual updates	KV
03/29/2012	Permit Renewal Reapplication and Legal/Local Contact Update	KV
06/07/2012	Updated Permitted SWMP Area and Map	KV
11/13/2013	Updated physical address and billing address	KV
06/04/2014	Redefined Contraction (Active and Complete) Phases and updated Legal and Local Contacts	KV

Volume 1
Master Stormwater Management Plan
North Parachute Ranch
COR-037689

Prepared by:
Encana Oil & Gas (USA) Inc.
Parachute, Colorado

Volume 1
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North Parachute Ranch
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List of Appendices

1.0 Introduction

This Master Stormwater Management Plan (Master SWMP) satisfies the Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (WQCD) General Permit No. COR-030000 issued on May 31, 2007 for Stormwater Discharges Associated with Construction Activities (the Stormwater Construction Permit). Encana Oil & Gas (USA) Inc. (Encana) has submitted a General Permit Application to WQCD, a copy of which is provided as Appendix A.

This Master SWMP has been prepared in compliance with CDPHE WQCD, the Federal Clean Water Act (CWA), and the National Pollutant Discharge Elimination Permit (NPDES) regulations found in 40 CFR, Part 122.26 for stormwater discharges.

The objectives of this Master SWMP are to:

1. Identify all potential sources of pollution which may reasonably be expected to affect the quality of stormwater discharges associated with construction activity within this Master SWMP permit area at each project site;
2. Describe the practices to be used to reduce the pollutants in stormwater discharges associated with construction activity within this Master SWMP permit area at each project site (also known as Best Management Practices (BMPs)); and ensure the practices are selected and described in accordance with good engineering practices, including the installation, implementation and maintenance requirements;
3. Be properly prepared and updated to ensure compliance with the terms and conditions of the Stormwater Construction Permit;
4. Work hand in hand with the Site Specific Records, as described in the following section; and
5. Serve as an education tool and comprehensive reference/guide to stormwater management for inspectors, surveyors, engineers, and Encana employees and contractors.

Encana construction activities fall under one of two types. Exploration and Production (E&P) sites involve the construction of well pads, roads, and other facilities. Midstream Services (also referred to as Gas Gathering) sites involve the construction of pipelines and compressor, treatment, and other facilities. This Master SWMP is intended to address stormwater management for any and all of these sites within this Master SWMP's Permit Coverage Area.

1.1 Site Specific Records

While Volume 1 of the Master SWMP contains all of the general permit area information, Volume 2 of the Master SWMP contains all of the Site Specific Records including all Individual Stormwater Site Plans (Site Plans), as discussed in Section 2.8, and all Inspection and Maintenance Reports (discussed in Section 5.4). These Site Specific Records contain information specific to each site (each well pad, compressor station, section of road/pipeline, etc.), including information on areas of disturbance, ecosystems and vegetation, soil types, percent pre-disturbance vegetation, etc. Any changes to the design of individual sites or the BMPs used at those sites will be noted on the Site Plans as those changes occur, and kept with the Site Specific Records.

The Site Specific Records (Volume 2 of the Master SWMP) are bound separately from the body of this Master SWMP; however, both are readily available during any inspection. Both the body of this SWMP (Volume 1) and the Site Specific Records (Volume 2) comprise the entire SWMP, and go hand in hand in keeping Encana in compliance with stormwater regulations. The Site Specific Records will be kept at the Encana Field office in Parachute during active construction and site inspections to ensure accurate implementation, inspections, and maintenance of BMPs, as well as timely revisions to the Site Specific Records.

1.2 SWMP Administrator

The SWMP Administrator is responsible for the process of developing, implementing, maintaining, and revising this SWMP as well as serving as the comprehensive point of contact for all aspects of the facility's SWMP.

SWMP Administrators:

- Legal Contact: Doug Rosa, Superintendent N. Piceance Ops
  143 Diamond Ave, Parachute, CO 81635
  (970)285-2686

- Local Contact: Kathy Vertiz, Environmental Specialist
  143 Diamond Ave, Parachute, CO 81635
  (970) 285-2626

2.0 Narrative Description of Master SWMP Permit Coverage Area

Name of Permit Coverage Area: North Parachute Ranch

Permit Number: COR-037689

Location of the Permit Coverage Area:

- County: Garfield County
- City: Located in Colorado approximately 10 miles West/ North West of Parachute. (See Site Maps for distance to the waters of the state.)
- Township/Section/Range:
    - Township 5S, Range 95W, Sections 15-17, 19-22, 27-34
    - Township 5S, Range 96W, Sections 3-5, 8-11, 14-17, 21-28, 33-36
    - Township 6S, Range 96W, Sections 1-36.
- Latitude/Longitude: Latitude 39.5731, Longitude 108.1093.

Activities at the Permit Coverage Area will likely involve the construction of:

- Well pads
- Access roads
- Pipelines
- Compressor stations

The above construction activities are only typical and may vary once construction begins. Up-to-date information on the construction of well pads, roads, pipelines, etc. will be kept with the Site Specific Records (Volume 2 of the Master SWMP).

2.1 Sequence of Major Activities

Site specific, scheduling, surface use agreements, and/or other constraints can and/or may dictate changes in construction sequences. Significant sequence changes are addressed in the Site Specific Records (Volume 2 of the Master SWMP). Specific details on the construction and maintenance of BMPs mentioned below are provided in the Stormwater Manual of Best Management Practices (BMP Manual) as discussed in Section 3.3.

2.1.1 Well Pads and Roads

Construction activities for well pads and roads are generally completed in the following sequence:

Preconstruction:

1. **Surveys.** Topographic, vegetation, wildlife and archeology, as dictated.
2. **Temporary BMP's.** Where physical access is available, installation of terminal perimeter and temporary sediment controls, such as wattles, silt fence and/or other as necessary. Actual BMPs used for each site are shown on the Site Plans (discussed in Section 2.8) and kept with the Site Specific Records (Volume 2 of the Master SWMP).

Construction (Active):

3. **Vegetation Clearing.** Vegetation will be cleared/grubbed and placed along the perimeter at the terminal discharge edges/points in a windrow and/or dam beyond the edge of excavation and at any run-on-protection discharge points, and/or chipped or other depending on landowner requirements.

4. **Diversions and Retention Reservoirs.** After vegetation clearing and prior to topsoil stockpiling, diversions are to be placed for run-on-protection (ROP) to prevent the greater landscape from discharging onto the planned disturbance. Temporary sediment control BMPs shall be placed at the discharge points of the ROP until permanent erosion controls can be installed along the entire length of the ROP. Diversions are to be installed along the terminal discharge edge inside of the vegetation windrows to convey site water/sediment to terminal discharge points where rough retention reservoirs are to be installed. The retention reservoir outlets are to receive temporary sediment control BMPs until permanent retention reservoirs and erosion, drainage, and sediment BMPs can be installed.
5. **Topsoil Stripping/Conservation.** All ACCESSIBLE TOPSOIL is to be removed from areas that are to be excavated, covered in subsoils, or turned into stabilized unpaved surfaces. If initial topsoil stockpile areas are insufficient to accommodate the quantities of topsoil being generated, the excess is to be placed at either end of the subsoil stockpile and segregated as much as possible. After major earthwork, grading, and erosion/drainage/sediment controls are complete, any areas that can be identified for immediate interim reclamation shall receive topsoil.
6. **General Rough Grading.** The site location will be graded to provide suitable surfaces for vehicle traffic and/or building sites, and may be graded to establish surface drainage patterns, such as berms or roadside ditches as necessary.
7. **Facility Specific Grading.** Individual facilities may require additional excavation to allow for construction of foundations. Excess soil will typically be used in general site grading.
8. **Foundation Construction.** To support facilities (such as tanks, processing equipment, etc), foundations will be constructed. Foundations may consist of select backfill, concrete spread footings, or piles. Finished support elevations are to be installed twelve to eighteen inches (12-18") above finished grade or the lowest point of the facility.
9. **Facility Construction.** Tanks, processing equipment, etc. will be constructed.

Construction (Complete):

10. **Stock Pile Soils Stabilized.** Vegetative seed mix and/or mulching will be applied.
11. **Stabilization of Unused Areas.** Areas not needed for facilities, roads, parking, or materials staging will generally be stabilized. Vegetative seed mix and/or mulching will be applied.
12. **Working Surface Stabilized.** Soil will be compacted and/or gravel surfaced.

Interim Reclamation:

13. **Gravel Surfacing.** Areas used for access, parking, or materials staging will typically be gravel surfaced.
14. **Reclamation of Unused Areas.** Areas not needed for facilities, roads, parking, or materials staging will generally be reclaimed. Salvaged topsoil will be spread when possible, and the vegetative seed mix will be applied.
15. **Application of Erosion Stabilization.** Depending on terrain (e.g. steep slopes and drainage crossings) additional measures may be applied to increase stability of the reclaimed area.

Final Reclamation:

16. **Reclamation of Post-Operation Areas.** When operation of well pad or road is no longer necessary, the area will be decommissioned and all newly disturbed areas will be reclaimed. Any remaining topsoil will be spread and the vegetative seed mix will be applied. This may occur after termination of this permit and under the coverage of a new construction permit.

2.1.2 Pipelines

Construction activities for pipelines are generally completed in the following sequence:

Preconstruction:

1. **Surveys.** Topographic, vegetation, wildlife and archeology, as dictated.
2. **Mark Right-Of-Way.** The construction right-of-way (ROW) will be marked prior to construction with laths and/or flagging.
3. **Temporary BMPs.** Encana's stormwater inspectors will determine locations to install preconstruction temporary erosion control devices, per site specific BMP installation plans and as necessary. Encana's contractor will maintain the erosion control structures as directed by the stormwater inspectors throughout all phases of construction, or until permanent erosion control measures are installed. Actual BMPs used for each site are shown on the Site Plans, which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

Construction (Active):

4. **Vegetation Clearing.** If necessary, vegetation will be cleared and placed in a windrow at the edge of the work area to be used later in reclamation activities, removed from the construction site, or burned/chipped depending on landowner requirements. Details for windrows are provided within the Stockpiling BMP of the BMP Manual (discussed in Section 3.3).
5. **Topsoil Stripping.** All ACCESSIBLE TOPSOIL (from the entire width of the right-of-way) will be removed and temporarily stockpiled along the up-hill side of the right-of-way (if terrain grades will allow) for later use in reclamation activities.
6. **General Grading.** For pipeline segments that occur in relatively rough terrain, general grading will be conducted to create a safe and workable ground surface. This is generally done to form a relatively level work surface on steep cross slopes and to reduce slopes in undulating terrain (arroyo and wash crossings). The site location will be graded to provide suitable surfaces for vehicle traffic and/or building sites, and may be graded to establish surface drainage patterns, such as berms or roadside ditches as necessary.
7. **Trench Excavation.** The trench needed for pipeline installation is almost always off-set in the ROW. The surveyors may indicate the location of the trench on their pipeline lateral. Generally, the trench will be located in the first third of the ROW. The remaining two thirds of the ROW will be used for working space. The trench depth and width will vary with the number of pipes to be installed and the pipe diameter. Generally, a 4-foot deep trench will be excavated by track-mounted excavators. The ditch will be excavated and sloped in accordance with OSHA specifications. The cover from top of pipe to ground level will be a minimum of 36 inches. Where rock is encountered, tractor-mounted mechanical rippers or rock trenching equipment may be used to facilitate excavation. The trench will be excavated and subsoil material stockpiled within the confines of the approved right-of-way limits unless a temporary use area is approved from the proper agency. Trench spoil will be stored in a separate location from the previously segregated topsoil.
8. **Pipe Installation.** Pipe installation will include stringing, bending for horizontal or vertical angles in the alignment, welding the pipe segments together, coating the joint areas to prevent corrosion, and then lowering-in and padding.
9. **Stringing.** Pipe will be hauled by truck to the pipeline ROW. Each joint of pipe will be unloaded and placed parallel to the ditch.
10. **Bending.** After the joints of pipe are strung along the ditch, individual joints of pipe may need to be bent to accommodate horizontal and vertical changes in direction. Field bends will be made utilizing a hydraulically operated bending machine. Where the deflection of a bend exceeds the allowable limits for a field-bent pipe, factory (induction) bends will be installed.
11. **Welding.** After the pipe joints are bent, the pipe is lined up end-to-end and clamped into position. The pipe is then welded in conformance with 49 CFR Part 192, Subpart E. "Welding of Steel Pipelines" and API 1104, "Standard for Welding Pipelines and Related Facilities".

12. **Welding Inspection.** Welds will be visually inspected by a qualified inspector. Any defects will be repaired or cut out as required under the specified regulations and standards.
13. **Coating.** To prevent corrosion, the pipe will be externally coated with fusion bonded epoxy coating prior to delivery. After welding, field joints will be coated with fusion bond epoxy coating, tape and primer, or shrink sleeves. Before the pipe is lowered into the ditch, the pipeline coating will be visually inspected and tested with an electronic detector, and any faults or scratches will be repaired.
14. **Lowering-In and Padding.** Once the pipe coating operation has been completed, a section of the pipe will be lowered into the ditch. Side-boom tractors may be used to simultaneously lift the pipe, position it over the ditch, and lower it in place. Inspection will be conducted to verify: that minimum cover is provided; the trench bottom is free of rocks, debris, etc.; external pipe coating is not damaged; and the pipe is properly fitted and installed into the ditch. Specialized padding machines will be used to sift soil fines from the excavated subsoil to provide rock-free pipeline padding and bedding. In rocky areas, padding material or a rock shield will be used to protect the pipe. Topsoil will not be used to pad the pipe. At the completion of lowering-in and padding activities the contractor may install trench breakers around the pipelines to minimize subsurface water flow. Details for trench breakers are provided within the BMP Manual (discussed in Section 3.3).
15. **Backfilling.** Backfilling will begin after a section of the pipe has been successfully placed in the ditch and final inspection has been completed. Backfilling will be conducted using a bulldozer, rotary auger backfill, padding machine or other suitable equipment. Backfilling the trench will use the subsoil previously excavated from the trench. Backfill will be graded and compacted, where necessary for ground stability, by being tamped or walked in with a wheeled or track vehicle. Compaction will be performed to the extent that there are no voids in the trench. Any excavated materials or materials unfit for backfill will be utilized or properly disposed of in conformance with applicable laws or regulations.
16. **General Grading.** If general grading was conducted to facilitate pipeline construction, these materials will be replaced and graded to recreate the preconstruction topography.

Final Reclamation:

17. **Cleanup.** Cleanup activities will be initiated as soon as practicable after backfilling activities have been completed. All construction-related debris will be removed and disposed of at an approved disposal facility.
18. **Subsoil and Topsoil Placement.** Subsoil will be evenly re-contoured across the right-of-way to pre-construction conditions. After the subsoil has been re-spread the contractor will spread the previously segregated topsoil back across the right-of-way. The topsoil will be evenly spread to original contours.
19. **Vegetation.** After any remaining topsoil is spread, the vegetative seed mix will be applied. The area will be revegetated according to private landowner Surface Use Agreements and/or according to the BLM/Forest Service reclamation requirements. Details for revegetation are provided within the BMP Manual (discussed in Section 3.3) and the Revegetation Manual (provided as Appendix B).
20. **Application of Erosion Stabilization.** Depending on terrain (e.g. steep slopes and drainage crossings) additional measures may be applied to increase stability of the reclaimed area. Possible erosion stabilization methods are provided within the BMP Manual (discussed in Section 3.3). Actual locations and measures used are shown on the Site Plans, which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

2.1.3 Compressor Stations, Treatment Facilities, or Other Facilities.

Construction activities for compressor stations, treatment facilities, and other facilities are generally completed in the following sequence:

Preconstruction:

1. **Surveys.** Topographic, vegetation, wildlife and archeology, as dictated.

2. **Temporary BMP's.** Where physical access is available, installation of terminal perimeter and temporary sediment controls, such as wattles, silt fence and/or other as necessary. Actual BMPs used for each site are shown on the Site Plans, which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

Construction (Active):

3. **Vegetation Clearing.** Vegetation will be cleared/grubbed and placed along the perimeter at the terminal discharge edges/points in a windrow and/or dam beyond the edge of excavation and at any run-on-protection discharge points, and/or chipped or other depending on landowner requirements.
4. **Diversions and Retention Reservoirs.** After vegetation clearing and prior to topsoil stockpiling, diversion are to be placed for ROP to prevent the greater landscape from discharging onto the planned disturbance. Temporary sediment control BMP's shall be placed at the discharge points of the ROP until permanent erosion controls can be installed along the entire length of the ROP. Diversions are to be installed along the terminal discharge edge inside of the vegetation windrows to convey site water/sediment to terminal discharge points where rough retention reservoirs are to be installed. The retention reservoir outlets are to receive temporary sediment control BMP's until permanent retention reservoirs and erosion, drainage, and sediment BMP's can be installed.
5. **Topsoil Stripping/Conservation.** All ACCESSIBLE TOPSOIL is to be removed from areas that are to be excavated, covered in subsoils, or turned into stabilized unpaved surfaces. If initial topsoil stockpile areas are insufficient to accommodate the quantities of topsoil being generated, the excess is to be placed at either end of the subsoil stockpile and segregated as much as possible. After major earthwork, grading, and erosion/drainage/sediment controls are complete, any areas that can be identified for immediate interim reclamation shall receive topsoil.
6. **General Rough Grading.** The site location will be graded to provide suitable surfaces for building sites and vehicle traffic, and may be graded to establish surface drainage patterns, such as berms or roadside ditches as necessary.
7. **Excavation.** Soil will be excavated to allow for the construction of foundations. Trenches will be excavated for all underground piping and conduit. Excess soil will typically be used in general site grading.
8. **Foundation Construction.** Foundations will be constructed to support facility buildings. Foundations may consist of select backfill, concrete spread footings, piles, etc. Finished support elevations are to be installed according to engineered drawings or twelve to eighteen inches (12-18") above finished grade or the lowest point of the facility.
9. **Facility Construction.** Buildings, tanks, processing equipment, etc. will be constructed. Utilities will be installed.

Construction (Complete):

10. **Stock Pile Soils Stabilized.** Vegetative seed mix and/or mulching will be applied.
11. **Stabilization of Unused Areas.** Areas not needed for facilities, roads, parking, or materials staging will generally be stabilized. Vegetative seed mix and/or mulching will be applied.
12. **Working Surface Stabilized.** Soil will be compacted and/or gravel surfaced.

Interim Reclamation:

13. **Landscaping.** If necessary, certain areas will be spread with topsoil and landscaped.
14. **Gravel Surfacing.** Areas used for access, parking, or materials staging will typically be gravel surfaced.
15. **Reclamation of Unused Areas.** Areas not needed for facilities, roads, parking, or materials staging will generally be reclaimed. Salvaged topsoil will be spread and the vegetative seed mix will be applied.

16. **Application of Erosion Stabilization.** Depending on terrain (e.g. steep slopes and drainage crossings) additional measures may be applied to increase stability of the reclaimed area. Possible erosion stabilization methods are provided within the BMP Manual (discussed in Section 3.3). Actual locations and measures used are shown on the Site Plans, which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

Final Reclamation:

17. **Reclamation of Closed Facilities.** When facilities are no longer necessary, the buildings may be demolished, according to approved procedures. All construction materials will be removed and the newly disturbed areas will be reclaimed. Any remaining topsoil will be spread and the vegetative seed mix will be applied. This may occur after termination of this permit and under the coverage of a new construction permit.

2.1.4 Man Camps and Helicopter Pads

Construction activities for man camps, helicopter pads, and other small areas are generally completed in the following sequence:

Preconstruction:

1. **Surveys.** Topographic, vegetation, wildlife and archeology, as dictated.
2. **Temporary BMPs.** Where physical access is available, installation of terminal perimeter and temporary sediment controls, such as wattles, silt fence and/or other as necessary. Actual BMPs used for each site are shown on the Site Plans, which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

Construction:

3. **Vegetation clearing.** Vegetation will be cleared/grubbed and placed along the perimeter at the terminal discharge edges/points in a windrow and/or dam beyond the edge of excavation and at any run-on-protection discharge points, and/or chipped or other depending on landowner requirements.
4. **Diversions and Retention Reservoirs.** After vegetation clearing and prior to topsoil stockpiling, diversions may be placed for ROP to prevent the greater landscape from discharging onto the planned disturbance. Temporary sediment control BMPs shall be placed at the discharge points of the ROP until permanent erosion controls can be installed along the entire length of the ROP. Diversions may be installed along the terminal discharge edge inside of the vegetation windrows to convey site water/sediment to terminal discharge points where rough retention reservoirs are to be installed. The retention reservoir outlets may receive temporary sediment control BMPs until permanent retention reservoirs and erosion, drainage, and sediment BMPs can be installed.
5. **Topsoil Stripping/Conservation.** All ACCESSIBLE TOPSOIL is to be removed from areas that are to be excavated, covered in subsoils, or turned into stabilized unpaved surfaces. If initial topsoil stockpile areas are insufficient to accommodate the quantities of topsoil being generated, the excess is to be placed at either end of the subsoil stockpile and segregated as much as possible. After major earthwork, grading, and erosion/drainage/sediment controls are complete, any areas that can be identified for immediate interim reclamation shall receive topsoil.
6. **General Rough Grading.** The site location will be graded to provide suitable surfaces for vehicle traffic, trailers, etc. and may be graded to establish surface drainage patterns, such as berms or roadside ditches as necessary.
7. **Facility Construction.** Trailers, buildings, or other structures will be installed or constructed.

Interim Reclamation:

8. **Gravel Surfacing.** Areas used for access, parking, or materials staging will typically be gravel surfaced.

9. **Reclamation of Unused Areas.** Areas not needed for facilities, roads, parking, or materials staging will generally be reclaimed. Salvaged topsoil will be spread and the vegetative seed mix will be applied.

10. **Application of Erosion Stabilization.** Depending on terrain (e.g. steep slopes and drainage crossings) additional measures may be applied to increase stability of the reclaimed area. Possible erosion stabilization methods are provided within the BMP Manual (discussed in Section 3.3). Actual locations and measures used are shown on the Site Plans, which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

Final Reclamation:

11. **Reclamation of Post-Operation Areas.** When operation of man camp or helicopter pad is no longer necessary, the area may be decommissioned and all newly disturbed areas will be reclaimed. Any remaining topsoil will be spread and the vegetative seed mix will be applied. This may occur after termination of this permit and under the coverage of a new construction permit.

2.2 Area Estimates

The total Permit Coverage Area is estimated to be approximately 27,000 Acres. The area that will undergo clearing, excavation, and/or grading is estimated to be approximately 400 acres. Because the area will vary over time, these are only approximate estimates. This information is used to help determine the extent of control measures (BMPs) needed.

2.3 Description of Existing Topography and Soils

The Permit Coverage Area consists of three climatic zones and are referred to as the Upper, Middle and Lower Zones.

The Upper Zone exists at elevations between 7,500 to 8,500 feet ASL; excluding southern facing slopes greater than 20%. Annual precipitation within this zone ranges from 16 to 25 inches annually. The soils within the Upper Zone are primarily loam textured soils within the Parachute-Rhone-Irigul series. These soils are mostly well drained, cool soils with dark-colored organic-rich surface layers derived from shale and sandstone. Soil textures above the rim are generally loam with loam to clay loam sub-soils and range in depth from <20" on ridges to >60" in swales. All of the upland soils above the rim are in low to medium erosion classes.

The Middle Zone exists at elevations between 7,500 to 6,000 feet ASL; including southern facing slopes greater than 20%. Annual precipitation within this zone ranges from 13 to 14 inches annually. The area below the rim encompassing the cliffs, talus and steep colluvial slope at the base of the cliffs are derived from the Green River shale. Below the cliffs and talus is a zone of soils formed from colluvium and Wasatch Formations. Soils are shallow, poorly developed and there are many rock outcrops and badlands. Badlands are steep, nearly barren areas dissected by many ephemeral drainages. Soils on the upper slopes of this zone have a thin, organic-rich surface layer and little development of soil horizons. Soils on lower slopes are shallow to moderately deep and are well-drained. Surface texture is loam, clay loam, or silty clay loam with variable amounts of gravel, cobbles and boulders, talus slopes and colluvial slopes below rock outcrops. Soils are moderate to highly alkaline. Sub-soils usually have higher clay content and are calcareous. Erosion hazard is usually severe.

The Lower Zone exists at elevations below 6,000 feet ASL and consists of lower terraces and floodplains along the valley bottoms of major drainages. Annual precipitation within this zone ranges from 10 to 13 inches annually. Soils in the Lower Zone are calcareous, moderate to strongly alkaline, some highly saline, loams and silty clay loams on benches, terraces and alluvial fans. Floodplain soils are sandy loam or loam stratified with sand, gravel or cobbles derived from shale or sandstone. Soils formed in the alluvium are derived from sandstones, shale's and marls and appear on benches, terraces, alluvial fans and floodplains in the Lower Zone. Surface texture ranges from loam and sandy loam to clay loam with sub-soils of sandy loam to clay.

A map and table summarizing the existing soils within the Permit Coverage Area (including permeability, available water capacity, surface runoff, and erosion hazard of those soils) are provided in Appendix C.

2.4 Description of Existing Vegetation

The existing percent vegetative ground cover for each well pad, section of roadway/pipeline, etc. within the Permit Coverage Area is estimated on each inspection and maintenance report form (discussed in Section 5.4), which are kept with the Site Specific Records (Volume 2 of the Master SWMP). A map indicating the existing ecosystem types within the Permit Coverage Area is provided in Appendix C.

A description of the existing vegetation within each ecosystem (Mutel, 1992) is as follows:

1. **Grasslands**

    a. **Plains Grasslands.** Plains grasslands are dominated by a mixture of blue grama *(Chondrosum gracile)* and buffalograss *(Buchloe dactyloides)*. Interspersed are occasional shrubs and bright flowered forbs, most of which are members of the pea and sunflower families. Taller grass species cover 10 to 25 percent of the ground of little-grazed, moist sites. Most are perennial bunch-grasses up to three feet tall. Needle-and-thread *(Stipa comata)*, sand dropseed *(Sporobolus cryptandrus)*, side-oats grama *(Bouteloua curtipendula)*, western wheatgrass *(Pascopyrum smithii)*, Junegrass *(Koeleria macrantha)*, and red three-awn *(Aristida purpurea)* are other common species. Common forbs consist of prickly pear *(Opuntia polyacantha),* pasture sage *(Artemisia frigida)*, and yucca *(Yucca glauca).*

    b. **Mountain Grasslands and Meadows.** Natural wet meadows and fens are dominated by moisture-loving species, primarily members of the sedge and rush families. Spike-rush *(Eleocharis palustris)*, sedges, Canadian reedgrass *(Calamagrostis canadensis)*, and tufted hairgrass *(Deschampsia cespitosa)* are common. Natural dry meadows are filled with members of the grass family. Bunchgrasses dominate at low elevations. Needle-and-thread, mountain muhly *(Muhlenbergia montana)*, Junegrass, blue grama, and species of wheatgrass and bluegrass are common. Successional meadows contain a combination of weedy, introduced plants and plants typical of dry, rocky slopes, such as common dandelion *(Taraxacum officinale)*, golden banner *(Thermopsis divaricarpa)*, Colorado locoweed *(Oxytropic sericea)*, mountain pussytoes *(Antennaria parvifolia)*, showy daisies *(Erigeron speciosus)*, stonecrop *(Sedum lanceolatum)*, and some sedges *(Carex* ssp.). Mountain grasslands, where Thurber fescue *(Festuca thurberi)* and mountain muhly were once the dominant grasses, are now largely dominated by blue grama, Canada bluegrass *(Poa compressa)*, foxtail barley *(Critesion jubatum)*, and other species as a result of grazing.

2. **Riparian Ecosystems**

    a. **Lowland Riparian Ecosystems.** The lowland riparian ecosystem is dominated by the plains cottonwood *(Populus deltoidea* ssp. *occidentalis),* the valley cottonwood *(Populus deltoidea* ssp. *wislizenii)* and the peach-leaved willow *(Salix amygdaloides).* Common shrubs and herbaceous plants include snowberry *(Symphoricarpos occidentalis)*, sandbar willow *(Salix exigua),* bulrush *(Schoenoplectus lacustris),* broad-leaved cat-tail *(Typha latifolia),* prairie cord-grass *(Spartina pectinata),* and western wheatgrass.

    b. **Mountain Riparian Ecosystems.** The mountain riparian ecosystem is dominated by quaking aspen *(Populus tremuloides*), lanceleaf cottonwood *(Populus X acuminata)*, narrowleaf cottonwood (*Populus angustifolia*), and Colorado blue spruce *(Picea pungens)*. Common shrubs include alder *(Alnus incana)*, river birch *(Betula fontinalis)*, chokecherry *(Padus virginiana)*, common gooseberry *(Ribes inerme)*, bush honeysuckle *(Distegia involucrata)*, and mountain maple *(Acer glabrum)*. The lush riparian herbaceous understory includes forbs, grasses, sedges, rushes, climbing vines, mosses, lichens, and liverworts. Weedy invaders are also common.

3. **Shrublands.** Shrub communities include semidesert shrublands found in dry lowlands, sagebrush shrublands that occupy a wide range of elevation from the Colorado Plateau to high mountain valleys, and montane shrublands other than sagebrush, characteristic of foothills and mountain regions.

a. **Semidesert Shrublands.** Common shrubs include Great Basin big sagebrush (*Seriphidium tridentatum*), greasewood *(Sarcobatus vermiculatus)*, rabbitbrush *(Chrysothamnus)*, four-winged saltbush *(Atriplex canescens)*, and shadscale *(Atriplex confertifolia)*. Common grasses and forbs include galletagrass (*Hilaria jamesii*), blue grama, alkali sacaton (*Sporobolus airoides*), nodding eriogonum (*Eriogonum cernuum*), copper mallow (*Sphaeralcea coccinea*), and prince's plume (*Stanleya pinnata*).

b. **Sagebrush Shrublands.** Common shrubs include Great Basin big sagebrush, mountain big sagebrush (*Seriphidium vaseyanum)*, rabbitbrush, and serviceberry *(Amelanchier alnifolia)*. Common grasses and forbs include nodding eriogonum, copper mallow, and Indian Paintbrush (*Castilleja* spp.).

c. **Montane Shrublands.** Common shrubs include mountain mahogany (*Cercocarpus*), Gamble oak (*Quercus gambelii*), rabbitbrush, serviceberry, and skunkbrush *(Rhus aromatica)*. Common grasses and forbs include needle-and-thread, western wheatgrass, copper mallow, and Indian Paintbrush.

4. **Pinyon-Juniper Woodlands.** Pinyon-juniper woodlands consist of scattered Utah juniper interspersed with big sagebrush. Pinyon pine is a minor component. Several other shrub species also occur in this community, including snowberry, bitterbrush *(Purshia tridentata)*, snakeweed *(Gutierrezia sarothrae)*, and serviceberry. In general, the sparse herbaceous layer consists of graminoids such as cheatgrass *(Anisantha tectorum)*, Kentucky bluegrass *(Poa pratensis)*, western wheatgrass, Indian ricegrass *(Oryzopsis hymenoides)*, and squirreltail *(Elymus elymoides)*. Forbs include Tracy's thistle *(Cirsium tracyi)*, mariposa lily *(Calochortus nuttallii)*, western wallflower *(Erysimum capitatum)*, tapertip onion *(Allium acuminatum)*, yarrow *(Achillea lanulosa)*, stemless four-nerve daisy *(Tetraneuris acaulis)*, and sharpleaf twinpod *(Physaria acutifolia)*. All of these are native species, except for cheatgrass (an invasive, non-native annual species) and Kentucky bluegrass (a widely naturalized non-native perennial species).

5. **Montane Forests**

a. **Ponderosa Pine Forests.** These forests are dominated by the ponderosa pine (Pinus ponderosa) and the Rocky Mountain juniper (Savina scopulorum). Common shrubs and herbaceous plants include the wax currant (*Ribes cereum*), blue grama, side-oats grama, Junegrass, needle-and-thread, spike fescue (*Leucopoa kingii*), and sulphur flower (*Eriogonum umbellatum*).

b. **Douglas Fir Forests.** These forests are dominated by the Douglas fir (*Pseudotsuga menziesii*). Common shrubs and herbaceous plants include common juniper (*Juniperus communis*), kinnikinnik (*Arctostaphylos*), mountain maple (*Acer glabrum*), mountain lover (*Paxistima myrsinites*), heart-leaved arnica *(Arnica cordifolia)*, and false Solomon's seal (*Maianthemum* spp.)

c. **Aspen forests.** Quaking aspen generally occur on north-facing slopes, and along drainage swales. The aspen forest generally has an understory of Wood's rose (*Rosa woodsii*), Colorado blue columbine (*Aquilegia caerulea*), showy daisy, Thurber fescue, white geranium (*Geranium richardsonii*), common lupine *(Lupinus argenteus*), Fendler meadowrue (*Thalictrum fendleri*), and American vetch (*Vicia americana*).

d. **Lodgepole Pine Forests.** These forests are dominated by the lodgepile pine *(Pinus contorta*). Common shrubs and herbaceous plants include broom huckleberry *(Vaccinium scoparium)*, common juniper, kinnikinnik, sticky-laurel *(Ceanothus velutinus)*, and heart-leaved arnica.

6. **Subalpine Forests**

a. **Engelmann Spruce and Subalpine Fir.** Engelmann spruce *(Picea engelmannii)* and subalpine fir *(Abies bifolia)* trees are the dominant species in this type of forest, however lodgepole pine, aspen, and sedge-bluegrass have been known to invade in areas which have been severely burned. Understory growth is patchy and consists primarily of dense, low-growing blueberry *(Vaccinium myrtillus)* and broom huckleberry bushes. Moisture-loving shrubs and herbs such as broad-leaved arnica *(Arnica latifolia)* and heart-leaved arnica, Jacob's ladder *(Polemonium*

pulcherrimum), curled lousewort *(Pedicularis racemosa)*, elk sedge *(Carex geyeri)*, and lesser wintergreen *(Pyrola minor)* are interspersed among the huckleberry.

b. **Limber and Bristlecone Pine Woodlands.** Limber pine *(Pinus flexilis)* and bristlecone pine *(Pinus aristata)* trees are the only tree species that can invade this harsh ecosystem. Common species among the sparse understory consist of common juniper, kinnikinnik*,* sticky-laurel, Junegrass, stonecrop, Colorado locoweed, and whitlow-wort *(Draba* spp.). Lichens cover exposed rock surfaces.

7. **Alpine Tundra.** Tundra vegetation consists of a low growth of shrubs, cushion plants, and small forbs with brilliantly colored flowers, and of lush meadows of narrow-leaved sedges and grasses. These plants cover gentle slopes and rock crevices filled with soil. Rock surfaces are partially covered with more primitive plants – lichens and mosses. Shrubs consist of arctic willow *(Salix arctica)*, barrenground *(Salix brachycarpa)*, planeleaf *(Salix planifolia)*, and snow *(Salix reticulate* ssp. *nivalis)*. Common grasses are alpine bluegrass *(Poa arctica)*, tufted hairgrass *(Deschampsia cespitosa)*, and kobresia *(Kobresia myosuroides)*. The most common forbs are alpine avens *(Acomastylis rossii)*, American bistort *(Bistorta bistortoides)*, marsh marigold *(Psychrophila leptosepala)*, old-man-on-the-mountain *(Rydbergia grandiflora)*, moss pink *(Silene acualis)*, rock selaginella *(Selaginella densa)*, and alpine sandwort *(Lidia obtusiloba)*. All plant species are slow-growing perennials except for the rare annual koenigia, a tiny member of the buckwheat family.

8. **Urban Areas.** Urban areas contain an increased density of human-created structures in comparison to the areas surrounding it. Depending on the area, vegetation may account for anywhere between 20 and 70 percent of the total land cover, with the remaining portion being constructed materials. Types of vegetation within urban areas may be any combination of the above ecosystems, and may include areas of blue grass yards and parks.

9. **Cropland**. Cropland vegetation may consist of wheat, corn, soybeans, or a variety of many other crops. Cropland may either lie fallow (bare of any crops) or contain crops at any stage of growth from seedlings to mature plants.

Detailed Description of Existing Vegetation

Mountain Grasslands and Meadows. Natural wet meadows and fens are dominated by moisture-loving species, primarily members of the sedge and rush families. Spike-rush *(Eleocharis palustris)*, sedges, Canadian reedgrass *(Calamagrostis canadensis)*, and tufted hairgrass *(Deschampsia cespitosa)* are common. Natural dry meadows are filled with members of the grass family. Bunchgrasses dominate at low elevations. Needle-and-thread, mountain muhly *(Muhlenbergia montana)*, Junegrass, blue grama, and species of wheatgrass and bluegrass are common. Successional meadows contain a combination of weedy, introduced plants and plants typical of dry, rocky slopes, such as common dandelion *(Taraxacum officinale)*, golden banner *(Thermopsis divaricarpa)*, Colorado locoweed *(Oxytropic sericea)*, mountain pussytoes *(Antennaria parvifolia)*, showy daisies *(Erigeron speciosus)*, stonecrop *(Sedum lanceolatum)*, and some sedges *(Carex* ssp.). Mountain grasslands, where Thurber fescue *(Festuca thurberi)* and mountain muhly were once the dominant grasses, are now largely dominated by blue grama, Canada bluegrass *(Poa compressa)*, foxtail barley *(Critesion jubatum)*, and other species as a result of grazing.

Riparian Ecosystems

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g. **Aspen forests.** Quaking aspen generally occur on north-facing slopes, and along drainage swales. The aspen forest generally has an understory of Wood's rose (*Rosa woodsii*), Colorado blue columbine (*Aquilegia caerulea*), showy daisy, Thurber fescue, white geranium (*Geranium richardsonii*), common lupine *(Lupinus argenteus*), Fendler meadowrue (*Thalictrum fendleri*), and American vetch (*Vicia americana*).

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Urban Areas. Urban areas contain an increased density of human-created structures in comparison to the areas surrounding it. Depending on the area, vegetation may account for anywhere between 20 and 70 percent of the total land cover, with the remaining portion being constructed materials. Types of vegetation within urban areas may be any combination of the above ecosystems, and may include areas of blue grass yards and parks.

Cropland. Cropland vegetation may consist of wheat, corn, soybeans, or a variety of many other crops. Cropland may either lie fallow (bare of any crops) or contain crops at any stage of growth from seedlings to mature plants.

2.5 Identification of Potential Pollution Sources

Potential sources of pollution are associated with all phases of the project from the start of construction though interim reclamation and up until final stabilization has occurred. Final stabilization occurs when construction activities have been completed and all disturbed areas have been either built on, paved, or a uniform vegetative cover has been established with a density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed.

The most common source of pollution during construction is sediment resulting from the erosion of recently cleared and/or graded areas, such as cut/fill slopes and soil stockpiles. However, there may be many potential pollution sources at any given site. The following types of conditions that might affect the potential for a pollutant source to contribute pollutants to stormwater (CDPHE, 2007B) shall be evaluated:

- The frequency of the activity (i.e., does it occur every day or just once a month? can it be scheduled to occur only during dry weather?);
- Characteristics of the area where the activity takes place (i.e., surface type (pavement, gravel, vegetation, etc.), physical characteristics (site gradients, slope lengths, etc.));
- Ability of primary and secondary containment (fuel tanks, drum storage, etc.) at product storage and loading/unloading facilities to prevent and contain spills and leaks;
- Proximity of product storage and loading/unloading facilities to waterways or drainage facilities;
- Concentration and toxicity of materials which may to be found in the site's stormwater runoff; and
- Contamination of storage facilities/containment with stored materials (i.e., used oil drums or tanks coated with spilled oil).

The following items are potential sources of pollutants at the North Parachute Ranch. Each of the potential sources of pollutants will be controlled using one or more of the following types of BMPs: Erosion Controls, Drainage Controls, Sediment Controls or Non-Stormwater Controls. Descriptions and details for each of these types of BMPs are provided in the BMP Manual (discussed in Section 3.3). Actual BMPs used at each site are shown on the Site Plans (discussed in Section 5.4).

Construction (Active and Complete):

- All Disturbed and Stored Soils: Erosion Controls, Drainage Controls, Sediment Controls.
- Vehicle Tracking of Sediments: Sediment Controls, Non-Stormwater Controls.
- Management of Contaminated Soils: Non-Stormwater Controls.
- Loading and Unloading Operations: Non-Stormwater Controls.
- Outdoor Storage Activities (Building Materials, Fertilizers, Chemicals, etc.): Non-Stormwater Controls.
- Vehicle and Equipment Maintenance and Fueling: Non-Stormwater Controls.
- Significant Dust or Particulate Generating Processes: Non-Stormwater Controls.

- Routine Maintenance Activities Involving Fertilizers, Pesticides, Detergents, Fuels, Solvents, Oils, etc.: Non-Stormwater Controls.
- On-Site Waste Management Practices (Waste Piles, Liquid Wastes, Dumpsters, etc.): Non-Stormwater Controls.
- Concrete Truck/Equipment Washing, Including the Concrete Truck Chute and Associated Fixtures and Equipment: Non-Stormwater Controls.
- Dedicated Asphalt and Concrete Batch Plants: There will be no asphalt or concrete batch plants located within the Permit Coverage Area of this SWMP.
- Non-Industrial Waste Sources Such as Worker Trash and Portable Toilets: Non-Stormwater Controls.

Interim/Final Reclamation:

- All Disturbed and Stored Soils: Erosion Controls, Drainage Controls, Sediment Controls.
- Vehicle Tracking of Sediments: Sediment Controls, Non-Stormwater Controls.
- Vehicle and Equipment Maintenance and Fueling: Non-Stormwater Controls.
- Significant Dust or Particulate Generating Processes: Non-Stormwater Controls.
- Non-Industrial Waste Sources such as Worker Trash and Portable Toilets: Non-Stormwater Controls.

2.6 Allowable Sources of Non-Stormwater Discharge

Allowable sources of non-stormwater discharge within the Permit Coverage Area include the following:

- **Uncontaminated Springs**. Although there are several springs within the Permit Coverage Area, None of these springs are currently located in areas where soil disturbance will occur. If this changes in the future, the controls used at any such location will be noted in the Site Specific Records. (Volume 2)
- **Landscape Irrigation Return Flow.** There are several locations in the Lower Zone where pipelines are within irrigated fields. These locations will be treated similarly to any water crossing with the use of an appropriate control which will be noted in the Site Specific Records.
- **Construction Dewatering.** Construction dewatering is described and discussed in Section 3.2.5.
- **Concrete Washout.** Concrete washout is described and discussed in Section 3.2.4.
- **Emergency Fire Fighting Water.** Water used to put out any type of fire is considered an allowable source of non-stormwater discharge.

No other non-stormwater discharges are allowed under the Stormwater Construction Permit. Other types of non-stormwater discharges must be addressed in a separate permit issued for that discharge.

2.7 Receiving Water

Runoff from disturbed areas during construction will be controlled and/or routed through the use of one or more BMPs, as described later in this plan, prior to being discharged to receiving waters. However, it may be expected that runoff from certain areas will infiltrate into the earth and is not expected to contribute to receiving waters.

In general, runoff from the Permit Coverage Area comes from springs and tributaries that lead to three different forks. West Fork will flow east to south east; Middle Fork will flow south to south east and East Fork will flow west to south west. All tributaries will flow to Parachute Creek and then in to the Colorado River.

2.8 Master SWMP Permit Area Map and Individual Stormwater Site Plans

An overall Master SWMP Permit Area Map is provided as Appendix D. This map is likely to change constantly and will be updated at least annually. The Master SWMP Permit Area Map includes:

- Contours and elevations (topography) with existing drainage patterns;
- Locations and names of major surface waters such as streams, wetlands, irrigation ditches, canals, etc…;
- Master SWMP permit area boundaries; and
- Construction area locations including roads, pipelines, well pads, compressor station facilities, treatment facilities, water parks, and all other facilities.

Individual Stormwater Site Plans (Site Plans) of each site (well pad, access road, section of pipeline, etc.) are provided with the Site Specific Records (Volume 2 of the Master SWMP) Separate Site Plans will be developed for each phase of construction: preconstruction, construction, interim reclamation (if applicable), final stabilization (if applicable) and final reclamation (if applicable). These Site Plans include:

- Construction site boundaries (this is the area expected to be disturbed by clearing, excavating, grading, or other construction activities);
- Contours and elevations (topography) with existing and proposed drainage patterns;
- Limits of well pads and locations of reserve pits and well heads (if applicable);
- All areas of ground surface disturbance, including areas of cut and fill;
- Locations of all potential pollutant sources listed in Section 2.5 (including areas used for vehicle fueling, the storage of materials, equipment, soil, or waste, etc…);
- Locations of all minor surface waters and all anticipated allowable sources of non-stormwater discharge (including springs, dewatering, concrete washout, etc…);
- Locations of all existing and planned BMPs (including erosion, drainage, and sediment controls);
- Locations, names, and distances to streams, wetlands, irrigation ditches, canals, and other surface waters; and
- The size, type and location of any outfall(s). If the stormwater discharge is to a municipal separate stormwater system, name that system, the location of the storm sewer discharge, and the ultimate receiving water(s).

Figures showing typical BMP locations along roadways and pipelines are provided as part of the BMP Manual (discussed in Section 3.3).

3.0 Best Management Practices (BMPs)

A key component of this Master SWMP is employing BMPs to improve stormwater quality. Local factors will be evaluated to determine what BMPs are suitable and practical at different locations. BMPs will be employed in different combinations during construction activities and phases as conditions warrant. Due to the fact that this Master SWMP is likely to cover more than one ecosystem (as described in Section 2.4), the selection of BMPs (including type, quantity, sequence/combination, etc.) will vary at each site within the Master SWMP Permit Area. Specific BMPs to be employed at each well pad, road, pipeline, or other facility are identified on the Site Plans, which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

3.1 Erosion, Drainage, and Sediment Control BMPs

The primary method for controlling erosion, drainage, and sediment transport consists of minimizing initial disturbance of the soil and ground cover. However, many other methods can also be used. All stormwater-related BMPs will fall under at least one of the following three types of controls:

- **Erosion Control.** Any source control practice that protects the soil surface and/or strengthens the subsurface in order to prevent soil particles from being detached by rain or wind, thus controlling raindrop, sheet, and/or rill erosion.

- **Runoff Control.** Any practice that reduces or eliminates gully, channel, and stream erosion by minimizing, diverting, or conveying runoff.

- **Sediment Control.** Any practice that traps the soil particles after they have been detached and moved by wind or water. Sediment control measures are usually passive systems that rely on filtering or settling the particles out of the water or wind that is transporting them prior to leaving the site boundary.

BMPs may also be classified as either structural or non-structural controls:

- **Structural Control.** Handles sediment-laden stormwater prior to it leaving each site. Structural BMPs are used to delay, capture, store, treat, or infiltrate stormwater runoff. Some examples of structural BMPs include sediment traps, diversions, and silt fences. Most Runoff Controls and Sediment Controls can also be classified as Structural Controls.

- **Non-structural Control.** Reduces the generation and accumulation of pollutants, including sediment, from a construction site by stabilizing disturbed areas and preventing the occurrence of erosion. Some examples of non-structural BMPs include revegetation, mulching, and surface roughening. These types of stabilization techniques are not only the most effective method for reducing soil loss, but they are also normally the most cost effective due to low initial cost and reduced maintenance requirements. Most, but not all, Erosion Controls can also be classified as Non-structural Controls.

The Site Plans, as mentioned previously and kept with the Site Specific Records (Volume 2 of the Master SWMP), show the proposed locations of all erosion, drainage, and sediment control BMPs (both structural and non-structural). Detailed descriptions, design criteria, construction specifications, and maintenance information for all BMPs are provided in the BMP Manual (discussed in Section 3.3).

3.2 Non-Stormwater Control BMPs

Non-stormwater controls include general site and materials management measures that indirectly aid in the minimization of water pollution. Types of pollution sources include, but are not limited to, litter, oil and grease, hazardous material spills, and sediment.

3.2.1 Materials Delivery and Storage

The good housekeeping practices listed below will be followed on site during construction and operation:

- An effort will be made to store only enough product required for task completion.
- All materials stored on site will be stored in a neat and orderly manner in appropriate containers and, where possible, under a roof or other enclosure, and/or within secondary containment areas to avoid contact with stormwater.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, all of the product will be used before disposing of the container.
- Manufacturer's recommendations for proper use and disposal will be followed.

Additional information on material delivery and storage is available in the BMP Manual (discussed in Section 3.3).

3.2.2 Material Handling and Spill Prevention

In addition to the material storage practices (listed in the previous section) that will be used to reduce the risk of spills or other accidental exposure of materials and substance, the BMP Manual (discussed in Section 3.3) will provide more detailed information on spill prevention and control. Furthermore, the Spill Prevention, Control and Countermeasure (SPCC) Plan will be followed for the control of hydrocarbons. In general, spill prevention and response procedures will include notification (CDPHE 24-hour spill reporting line – 877-518-5608), clean-up with the use of spill kits and absorbents, and ensuring that materials and wash water can not discharge from the site, and never into a storm drain system or stream.

3.2.3 Vehicle Cleaning, Fueling, Maintenance, and Tracking Controls

As required by Encana Oil & Gas (USA), Inc. master service agreement(s) and drilling contract(s), contracting companies and/or vendors are required to service all vehicles and equipment prior to entering Encana facilities. However, in the event maintenance procedures are required at Encana facilities, all fluids transferred must utilize secondary containment and drip pans to minimize a release of materials and properly dispose or recycle spent materials in compliance with local, state, and federal guidelines.

While on site, equipment will be parked, serviced, and fueled within designated areas. Equipment fueling on pipeline rights-of-way will be completed where necessary during active construction. Periodic inspections of equipment and control procedures will be implemented. Selected equipment may be fueled in place using fuel trucks. When necessary, equipment and machinery will be decontaminated at an on-site decontamination area prior to removal from the construction area. Areas will be provided with adequate waste disposal receptacles for liquid as well as solid waste.

Vehicle tracking of sediments is not expected to be a problem due to construction scheduling. Construction vehicles will remain on site throughout earth-moving activities. All other vehicles remain in stabilized areas and do not enter the construction area until that area is stabilized. However, applicable BMPs (such as scheduling (to minimize site access), stabilized construction entrances, vehicle cleaning, etc.) will be utilized if sediment tracking does become a problem.

In addition to the typical practices listed above, the BMP Manual (discussed in Section 3.3) provides more detailed information on vehicle cleaning, fueling, maintenance, and tracking controls.

3.2.4 Waste Management and Disposal

As required by Encana Oil & Gas (USA), Inc. master service agreement(s) and drilling contract(s), contracting companies and/or vendors are required to manage all waste generated by their activities at Encana facilities in

compliance with local, state, and federal guidelines. Encana Oil & Gas (USA) utilizes a periodic inspection program to ensure waste management requirements are fulfilled and inspections are documented.

A few of the waste management procedures that will be followed include the following:

- Proper bins will be provided for trash collection and disposal in compliance with local, state, and federal guidelines.
- Contaminated soils will be placed into a lined and bermed area. Samples of the impacted soil will be collected and a complete characterization analysis will be performed. When applicable, the impacted soil will be sent to a licensed disposal facility.
- The contractor will provide portable toilets. Sanitary waste will be regularly collected by a licensed sanitary waste management contractor and disposed of in an approved manner.
- In the event that sediment is inadvertently transported off the construction site, it will be collected and returned to the site and placed on the soil stockpile or spread over the construction pad area and compacted.

On well pads and access roads concrete washout is used as an interior conductor pipe ballast. Concrete washout water can NOT be discharged to surface waters or to storm sewer systems without separate permit coverage. However, discharge to the ground of concrete washout water from washing of tools and concrete mixer chutes may be authorized by this permit, provided that (CDPHE, 2007a):

1. The source is identified in the SWMP;

2. BMPs are included in the SWMP to prevent pollution of groundwater; and

3. These discharges do not leave the site as surface runoff or to surface waters.

Locations where concrete washout activities take place are shown on the Site Plans.

Additional waste management procedures, including solid waste, hazardous waste, contaminated soil, concrete washout, and septic and sanitary waste, are included in the BMP Manual (discussed in Section 3.3).

3.2.5 Dewatering

Dewatering refers to the mechanical removal of water from an excavation or other structure. Both groundwater and stormwater may require dewatering during construction. Dewatering of pipelines at the completion of hydrostatic testing will be required for most pipeline installations.

3.2.5.1 Groundwater Dewatering

Groundwater is very rarely encountered during the construction activities associated with either E&P sites or Midstream Services. If groundwater is encountered, it is typically during construction of a pipeline across a stream crossing. These pipelines are either bored under the stream or a flume is utilized.

Non-stormwater construction dewatering of groundwater can NOT be discharged to surface waters or to storm sewer systems without separate permit coverage. However, discharges to the ground of water from construction dewatering activities may be authorized by this permit, provided that (CDPHE, 2007a):

1. The source is groundwater and/or groundwater combined with stormwater that does not contain pollutants in concentrations exceeding the State groundwater standards in Regulations 5 CCR 1002-41 and 42;

2. The source is identified in the SWMP;

3. BMPs are included in the SWMP; and

4. These discharges do not leave the site as surface runoff or to surface waters.

Dewatered groundwater shall be pumped or diverted to a sediment control BMP prior to discharge to the ground. Locations of groundwater dewatering, as well as any BMPs utilized, will be noted on the Site Plans as soon as such dewatering occurs. Additional information on groundwater dewatering is provided in the BMP Manual, discussed in Section 3.3.

3.2.5.2 Stormwater Dewatering

The discharge of pumped stormwater (not including groundwater or other non-stormwater sources) from excavations, ponds, depressions, etc., to surface water, or to a municipal separate storm-sewer system is allowed by the Stormwater Construction Permit, as long as the dewatering activity and associated BMPs are identified in the SWMP (including location of the activity), and BMPs are implemented in accordance with the BMP Manual, discussed in Section 3.3 (CDPHE, 2007c).

Stormwater that collects in open depressions or trenches during construction activities will be dewatered into an existing sediment control, such as a detention pond, a sediment trap, or simply into a well-vegetated area to percolate into the ground and catch suspended sediment. The quality, source, and location of dewatering, as well as any BMPs utilized, will be noted on the Site Plans as soon as such dewatering occurs. Additional information on stormwater dewatering is provided in the BMP Manual, discussed in Section 3.3.

3.2.5.3 Pipeline Dewatering

New Department of Transportation (DOT) pipelines are hydrostatically tested with water upon completion of construction. Once the hydrostatic testing has been completed, dewatering of the pipeline must occur. This will involve the insertion of a displacer, commonly referred to as a pig, in the pipeline. The discharge rate will be regulated, and energy dissipation devices, and/or sediment controls will be used, as necessary, to prevent erosion, streambed scour, suspension of sediments, or excessive stream flow. Locations on pipeline dewatering, as well as any BMPs utilized, will be noted on the Site Plans as soon as such dewatering occurs. Additional information on stormwater dewatering is provided in the BMP Manual, discussed in Section 3.3.

3.3 Stormwater Manual of BMPs

A Stormwater Manual of Best Management Practices (BMP Manual) is provided as Appendix E. The BMP Manual has been prepared to provide Encana personnel, contractors, and subcontractors with information on the proper selection, design, installation, and maintenance of BMPs to manage oil and gas related stormwater and to meet federal and state SWMP implementation requirements. The main objectives of the BMP manual are to:

- Serve as an easy-to-use guide for selecting, designing, installing, and maintaining BMPs.
- Function as a reference for construction plans and specifications.
- Ultimately lead to the avoidance of any net increase in off-site erosion and sedimentation of waters of the U.S.

The BMPs within this BMP Manual are organized into four main types of controls for easy reference: Erosion Controls, Runoff Controls, Sediment Controls, and Non-stormwater Controls. Each of these types of controls has been discussed earlier in this section of the SWMP.

3.4 Phased BMP Implementation

Various BMPs will be implemented and maintained during different phases of the project. A description of each phase is as follows:

- **Preconstruction.** The preconstruction phase involves the installation of BMPs (temporary and/or permanent) around each site perimeter and at discharge points (such as vegetation buffers (no installation required for this BMP), slash, wattles, diversions, sediment basins and reservoirs, etc…).
- **Construction (Active).** The active construction phase involves the stripping and stockpiling of topsoil, the excavation and backfill for access roads, pipelines, and well pads, and the installation of additional BMPs (preferably permanent BMPs) to control erosion and sedimentation (such as tracking topsoil piles and the installation of roadside channels, culverts, diversions, etc…).
- **Construction (Complete).** The construction complete phase involves stabilizing topsoil stockpiles and any unused areas with seeding and/or mulch or other erosion control BMPs.
- **Interim Reclamation.** The interim reclamation phase primarily involves seeding of all disturbed areas not needed during operation of the well pads. However, this phase also involves the installation of any additional permanent BMPs that may be needed, as well as the continued maintenance and inspections of all BMPs until final stabilization occurs. Final stabilization occurs once all surfaces are built on, paved or graveled, and/or a uniform stabilized vegetative cover with a density of 70 percent of pre-disturbance levels has been established or when an equivalent permanent, physical erosion reduction method has been employed. A further explanation of final stabilization is provided as section 4 of this plan.
- **Final Reclamation.** For pipelines, this phase involves seeding of all disturbed areas, and the installation of any additional permanent BMPs that may be needed, as well as the continued maintenance and inspections of all BMPs until final stabilization occurs. For other areas (roads, well pads, facilities, etc…), this phase (which may occur after termination of this permit and under the coverage of a new construction permit) occurs when operation of the area is no longer necessary. In these cases, this phase will include the installation of any additional BMPs required during facility decommissioning as well as the spreading of any remaining topsoil, the application of seed, and the inspection/maintenance of all BMPs until final stabilization occurs.

Temporary controls, such as silt fencing, may be used to control sediment and erosion during preconstruction, construction (active and complete) activities. Permanent controls, such as diversions and sediment traps, may also be used during the initial phases of the project. However, only permanent controls will be used during interim reclamation and final stabilization. Temporary controls may be converted into permanent controls (such as revegetating a diversion) if needed. The primary control used during interim and final stabilization will be revegetation. Seeding will occur as soon as possible after disturbance of an area is complete. If the seeding is not successful, the area will either be reseeded or other controls will be put in place until reseeding can occur.

4.0 Final Stabilization

As soon as practicable after construction activities have been completed in a disturbed area, interim (for well pads, or other facilities) or final (for roads and pipelines) reclamation will be started to prevent further erosion of soil from that area. All disturbed areas (except for the surface of dirt roads, those portions covered by pavement or a structure, and those areas used during operation of a well) will be stabilized with permanent controls. The most common measure used to achieve final stabilization is revegetation. Mulching, erosion control blankets, surfacing with gravel or slash, and/or other methods may also be used. Structural controls (such as diversions, berms, and sediment traps) may be revegetated and used as permanent measures to control pollutants in stormwater discharges that will occur after construction operations have been completed. Appendix E includes detailed information on each of the previously discussed BMPs. In addition, a revegetation manual is provided as Appendix B, which provides guidance as to possible methods and materials needed to accomplish revegetation on differing site conditions. The specific BMPs used at each site are shown on the Site Plans which are kept with the Site Specific Records (Volume 2 of the Master SWMP).

If a site cannot immediately be interim reclaimed upon completion of site construction due to, for example, the need for a large working surface for well activities, the site will be placed into the construction complete phase. This phase prepares the area for final stabilization until the site can be interim reclaimed, and it typically occurs immediately upon completion of earthwork activities. All disturbed areas not in use or needed for well activities will be stabilized, usually with hydraulic mulch and/or seed or erosion control blanket, but other BMPs may be used.

Final stabilization means that all ground surface disturbing activities at the site have been completed, and all disturbed areas have been either built on, paved, or a uniform vegetative cover has been established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed. For purposes of this permit, establishment of a vegetative cover capable of providing erosion control equivalent to pre-existing conditions at the site will be considered final stabilization. Areas developed as stabilized unpaved surfaces as needed for operation of the facility after interim reclamation, will also qualify as “finally stabilized.” This includes dirt road surfaces and the portions of the well pad surfaces that cannot be revegetated due to operational necessity, but does not include slopes, ditches, and other areas where revegetation is necessary. Stabilized unpaved surfaces will be prepared in such a way as to prevent ongoing erosion issues.

Coverage under the Stormwater Construction Permit may be inactivated for any individual site or a portion/section of that site (i.e. the access road to a well pad) when the area has attained final stabilization and all temporary erosion and sediment control measures associated with that area have been removed. An area will be considered finally stabilized when construction and interim reclamation is complete and when the above final stabilization criteria have been met, even though the site may be disturbed again in the future for final reclamation. However, future land disturbances that follow final stabilization and result in disturbance of one acre or greater (such as final reclamation) will require new permit coverage at that time.

Upon final stabilization of any site or portion/section of a site, Oil and Gas Construction Field Permit Certification NOTICE OF AMENDMENT OF PERMIT COVERAGE and/or Final Stabilization Certification (provided in Appendix F) will be placed into the Site Specific Records binder to replace the Site Plans and the inspection and maintenance records for that area. However, the Site Plans and inspection reports shall be retained in a separate location for a period of three years following final stabilization of the Permit Coverage Area. These documents will be made available to WQCD or EPA upon request and at the time of inspection.

5.0 Inspection and Maintenance

Inspections and maintenance is an extremely important part of the Stormwater Construction Permit. The Construction Manager will ensure that all stormwater management controls are constructed or applied in accordance with governing specifications or good engineering practices. Experienced teams will be used for construction. A first inspection will occur upon installation of the controls. In addition, all workers on the site will be trained as to the location and use of the controls, especially those controls that will be disturbed as construction proceeds across the site. The goal is to minimize the potential for inadvertent removal or disturbance of BMPs and to prevent the off site transport of sediment and other pollutants.

5.1 Inspection Schedule

Inspections are required as soon as the first soil disturbance occurs at the site. Once final stabilization of the site has occurred and the Encana inspector has filled out the final stabilization certification sheet (see Section 4), inspections are no longer necessary. Specific information regarding inspection schedules are provided in the following sections.

5.1.1 Minimum Inspection Schedule for active sites

The minimum inspection schedule applies to those sites under active construction, which includes the period from when the ground is initially disturbed to when construction activity is completed, and also includes the preparation of areas that will be revegetated for interim reclamation. During the Active Site period, a thorough inspection of the site stormwater management system (which includes all utilized BMPs) must be conducted at least every 14 calendar days. Also, post-storm event inspections must be conducted within 24 hours after the end of any precipitation or snowmelt event that causes surface erosion.

There are three exceptions to the minimum inspection schedule which are described in detail within the next three sections: post-storm event inspections at temporarily idle sites (inspections required within 72 hours after a storm), inspections at completed sites (inspections required monthly), and inspections during certain winter conditions (inspections may not be required). Any use of an exception is temporary, and does not eliminate the requirement to perform routine maintenance due to the effects of a storm event or other conditions that may impact BMP performance, including maintaining vehicle tracking controls and removing sediment from impervious areas. Inspections, as described above, are required at all other times.

5.1.2 Post-Storm Event Inspections at Temporarily Idle Sites

Temporarily idle sites are those where there are no construction activities occurring following a storm event. At such sites, post-storm event inspections must be conducted prior to restarting construction activities at the site, but no later than 72 hours following the storm event, and the delay noted in the inspection report. Routine inspections still must be conducted at least every 14 calendar days.

5.1.3 Completed Sites

Once construction activities that disturb the ground surface are complete and the site has been prepared for the construction complete phase, interim reclamation, or final reclamation (completion of appropriate soil preparation, amendments and stabilization practices), the site (or portion of the site) is considered a Completed Site (for purposes of the stormwater permit). Note: only construction activities that result in a disturbance of the ground surface must be completed. Construction activities that can be conducted without disturbance of the ground surface, such as certain well completion activities, would not prohibit a site from otherwise qualifying as a Completed Site. (Completed Sites still require permit coverage until the final stabilization criteria have been met)

Completed Sites qualify for a reduced inspection schedule, as the potential for pollution is reduced if the site has been adequately prepared and/or seeded. However, because slopes and other disturbed areas may not

be fully vegetated, erosion in these areas still occurs which requires maintenance activities such as regrading and seeding of problem areas. As such, inspections must continue in order to address these situations. During the Completed Site period, a thorough inspection of the site stormwater management system (which included all utilized BMPs) is required at least once every month. The SWMP must be amended to indicate those areas that will be inspected at this reduced frequency.

5.1.4 Winter Conditions Inspections Exclusion

Inspections are not required at sites where construction activities are temporarily halted, snow cover exists over the entire site for an extended period, ***and*** melting conditions posing a risk of soil erosion ***do not exist***. This temporary exclusion is applicable only during the period where melting conditions do not exist, and applies to the routine 14-day and monthly inspections, as well as the post-storm-event inspections. It is typical that when snow cover exists, even at a Completed Site, significant potential for erosion and BMP failure exists when melting does finally occur. Therefore, the site should prepared prior to snow cover to ensure it is as stabilized as possible, and be prepared to perform site maintenance when melt-off occurs, to alleviate any potential problems. Inspection records (see Section 5.4) must document the following information when this exclusion is used: dates when snow cover occurred, date when construction activities ceased, and date melting conditions began.

5.2 Performing Inspections

Inspections will be conducted by qualified personnel on the following areas:

- All vegetated areas until 70% of pre-disturbance vegetation levels are reached.
- All BMP measures identified in this document.
- Construction site perimeter and discharge points.
- All disturbed areas.
- Areas used for storage of material/waste that are exposed to precipitation.
- Other areas determined to have a significant potential for stormwater pollution, such as demolition areas or concrete washout locations, or locations where vehicles enter or exit the site.

These areas will be inspected to determine if there is evidence of, or the potential for, pollutants leaving the construction site boundaries, entering the stormwater drainage system, or discharging to state waters. All BMPs will be evaluated to determine if they still meet the design and operational criteria in the SWMP and if they continue to adequately control pollutants at the site. Any BMPs not operating in accordance with Appendix E of this SWMP will be repaired or replaced (according to the following section) and the Site Specific Records will be updated.

5.3 Maintenance

Maintenance activities will ensure that all control measures are functioning at optimum levels and that all procedures and techniques will be in proper working order during a runoff event or spill condition. Any maintenance, repairs, or replacements deemed necessary after required inspections will be corrected as soon as possible (if not immediately), to minimize the discharge of pollutants. Certain maintenance procedures may take a short period of time to make sure that all the proper safety precautions are in place, such as a “one call” for utilities, if the maintenance involves excavation of sediment located above a buried pipeline.

Maintenance will include, but is not limited to:

- Pickup or otherwise prevention of litter, construction debris, and construction chemicals from becoming a pollutant source prior to anticipated storm events.
- Removal of sediment from silt fences, sediment traps, and other sediment controls.

- Reseeding of any bare spots where vegetation has failed to establish.
- Repairs and/or adjustments to any erosion and sediment control that is deteriorating or found to be performing inadequately.

Detailed maintenance requirements for each BMP are identified in Appendix E.

When maintenance is required, the following process will typically be followed:

1. Perform inspections according to the minimum inspection schedule discussed in Section 5.1.
2. Note the need for maintenance on the inspection and maintenance report form.
3. If necessary, collect the additional materials and/or resources needed to perform the maintenance activity.
4. Perform maintenance and note the date performed on the inspection and maintenance report form.
5. Re-inspect the area to ensure compliance.

5.4 Documenting Inspections and Maintenance

The permittee must document inspection results, maintenance activities, and maintain a record of the results for a period of 3 years following expiration or inactivation of permit coverage. A typical inspection and maintenance report form is provided in Appendix G. Although the site may have a phased construction schedule, all construction areas may be inspected at the same time and on one form. Each well pad, road, pipeline, or other facility which is inspected shall be clearly noted on the inspection form. Inspection reports will include the following:

- Date of inspection, name of inspector, and title of inspector
- The area inspected (Site ID), type of area (well pad, access road, pipeline, etc.), phase of construction (preconstruction, construction, etc.), and type of inspection (active, completed, etc.)
- Site specific information including disturbed area, soil type(s), ecosystem/vegetation type(s), receiving waters, etc.
- Vegetation observations including the percent pre-disturbance vegetation and whether or not vegetation growth has reached 70% of pre-disturbance levels
- Specific inspection requirements (all BMPs and areas of potential pollutant sources)
- Observed conditions including:
    - Location(s) of discharges of sediment or other pollutants from the site
    - Location(s) of BMPs that need to be maintained
    - Location(s) of BMPs that failed to operate as designed or proved inadequate for a particular location
    - Location(s) where additional BMPs are needed that were not in place at the time of inspection
- Description and date(s) of corrective action(s) taken, and measures taken to prevent future violations
- Changes necessary to the SWMP

A hand drawn Site Plan shall be included, if necessary, to show the location(s) of any observed condition (as listed above).

After adequate corrective action(s) has been taken and recorded, or where a report does not identify any incidents requiring corrective action, the report will contain a signed statement indicating the site is in compliance with the permit to the best of the signer's knowledge and belief.

All completed inspection and maintenance report forms (a blank copy of which is included in Appendix G) are kept with the Site Specific Records (Volume 2 of the Master SWMP).

6.0 Plan Revisions and Retention

When BMPs or site conditions change, the Master SWMP (Volume 1) and/or the Site Specific Records (Volume 2) will be amended to accurately reflect the actual field conditions. Examples include, but are not limited to, removal of BMPs, identification of new potential pollutant sources, addition of BMPs, modification of BMP installation/implementation specifications or maintenance procedures, and changes in items included in the Site Plans. Changes to the Master SWMP (Volume 1) shall be noted on the SWMP Revisions log at the front of this plan. Changes to individual site conditions will be noted in the Site Specific Records (Volume 2) on the applicable inspection and maintenance report form. All changes in Volume 1 and Volume 2 shall be made prior to actual changes in the site conditions, except for responsive SWMP changes, which shall be made immediately after changes are made in the field or as soon as practical, but in no case more than 72 hours after the change(s) in BMP installation and/or implementation occur at the site that require development of materials to modify the SWMP. At a minimum, the Master SWMP will be updated annually.

The Master SWMP and the Site Specific Records will be retained at the Encana field office in Parachute during active construction and site inspections to ensure accurate implementation and maintenance of BMPs, and required revisions. These documents will be retained for a period of three years following final stabilization of the Permit Coverage Area. These reports will be made available to WQCD or EPA upon request and at the time of inspection.

7.0 Inactivation Notice

When all disturbed areas associated with the Stormwater Construction Permit have reached “final stabilization" (as described in Section 4), all temporary erosion and sediment control measures have been removed, and all components of the SWMP are complete, the area no longer requires coverage under the permit terms. At that time, Encana will submit an Inactivation Notice that closes this permit to the WQCD upon final stabilization of all areas covered by the permit. A blank copy of this form is included in Appendix H of this document.

Upon receipt of the Inactivation Notice, the WQCD will provide written confirmation that coverage under this permit has been terminated. This historical documentation will be maintained at the Encana field office in Parachute for a period of at least three years following termination of permit coverage.

8.0 Signature

The signature page will not be signed unless the SWMP is requested by an agency as a legal document. At that time, the supervisor will review the most updated version of the SWMP and sign it before submitting to an agency.

"*I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, to the best of my knowledge and belief, is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment or knowing violations.*"

Printed name (Legal Contact) Title

Signature Date

Printed name (Local Contact) Title

Signature Date

9.0 References

CDPHE, 2007a. *CDPS General Permit, Authorization to Discharge under the Colorado Discharge Permit System.* Colorado Department of Public Health and Environment. Water Quality Control Division. Issued May 31, 2007. http://www.cdphe.state.co.us/wq/PermitsUnit/stormwater/SWConstructionPermit.pdf

CDPHE, 2007b. *General Permit Application and Stormwater Management Plan Preparation Guidance.* Colorado Department of Public Health and Environment. Water Quality Control Division. Revised July, 2007. http://www.cdphe.state.co.us/wq/PermitsUnit/stormwater/SWConstructionApplication.pdf

CDPHE, 2007c. *Rationale.* Colorado Department of Public Health and Environment. Water Quality Control Division. 2007. http://www.cdphe.state.co.us/wq/PermitsUnit/stormwater/SWConstructionRationale.pdf

CDPHE, 2007d. *Stormwater Fact Sheet – Construction at Oil and Gas Facilities*. Colorado Department of Public Health and Environment. Water Quality Control Division. Revised July, 2007. http://www.cdphe.state.co.us/wq/PermitsUnit/stormwater/OGfactsheet.pdf

Encana. 2005. Orchard Unit Geographic Area Plan. Encana Oil & Gas (USA) Inc.

Encana. 2007. Environmental Assessment of the Rulison Geographic Area Plan for Oil and Gas Development. Encana Oil & Gas (USA) Inc.

Mutel, C.F., and Emerick, J.C., 1992. From Grassland to Glacier - The Natural History of Colorado and the Surrounding Region.

USEPA, 1990. *NPDES Stormwater Regulations*, 40 CFR Parts 122.26. U.S. Environmental Protection Agency.

Appendix A

General Permit Application

STATE OF COLORADO

John W. Hickenlooper, Governor
Christopher E. Urbina, MD, MPH
Executive Director and Chief Medical Officer

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
Located in Glendale, Colorado

Laboratory Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

http://www.cdphe.state.co.us

Colorado Department
of Public Health
and Environment

June 21, 2012

Cindy Allen, EHS Team Lead
Encana Oil & Gas (USA) Inc
370 17 St Ste 1700
Denver, CO 80202

RE: Renewal of Permit/Certification
Administrative Continuation
For: North Parachute Ranch
Located at: 10652 CR 215, Parachute, Garfield County
Permit No.: COR037689

Dear Mr. Allen;

The Division has received an application to renew the above permit/certification. It has been determined that there is sufficient information to make this permit/certification eligible for renewal. More information may be requested by the Division as progress is made in developing a new permit/certification for the above listed facility. This information must be made available to the Division when requested to complete the permit process.

The Division is currently in the process of developing a new permit or master general permit and associated certification for the above permitted facility. The development and review procedures required by law have not yet been completed. When the discharge permit issued to you for your facility expired on **June 30, 2012** your permit is administratively continued and remains in effect under Section 104(7) of the Administrative Procedures Act, C.R.S. 1973, 24-4-101, et seq (1982 repl. vol. 10) until the new permit/certification is issued and effective.

All effluent permit terms and conditions in your current permit will remain in effect until your new permit/certification is issued and effective.

PLEASE KEEP THIS LETTER WITH YOUR PERMIT AND SWMP TO SHOW CONTINUATION OF PERMIT COVERAGE.

Sincerely,

Debbie Jessop
Permits Section
WATER QUALITY CONTROL DIVISION

xc: Permit File

STATE OF COLORADO

Dedicated to protecting and improving the health and environment of the people of Colorado
4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado
http://www.cdphe.state.co.us

Colorado Department of Public Health and Environment

RENEWAL COLORADO DISCHARGE PERMIT SYSTEM (CDPS) STORMWATER DISCHARGE ASSOCIATED WITH CONSTRUCTION ACTIVITIES APPLICATION
Permit COR030000
Cert#COR037689

RENEWAL REAPPLICATION -- RESPONSE REQUIRED

THE CDPS GENERAL PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES (COR030000) WILL EXPIRE JUNE 30, 2012 AND WILL BE ADMINISTRATIVELY CONTINUED AT THAT TIME.

For Additional Information, see the Q&A Guidance:

http://www.cdphe.state.co.us/wq/PermitsUnit/PermittingWhatsNew.htm

- This reapplication form shows the current record for the facility listed on page 2 - active certification **COR037689**
- For certification **COR037689** to be administratively continued, this reapplication must be reviewed, corrected (if needed), signed, and returned to the division prior to **March 31, 2012**. This is the only action necessary to renew this certification.
- If certification is no longer needed, please send in an inactivation form as soon as the facility is eligible.
    - Receipt of this form will be tracked on the Division's web site: http://www.cdphe.state.co.us/wq/PermitsUnit/construction.html. Select: *Active Stormwater Construction Certifications* (this list will be updated in the first week of each month). A date entry under "Application Received" indicates the date the Division received this renewal application. This also indicates that the certification is administratively continued.
    - A postcard will be sent to confirm the Division's receipt of the form a certification is administratively continued. Please allow up to 45 days for receipt of this confirmation.
    - Certifications for which no renewal is received will expire and be terminated effective June 30, 2012.
- **Please keep a copy of this application for your records.**

Please direct questions to cdphe.wqstorm@state.co.us, (303) 692-3517, or visit our website at **www.coloradowaterpermits.com**.

Mail to: CDPHE/WQCD Attn Permits.
4300 Cherry Creek Dr South Denver CO 80246

Photo copies, faxed copies, pdf copies or emails will not be accepted by the Division.

REVIEW AND CONFIRM THE FOLLOWING INFORMATION IS CORRECT

(Verify That This Information Is Correct. Cross out and make changes as necessary.)

APPLICATION to RENEW CERT # COR037689

1. CONTACTS:

PERMITTEE ORGANIZATION FORMAL NAME **Encana Oil & Gas (USA) Inc**

LEGAL CONTACT (This is the party who must sign on page 2)

Cindy Allen Team
~~**Brant Gimmeson**~~, **EHS ~~Group~~ Lead**
370 17 St Ste 1700
Denver CO 80202
Phone **720-876-5030** Email **brant.gimmeson@encana.com**

LOCAL CONTACT

Kathy Kiloh, Surface Mgmt Coord
Phone **970-285-2626** Email **kathy.kiloh@encana.com**
Organization: _____
Mailing Address: _____
City: _____ State: _____ Zip: _____

CONTINUE TO BACK OF FORM

BILLING CONTACT

Kathy Kiloh, Surface Mgmt Coord
Encana Oil & Gas (USA) Inc
2717 County Rd 215 Ste 100
Parachute CO 81635
Phone **970-285-2626** Email **kathy.kiloh@encana.com**

2. PERMITTED PROJECT/FACILITY INFORMATION Verify That This Information Is Correct. Cross out and make changes as necessary:

Project/Facility Name **North Parachute Ranch**

Address Or Cross Streets **10652 CR 215**

City **Parachute** County **Garfield** Zip Code **81635**

Facility Latitude **39.5731** Longitude **108.1093**

Total Area Of Project Site (Acres):**27,000**

Area Of Disturbance (Acres) **400**

Nature Of Construction Activity **Gas/Oil Field Exploration and/or Development**

Immediate Receiving Water(S):

Ultimate Receiving Water(S): **Parachute Creek**

3. SIGNATURE OF PERMIT LEGAL CONTACT

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

"I understand that submittal of this application is for coverage under the State of Colorado General Permit for Stormwater Discharges Associated with Construction Activity **for the entirety of the construction site/project described and applied for, until such time as the application is amended or the certification is transferred, inactivated, or expired.**"

XX Cindy Allen 3/29/2012

Signature of Legally Responsible Person listed in item 1 (submission must include original signature) Date Signed

Cindy Allen Team Lead, SRBU EH&S

Name (printed) Title

Per Regulation 61 In all cases, APPLICATION shall be signed as follows:

a) In the case of corporations, by a responsible corporate officer. For the purposes of this section, the responsible corporate officer is responsible for the overall operation of the facility from which the discharge described in the application originates.
b) In the case of a partnership, by a general partner.
c) In the case of a sole proprietorship, by the proprietor.
d) In the case of a municipal, state, or other public facility, by either a principal executive officer or ranking elected official

WQCD Mail Code 2034
Brant Gimmeson, EHS Group Lead
Or environmental permitting representative for:
Encana Oil & Gas (USA) Inc
370 17 St Ste 1700
Denver, CO 81635

STATE OF COLORADO

Dedicated to protecting and improving the health and environment of the people of Colorado

COLORADO DEPARTMENT OF PUBLIC
HEALTH AND ENVIRONMENT
Water Quality Control Division
4300 Cherry Creek Drive South B2 Permits
Denver, Colorado 80246-1530

Colorado Department of Public Health and Environment

For Agency Use Only

Date Received ____/____/____

Effective Date ____/____/____

CHANGE OF CONTACT(s) and/or DESIGNATION of DULY AUTHORIZED AGENT(s) for all PERMITS, CERTIFICATIONS, AND AUTHORIZATIONS

This form must be submitted for the following actions:

1. A change has been made to the legally responsible contact or local contact.
   OR
2. A representative of the Permittee is signing an attached document (or will be signing documents) in place of the legally responsible party.

PHOTO COPIES, FAXED COPIES, PDF COPIES OR EMAILS WILL NOT BE ACCEPTED.

Permit, Certification, or Authorization Number COR037689
(A separate form must be prepared for each Permit, Certification, or Authorization covered by these changes.)

Company name: Encana Oil and Gas (USA) Inc.

(Company name changes must be handled as a modification to the permit, certification, or authorization)

1) CHANGE TO LEGAL CONTACT

receives all future permit correspondences and is legally responsible for compliance with the permit.

Legal Contact: Cindy Allen email address cindy.allen@encana.

Title: Team Lead, EH&S South Rockies Telephone No: 720-876-5474

Mailing Address: 370 17th St, Suite 1700

City: Denver State: CO Zip: 80202

2) CHANGE TO LOCAL CONTACT

contacted for questions relating to the facility & discharge authorized by the permit for the facility.

Local Contact: Kathy Vertiz email address kathy.vertiz@encana.com

Title: Surface Management Lead Telephone No: 970-285-2626

Mailing Address: 2717 County Road 215, Suite 100

City: Parachute State: CO Zip: 81635

3) ASSIGNMENT OF AUTHORIZED AGENT(s)

Per Regulation 61 : All reports required by permits, and other information requested by the Division shall be signed by a person described in section 61.4(1)(e) as the legal contact for the permit or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(i) The authorization is made in writing by a person described in paragraph 61.4(1)(e)- legally responsible party

(ii) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a **named individual** or any individual occupying a **named position** may sign reports (such as DMR's or Annual Reports) required by the permit.

Authorized Agent _____ Email Address _____

Title _____ Telephone No. _____

Authorized Position _____ Telephone No: _____

Currently held by: _____ email address: _____

DMR's are to be mailed to this individual. ☐ YES ☐ NO

If NO, to whom shall DMR's be sent (email is the Division's preferred method of sending DMR's)

Contact _____ Title _____

Email address _____

Mailing Address: _____

City: _____ State: _____ Zip: _____ Telephone No: _____

4) CHANGE TO BILLING CONTACT INFORMATION if billing address is different than legal contact

Name: Kathy Vertiz email address kathy.vertiz@encana.com

Company Name: Encana Oil and Gas (USA) Inc.

Mailing Address: 2717 County Road 215, Suite 100

City: Parachute State: CO Zip: 81635 Telephone No: 970-285-2626

REQUIRED CERTIFICATION SIGNATURE

Signature of Permittee/Legally Responsible party must be by either the owner and/or operator of the facility or project. The form must be signed by the Permittee/Legally Responsible party to be considered complete.
In all cases, it shall be signed as follows:

a) In the case of corporations, by a principal executive officer of at least the level of vice-president or his or her duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge described in the application originates.
b) In the case of a partnership, by a general partner.
c) In the case of a sole proprietorship, by the proprietor.
d) In the case of a municipal, state, or other public facility, by either a principal executive officer, ranking elected official, or other duly authorized employee if such representative is responsible for the overall operation of the facility from which the discharge described in the form originates.

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature(Legally Responsible Party) Cindy Allen Date 3/27/12

Name (printed) Cindy Allen Title Team Lead, EH&S South Rockies

STATE OF COLORADO

Bill Ritter, Jr., Governor
James B. Martin, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

http://www.cdphe.state.co.us

Laboratory Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

Colorado Department
of Public Health
and Environment

June 20, 2007

Terry Gosney, Reg Env Coord
EnCana Oil & Gas (USA) Inc.,
2717 County Road 215 Ste. 100
Parachute, CO 81635
970/285-2687

RE: Final Permit, Colorado Discharge Permit System – Stormwater
Certification No: COR-037689
North Parachute Ranch
Garfield County

Local Contact: Terry Gosney, Reg Env Coord
970/285-2687

Dear Sir or Madam:

Enclosed please find a copy of the new permit and certification which have been re-issued to you under the Colorado Water Quality Control Act.

Your old permit expires on June 30, 2007. This is a renewal to the permit, and replaces the old one. See page 2 of the Rationale (the pages in italics) for a summary of the changes to the permit.

Your Certification under the permit requires that specific actions be performed at designated times. You are legally obligated to comply with all terms and conditions of the permit.

Please read the permit and certification. If you have any questions please visit our website at : www.cdphe.state.co.us/wq/permitsunit/stormwater or contact Matt Czahor at (303) 692-3517.

Sincerely,

Kathryn Dolan
Stormwater Program Coordinator
Permits Unit
WATER QUALITY CONTROL DIVISION
xc: Regional Council of Governments
Local County Health Department
District Engineer, Technical Services, WQCD
Permit File

STATE OF COLORADO

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
WATER QUALITY CONTROL DIVISION
TELEPHONE: (303) 692-3500

CERTIFICATION TO DISCHARGE
UNDER
CDPS GENERAL PERMIT COR-030000
STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION

Certification Number **COR037689**

This Certification to Discharge specifically authorizes:

EnCana Oil & Gas (USA) Inc.

LEGAL CONTACT:
Terry Gosney, Reg Env Coord
EnCana Oil & Gas (USA) Inc.
2717 County Road 215 Ste. 100
Parachute, CO 81635
Phone # 970/285-2687
Terry.gosney@encana.com

LOCAL CONTACT:
Terry Gosney, Reg Env Coord,
Phone # 970/285-2687
terry.gosney@encana.com

During the Construction Activity: **Gas/Oil Field Exploration and/or Development**
to discharge stormwater from the facility identified as **North Parachute Ranch** which is located at:

10652 Garfield County Road 215.
Parachute, Co 81635

Latitude **39.5731,** Longitude **108.1093**
In **Garfield County**

to: -- Parachute Creek

Anticipated Activity begins **09/01/2004** continuing through **06/30/2010**
On **27,000** acres **(400** acres disturbed)

Certification is effective: **07/01/2007** Certification Expires: **06/30/2012**

Annual Fee: $245.00 **(DO NOT PAY NOW** – A prorated bill will be sent shortly.)

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Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

http://www.cdphe.state.co.us

Colorado Department
of Public Health
and Environment

MODIFICATION FORM

Please print or type all information. All items must be filled out completely and correctly. If the form is not complete, it will be returned. All modification dates are established by the Division. This form is for modifying an established permit or certification. Terminations, Change of Contacts, Transfer of Permit, and Withdrawl of Permit Application and/or modification requests must be submitted on the appropriate form:

MAIL ORIGINAL FORM WITH INK SIGNATURES TO THE FOLLOWING ADDRESS:

Colorado Dept of Public Health and Environment
Water Quality Control Division
4300 Cherry Creek Dr South WQCD-P-B2
Denver, CO 80246-1530

FAXED or EMAILED FORMS WILL NOT BE ACCEPTED

- **PART A. IDENTIFICATION OF PERMIT** Please write the permit number to be modified

  PERMIT NUMBER (Prefix + 6 digits - not ending in 0000) COR-037689

- **PART B. PERMITEE INFORMATION**

  Company Name: Encana Oil and Gas (USA) Inc.
  Mailing Address: 370 17th Street Suite 1700
  City: Denver State: CO Zipcode: 80202
  Legal Contact Name: Cindy Allen Phone Number: 720-876-5474
  Title: Team Lead, EH&S South Rockies Email: cindy.allen@encana.com

- **PART C. FACILITY/PROJECT INFORMATION**

  Facility/Project Name: 003 596 Story Booster and access road, within North Parachute Ranch CDPS boundary.
  Location (address): see attached map
  City: County: Garfield
  Local Contact Name: Kathy Vertiz Phone Number: 970-285-2626
  Title: Lead, Surface Management Email: kathy.vertiz@encana.com

- **PART D. DESCRIPTION OF MODIFICATION REQUESTED:**

Encana Oil and Gas (USA) Inc. has recently divested the O03 596 Story Booster and its Access Road to Hunter Ridge Energy Services, LLC. (See attached map of assets.)

Hunter Ridge Energy Services, LLC. will take ownership of these locations regarding CDPHE Discharge Permit requirements for stormwater associated with construction activity. These locations will be added to an existing Hunter Ridge Energy Services, LLC. owner CDPS, COR-03K022 titled the Hunter Ridge.

Encana Oil and Gas (USA) Inc. will be removing these Oil and Gas locations from their existing CDPS, COR-037689 titled North Parachute Ranch.

The total disturbed area for these locations is 8.0 acres.

Please see the attached reference map for this Oil and Gas location.

- **PART E. CERTIFICATION Required Signatures**

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment.
"I understand that submittal of this application is for coverage under the State of Colorado Discharge Permit System until such time as the application is amended or the certification is transferred, inactivated, or expired."

Cindy Allen — 4/1/13

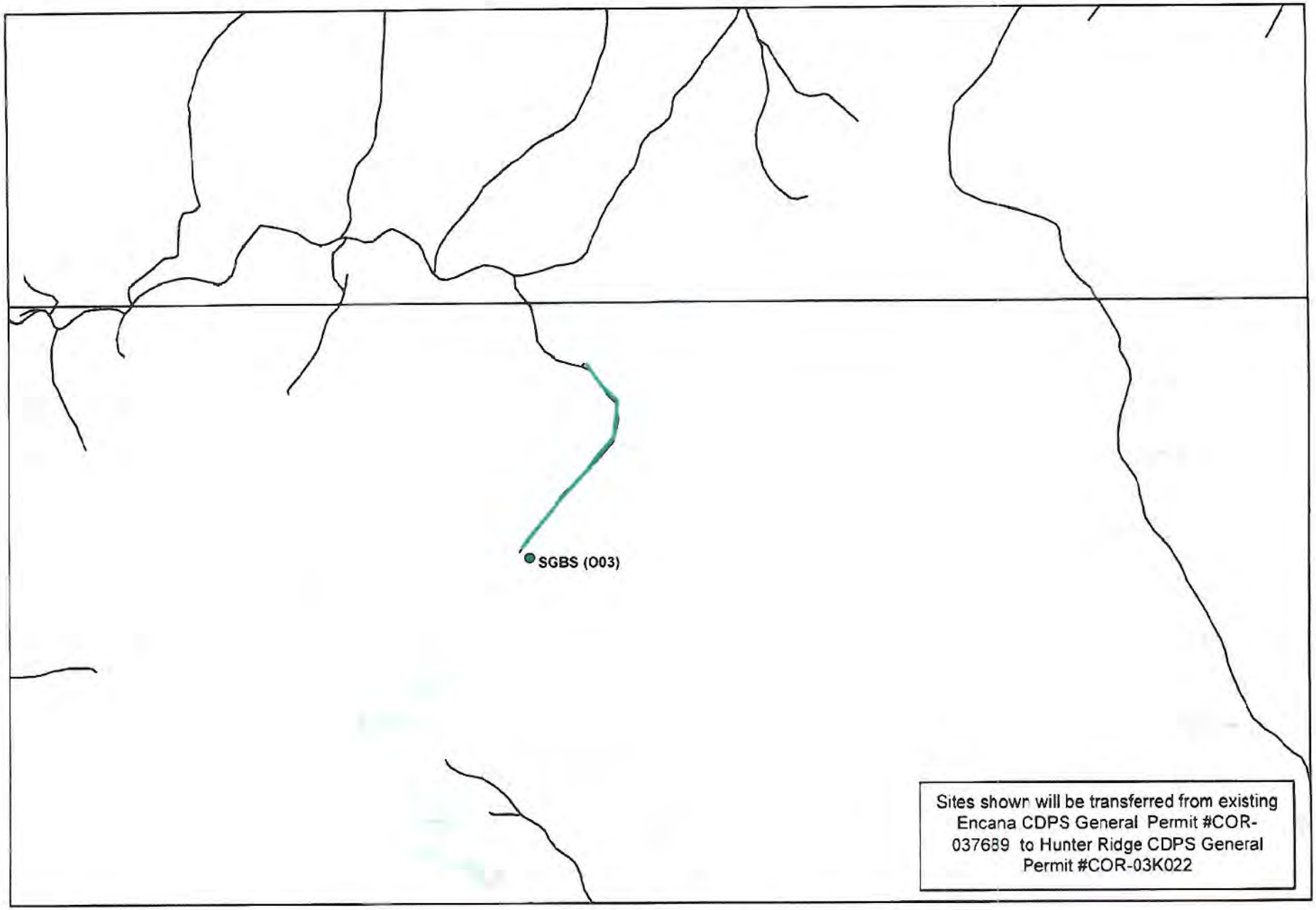
Signature of Legally Responsible Party — Date Signed

Cindy Allen — Team Lead, EH&S South Rockies

Name (printed) — Title

Signatory requirements: This withdraw of permit application request shall be signed, dated, and certified for accuracy by the permittee in accord with the following criteria:

1. In the case of a corporation, by a principal executive officer of at least the level of vice-president, or his or her duly authorized representative, if such representative is responsible for the overall operation of the operation from which the discharge described herein originates;
2. In the case of a partnership, by a general partner;
3. In the case of a sole proprietorship, by the proprietor;
4. In the case of a municipal, state, or other public operation, by wither a principal executive officer, ranking elected official, or other duly authorized employee.



Legend

- Encana Assets to be Transfered
- Encana Assets to be Transfered
- Encana Access Roads

Encana Asset Transfer to Hunter Ridge CDPS Genral Permit COR-03K022

0 0.25 0.5 1 Mile

N

encana

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Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

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Colorado Department
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Water Quality Control Division
4300 Cherry Creek Dr South WQCD-P-B2
Denver, CO 80246-1530

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- **PART A. IDENTIFICATION OF PERMIT** Please write the permit number to be modified

PERMIT NUMBER (Prefix + 6 digits - not ending in 0000) COR-037689

- **PART B. PERMITEE INFORMATION**

Company Name: Encana Oil and Gas (USA) Inc.
Mailing Address: 370 17th Street Suite 1700
City: Denver State: CO Zipcode: 80202
Legal Contact Name: Cindy Allen Phone Number: (720) 876-5474
Title: Team Lead, EH&S South Rockies Email: cindy.allen@encana.com

- **PART C. FACILITY/PROJECT INFORMATION**

Facility/Project Name: Multiple facilities and ROWs within the North Parachute Ranch CDPS boundary
Location (address): See attached map of assets
City: County: Garfield
Local Contact Name: Kathy Vertiz Phone Number: (970) 285-2626
Title: Lead, Surface Management Email: kathy.vertiz@encana.com

- **PART D. DESCRIPTION OF MODIFICATION REQUESTED:**

Encana Oil and Gas (USA) Inc. has recently divested multiple facilities and ROWs to Hunter Ridge Energy Services, LLC. (See attached map of assets.)

Hunter Ridge Energy Services, LLC. will take ownership of these multiple facilities and ROW sregarding CDPHE Discharge Permit requirements for stormwater associated with construction activity. These multiple facilities and ROWs will be added to an existing Hunter Ridge Energy Services, LLC. owner CDPS, COR-03K022 titled Hunter Ridge SWMP Unit.

Encana Oil and Gas (USA) Inc. will be removing these multiple facilities and ROWs from their existing CDPS, COR-037689 titled North Parachute Ranch SWMP Unit.

The total disturbed area for these locations is 62.27 acres.

Please see attached map of assets, titled North Parachute Ranch SWMP Unit for these multiple facilities and ROWs.

- **PART E. CERTIFICATION Required Signatures**

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment.
"I understand that submittal of this application is for coverage under the State of Colorado Discharge Permit System until such time as the application is amended or the certification is transferred, inactivated, or expired."

Cindy All — 5/6/13

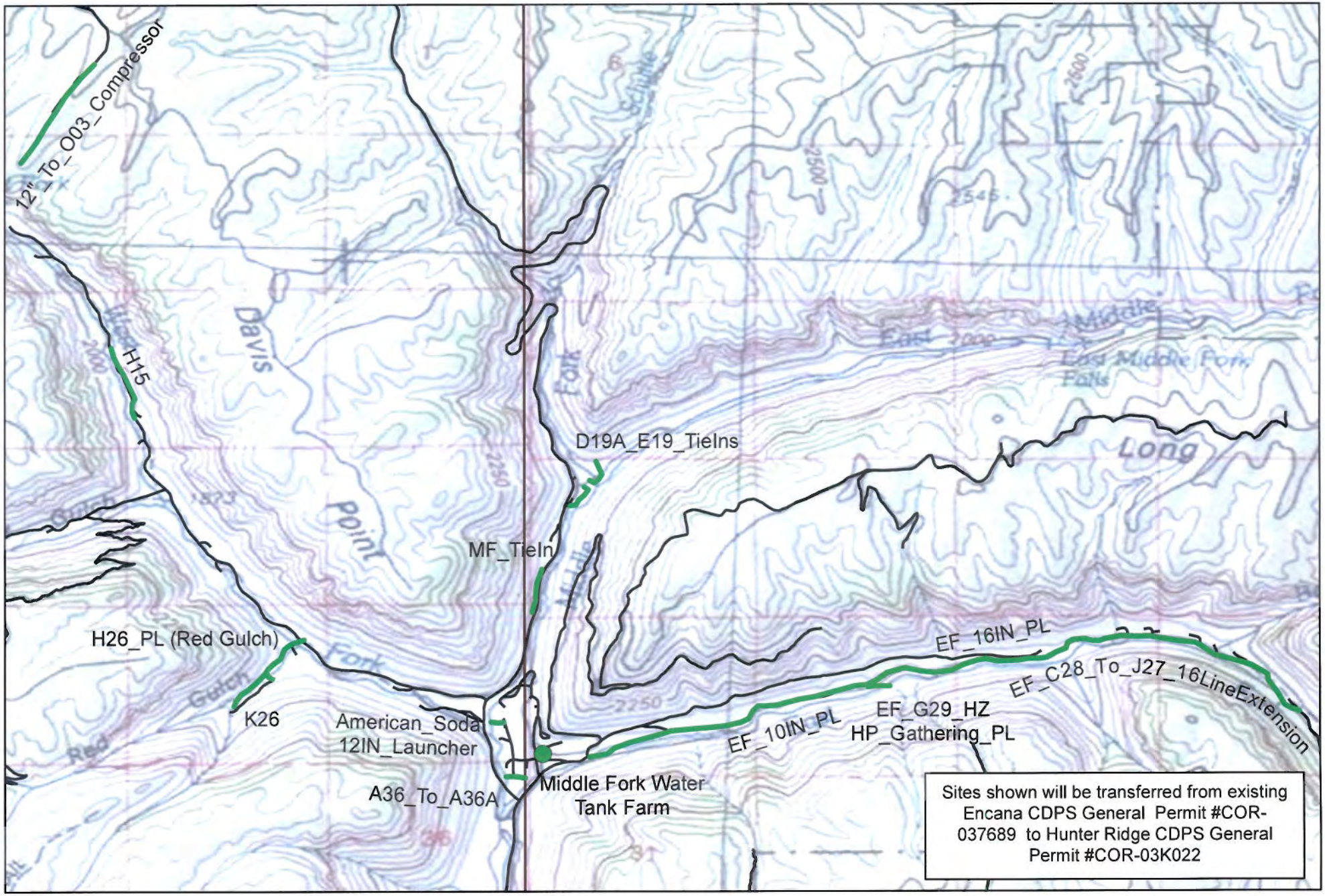
Signature of **Legally Responsible Party** — Date Signed

Cindy Allen — Team Lead, EH&S South Rockies

Name (printed) — Title

Signatory requirements: This withdraw of permit application request shall be signed, dated, and certified for accuracy by the permittee in accord with the following criteria:

1. In the case of a corporation, by a principal executive officer of at least the level of vice-president, or his or her duly authorized representative, if such representative is responsible for the overall operation of the operation from which the discharge described herein originates;
2. In the case of a partnership, by a general partner;
3. In the case of a sole proprietorship, by the proprietor;
4. In the case of a municipal, state, or other public operation, by wither a principal executive officer, ranking elected official, or other duly authorized employee.



Legend

SWMP

- Encana Assets to be Transfered
- Encana Assets to be Transfered
- Encana Access Roads

Encana Asset Transfer to Hunter Ridge CDPS Genral Permit COR-03K022

0 0.25 0.5 1 1.5 2 Mile

N

encana

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PERMIT NUMBER (Prefix + 6 digits - not ending in 0000) COR-037689

- **PART B. PERMITEE INFORMATION**

Company Name: Encana Oil and Gas (USA) Inc.
Mailing Address: 2717 County Road 215, Suite 100
City: Parachute State: CO Zipcode: 81635
Legal Contact Name: Brant Gimmeson Phone Number: 720-876-5030
Title: Group Lead, EH&S South Rockies Email: brant.gimmeson@encana.com

- **PART C. FACILITY/PROJECT INFORMATION**

Facility/Project Name: North Parachute Ranch
Location (address): Latitude 39.5731 Longitude 108.1093
City: County:
Local Contact Name: Kathy Vertiz Phone Number: 970-285-2626
Title: Surface Management Lead Email: kathy.vertiz@encana.com

- **PART D. DESCRIPTION OF MODIFICATION REQUESTED:**

Location of the Permit Coverage Area:
- County: Rio Blanco & Garfield Counties
- City: Located approximately 25 miles West/Northwest of Parachute, Colorado.
- Township/Range/Section:
  Township 5S, Range 95W, Sections 15-17, 19-22, & 27-34
  Township 5S, Range 96W, Section 3-5, 8-11, 14-17, 21-28 & 33-36
  Township 6S, Range 96W, Section 1-5, 8-10, 15-17, 20-22, 27, & 28

- **PART E. CERTIFICATION Required Signatures**

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment.
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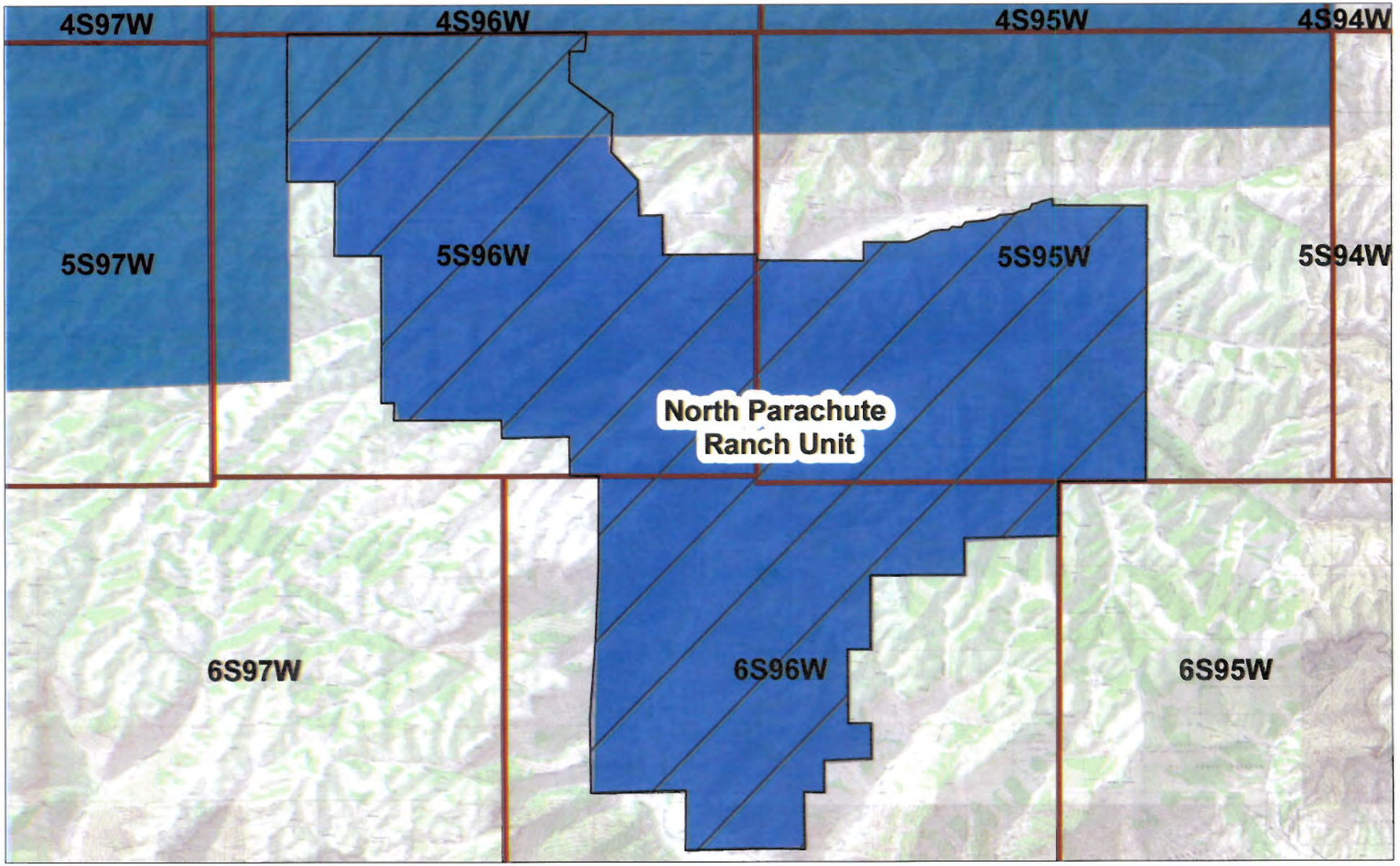
Brant Gimmeson 9-6-11

Signature of **Legally Responsible Party** Date Signed

Brant Gimmeson Group Lead, EH&S South Rockies

Name (printed) Title



Legend

SWMP Name

North Parachute Ranch Unit

North Parachute Ranch Unit
SWMP Boundary
Encana Oil & Gas (USA), Inc.

10 5 0 Miles

N
W E
S

Created by: Leslie Booth
Date: 09/06/2011

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PERMIT NUMBER (Prefix + 6 digits - not ending in 0000) COR-037689

- **PART B. PERMITEE INFORMATION**

Company Name: Encana Oil and Gas (USA) Inc.
Mailing Address: 2717 County Road 215, Suite 100
City: Parachute State: CO Zipcode: 81635
Legal Contact Name: Cindy Allen Phone Number: 720-876-5474
Title: Team Lead, EH&S South Rockies Email: cindy.allen@encana.com

- **PART C. FACILITY/PROJECT INFORMATION**

Facility/Project Name: North Parachute Ranch
Location (address): Latitude 39.5731 Longitude 108.1093
City: County:
Local Contact Name: Kathy Vertiz Phone Number: 970-285-2626
Title: Surface Management Lead Email: kathy.vertiz@encana.com

form last revised January 2010

- **PART D. DESCRIPTION OF MODIFICATION REQUESTED:**

Location of the Permit Coverage Area:
- County: Rio Blanco & Garfield Counties
- City: Located approximately 25 miles West/Northwest of Parachute, Colorado.
- Township/Range/Section:
  Township 5S, Range 95W, Sections 15-17, 19-22, & 27-34
  Township 5S, Range 96W, Section 3-5, 8-11, 14-17, 21-28 & 33-36
  Township 6S, Range 96W, Section 1-36

- **PART E. CERTIFICATION Required Signatures**

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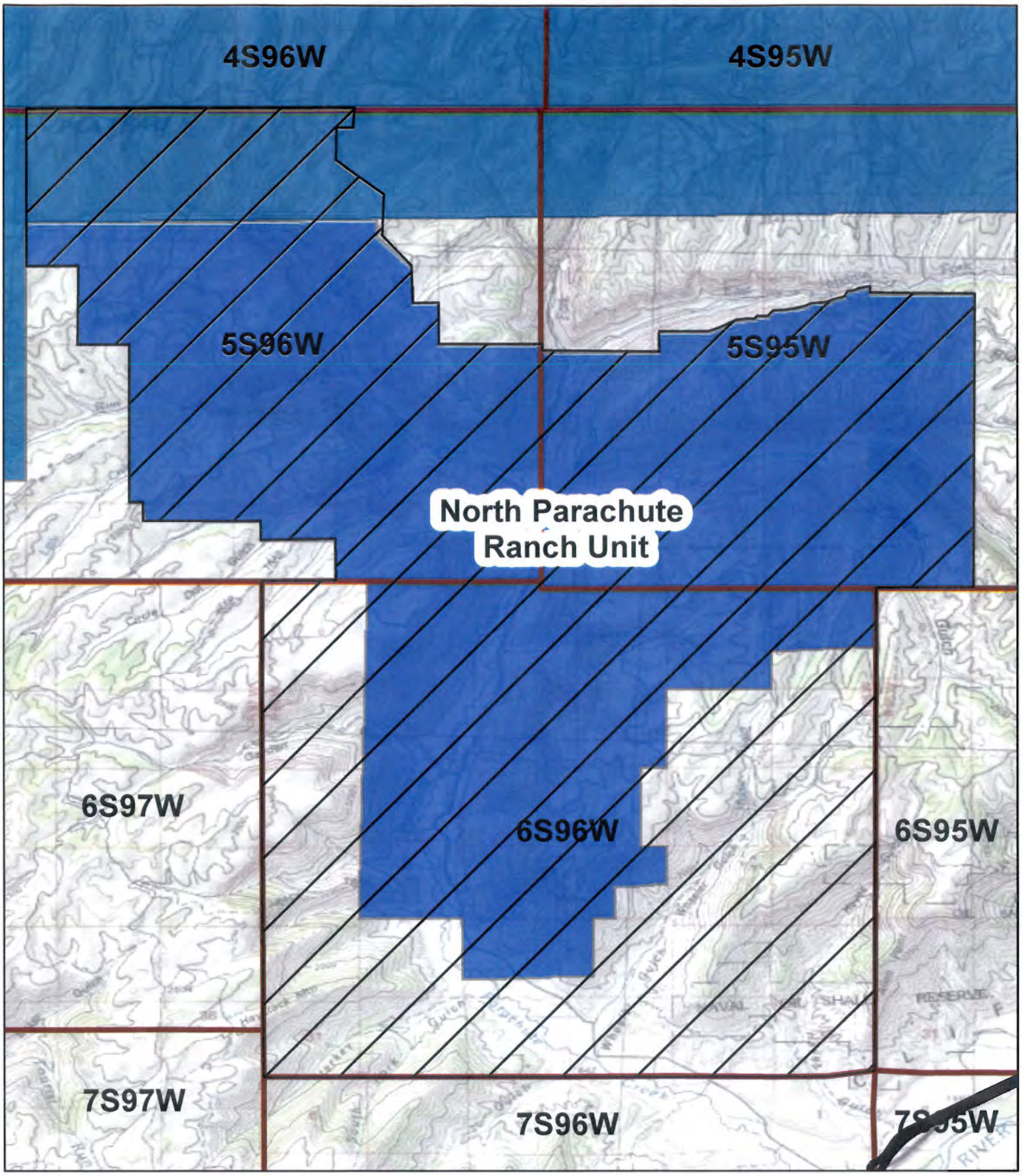
Cindy All — 6/7/12

Signature of Legally **Responsible Party** — Date Signed

Cindy Allen — Team Lead, EH&S South Rockies

Name (printed) — Title



North Parachute Ranch Unit
SWMP Boundary
Encana Oil & Gas (USA), Inc.

Legend

SWMP Name

North Parachute Ranch Unit

0 2.5 5 Miles

N
W E
S

Created by: Leslie Booth
Date: 06/07/2012

Appendix B

Revegetation Manual

EnCana Oil & Gas (USA), Inc. Revegetation Manual

Table of Contents

EnCana Oil & Gas (USA), Inc. Revegetation Manual

Introduction

The objective of a revegetation program is to establish a diverse self sustaining vegetative cover that provides for erosion control and a productive land use. There is not a single best method to revegetation practices. This is why revegetation is considered "an Art and a Science". As many revegetation practitioners have said in the past it is better to be lucky than good. Meaning that the most critical ingredient needed to complete the cycle of revegetation is adequate and timely rainfall. Achieving successful revegetation of a disturbed area is even more complicated than a successful crop from dry land farming. Farming practices are normally completed on land that has prime soil for plant growth and consist of cereal grain crops that are easier to grow than native grasses.

This manual is for the layman who needs to understand revegetation as part of their job duties with EnCana Oil & Gas (USA), Inc., but does not necessarily have the college degree or hands on experience to complete this type of work. This manual will present steps and options that will help increase the chances of successful revegetation. There are sections that outline methods and materials needed to accomplish revegetation on differing site conditions.

1.0 Fertilization

Fertilization of areas to be revegetated is often times a consideration. Soil test of the areas to be seeded are the best way to determine if fertilizer is needed. The major nutrients needed by native vegetation for growth is Nitrogen, Phosphorus, and Potassium. Nitrogen is for top growth of plants, Phosphorus is for root growth, and Potassium is for the overall health and vigor of plants. All fertilizer will list the nutrients in the order of Nitrogen, Phosphorus, and Potassium or N-P-K. For example a product listed as 18-46-0 will contain 18 % Nitrogen, 46% Phosphorus, and 0% Potassium.

Nitrogen may not be at desirable levels in the soil at the time of seeding. However, research has shown that adding nitrogen at the time of seeding can often times increase the growth and cover of weed species at the expense of the desirable seeded species. Also, nitrogen can not be metabolized by native grasses until they are approximately one year old. For these reasons, most experienced revegetation specialists will not recommend the use of nitrogen at the time of seeding. Instead, they will tend to place nitrogen fixing legumes in the seed mixture. These legumes will pull nitrogen from the atmosphere and provide it later to other plants such as grasses.

Phosphorus most likely will be the limiting nutrient in the soil. It is advisable to add phosphorus prior to soil tillage and work it into the soil to a depth of 6 to 8 inches.

Most native soils in Colorado contain optimum levels of potassium. Therefore, potassium should very seldom if ever be needed in the Colorado Fields.

Fertilizer is typically applied using a Three Point Hitch Tractor Mounted Spreader or Fertilizer Buggy Wagon Implement (See photo #'s 1 and 2: Three Point Spreader and Fertilizer Buggy Wagon). Both of these styles of spreaders are considered broadcast spreaders. Their width of application is typically between 10 and 30 feet. The amount of fertilizer applied per acre is controlled by a slide gate opening on the bottom of the spreader.

2.0 Soil Preparation

Soil Preparation is a critical first step to revegetation. The objective is to have the surface 8 inches of soil loose enough to allow for root growth and firm enough on the surface for good seed to soil contact. The soil surface should also be relatively free of rocks, debris, and dirt clods greater than 3 inches in diameter. Too much debris, rock, and clods will prohibit proper seed placement.

There are several types of implements that can be pulled behind farm tractors or small dozers to till the soil. These consist of disk, chisel plows, subsoilers, and harrows. The working widths commercially available for soil preparation implements typically vary 6 feet to over 20 feet. The working width of implements used by contractors is typically based on site access and size. Also, smaller contractors may have a limited number and size of tillage implements in their equipment fleet.

2a. Disking

Disks are normally used where there is significant surface compaction and the soil needs to be tilled to loosen and large soil clods need to be broken down. Disks also are used where there is a concern of bringing more rock up to the soil surface as will occur with chisels, rippers, and subsoilers. Disks should not be used alone where extreme subsoil compaction exist. There are offset disks and tandem disks available on the market. Tandem disks turn the soil twice and offset disks move the soil in opposing directions and help level the surface (See photo #'s 3 and 4: Tandem Disk and Rhome Offset Construction Disk). On very rough sites a Rhome brand construction type disk is recommended because of the weight of the disk and its ability to withstand rough conditions (See photo #4: Rhome Offset Construction Disk). A heavy construction disk normally needs to be pulled behind a mid-size dozer or large 4WD tractor because of its weight and soil penetration ability.

2b. Chisel Plowing

A chisel plow cuts through the soil and helps to eliminate soil compaction to a depth of approximately 8 inches (See photo #'s 5 and 6: Chisel Plow). Chisel plowing to a shallower depth can help cut off and kill weeds. Some rock and clod material can be brought to the soil surface during this operation. If a significant amount of clods are brought up to the soil surface then a cultipacker (See Section 2e.) should be utilized to break clods back down prior to seeding.

2c. Subsoiling

Subsoiling is used to break up compacted soil layers 6 to 24 inches in depth (See photo #7: Subsoiler). Subsoiling helps to improve water infiltration and aerates subsoil layers to encourage root penetration. Subsoiling can bring up significant large clods in zones with heavy clays and compacted zones. Cultipacking (See Section 2e.) will need to follow subsoiling when large volumes of clods greater than 3 inches are brought to the soil surface.

2d. Harrowing

Harrows lightly scratch the ground to loosen a shallow layer of soil (4 inches or shallower). The three styles of harrows consist of a spike tooth harrow (See photo #8), flex-tine tooth harrow (See photo #9), and spring tooth harrow (See photo #10). Harrows should only be used on loose friable soils that do not require deep tillage. Harrows can be used to remove undesirable vegetation such as weeds that will interfere with seeding operations. Harrows will break up surface crust and generally break up clods of topsoil material, but not hard and massive subsoil material. Harrows are excellent for preparing a seedbed for small seeds such as forbs and some shrub seeds.

2e. Cultipacking

Cultipackers consist of front rollers that are an open mesh, a middle set of rippers, and a back set of rollers with knurled edges (See photo #11: Cultipacker). The front set of rollers crushes clods, the rippers bring additional clod material to the soil surface, and the rear roller crushes remaining clods and firms the soil surface.

3.0 Drill Seeding

3a. Equipment

Drill seeders are implements that are towed behind an agricultural seeder or small crawler dozer (See photo #'s 12 and 13: Truax and Horizon Brand Drills). Drill seeding is considered the optimum means of planting grasses, forbs, and most shrub seed. Rangeland type drill seeders used for planting native vegetation should have several critical features or components. This includes three seed boxes, double disk furrow openers equipped with depth bands, press wheels or drag chains (See photo #'s 14, 15, and 16: Close-up of Double Disk Furrow Openers and Depth Bands, Press Wheels, and Drag Chains in Transport Position).

The drill seeder should be equipped with three different seed boxes: A legume box is needed for small seed such as wildflowers, alfalfa, sweet clover, etc., a trashy seed box with aggressive picker wheels for handling trashy seed such as bluestems and gramas (See photo #17: Trashy Seed Box Picker Wheels), and a standard seed box used for flowable seeds such as wheat grasses and small grains (See photo #18: Small Grain Standard Seed Box/Seed Cups). Most native grass drill seeders come in 8 to 10 foot planting widths.

The seed drill is activated by a series of gears and chains that are attached to one of the drill wheels on the drill (See photo #19: Seed Drill Gear Assembly). When the drive wheel is activated it turns the gears which turn the shafts that run through the seed boxes. The seed gravity feeds into seed cups that are attached to the shaft (See photo #18: Small Grain Standard Seed Box/Seed Cups). The trashy seed box has an extra shaft that runs above the seed cup shaft and has an aggressive picker spiral agitator wheel which forces the seed down to the seed cup so it does not simply float in the seed box (See photo #17: Trashy Seed Box Picker Wheels). The seed from all seed boxes falls through a hole in the seed box where a flexible rubber tube is connected between the bottom of the seed box and the double disk furrow openers (See photo #20: Seed Tubes). The double disk furrow openers, as the name implies, opens a small trench in the soil that the seed falls into. As the drill moves forward the seed is covered with soil and pressed into the ground by the press wheels or drag chains (See photo #'s 15 and 16: Press Wheels and Drag Chains in Transport Position). It is very important that the seed is planted to the right depth and the seed is pressed into the soil firmly to press out air and allow the seed to absorb moisture as it becomes available to help germinate the seed. The double disk is attached to a lift arm assembly that allows it to roll and float over minor obstacles in the ground such as small rocks tree branches, and dirt clods. The drill should be lifted up by using the hydraulic cylinder when large rocks and debris are encountered in the drills path. While rangeland type drill seeders are built to handle tough conditions they can be high maintenance and require a supply of extra parts in the field when breakdowns occur.

3b. Methods of Use

Drill seeders should be calibrated for use on a small area before all seeding is completed. Most manufacturers of drill seeding equipment can provide general guidelines as to the amount of seed output by seed box for flowable seeds versus trashy seeds. Calibration will help ensure that the proper amount of Pure Live Seed (PLS) is planted. PLS of any given vegetation species is determined by a registered seed testing laboratory. Individual seeds from individual species are normally placed in a growth chamber to determine the percentage of seeds that will germinate, For example, if 100 seeds are placed in a growth chamber and forced to germinate and only 90 germinate, the germination percentage is considered 90%. Purity is the measure of viable seed and separates out inert material, weed seed (not more than 1% according to federal regulations) and other crop seed. Therefore, the total viable seed is the percent by count that will germinate. The following example provides an illustration of a method of calculating an amount of seed to be planted which takes into account the variation of seed germination and purity of the seed source:

Example of a Pure Live Seed (PLS) Calculation:

A recommended seed mixture requires that 5 lbs. (PLS) of intermediate wheatgrass be planted:

Intermediate wheatgrass germination = 80%
Intermediate wheatgrass purity = 90%

80% X 90% (PLS) = 0.72

$$\frac{\text{5 lbs (PLS) to be planted}}{\text{0.72 (PLS factor)}} = \text{Approximately 7 lbs of bagged seed should be included in the mixture so that 5 lbs of PLS will be planted.}$$

Thus, a seed species PLS factor is based on germination X purity. In order to plant one PLS pound of a species you may end up planting 1.6 to 2.0 times more seed which is considered the bulk seed amount.

The operator should first decide whether to have the seed mixture divided by trashy vs. flowable species or to combine the species and utilize both seed boxes to achieve proper seed output. It is best to consult with your seed dealer to determine just how trashy or fluffy the seed will be. There are several different opinions in the industry as to how to calibrate a native grass seed drill. The most elaborate method of calibration involves jacking up the drill and spinning the drive wheel the number of revolutions that represent an acre. Seed is caught from one of the seed tubes and weighed after spinning the gauge wheel and the seed weight for one tube is converted into the fraction of an acre that the tube represents. Most drill seeders contain either a slide bar with number settings or gear ratios with numbers to increase or decrease the seed output. These adjustments should be made if more than a 10 % variance of less seed than required occurs. Also, adjustments should be made for too much seed being put down which can be a costly mistake as well as planting too much seed for what the soil and environment will support.

The simplest way to calibrate a seed drill is to place two acres worth of seed in the seed box and drill seed ½ acre. Fill the seed box back up to the height it existed with two acres worth of material. Next determine if you had to fill more than a ½ acre of material or less than, or you were right on with the calibration. Be aware that if you had to place less seed back in the

box, than the volume you started with, you are not seeding enough. Calibration of a seed drill can change overnight if seed is left in the drill. Seed may settle in the seed box causing a slight amount of packing and humidity can change the way seed flows from the drill. It is best to finish out the seed in the seed box by the end of the day and start fresh the next day. Remember to check the calibration of the drill at least every 10 acres or each time you refill the drill. Always keep the drill boxes full enough that the seed feeds properly. Remember when seeding on side slopes that seed can slide to the down hill side of the seed box leaving little or no seed to be planted on the high side of the drill. Most drills come equipped with divider boxes to keep seed from sliding all the way to the low end of the drill. If the seed drill does not have divider boxes think of ways to place sheet metal or even card board in the drill to divide it into at least three different compartments.

All drill seeding should be completed parallel to slopes or on the slope contour. Drill seeding up and down a slope can result in accelerating erosion after rainfall since the indentations from the drill rows help to concentrate flow and accelerate soil movement down hill. Most native grass species and forbs germinate best if seeded to a depth of ¼ to ½ inch. Most depth bands on drills are set at ½ inch so the seed can not be planted any deeper.

4.0 Broadcast Seeding

Broadcast seeding is typically done where steep slopes prohibit safe operation of a farm tractor or the soil surface is covered with large rock that cannot be economically removed. Hand seeding may be needed in small, tight access areas where machinery cannot effectively operate. Broadcast seeding can be performed either with a hand seeder (See photo #21: Hand Broadcast Seeder) or tractor mounted spreader (See photo #1: Three Point Spreader). Broadcast spreaders typically spread an even swath of seed onto the soil surface. Depending on the roughness of the ground, the seed can end up at various depths in the soil. Broadcast seeding by hand or machine alone will not typically provide good results unless the seed is covered with soil. Broadcast seeding with a tractor should be followed by using a flex harrow to cover the seed with soil. Hand broadcast seeding should be followed by hand raking with a hard tine rake. In both cases the seed should not be raked deeper than ½ inch into the ground.

5.0 Hydroseeding

Hydroseeding is completed with an actual hydroseeder machine. Most people in the industry use the term hydroseeder/hydromulcher interchangeably since they do both operations (See photo #22: Hydroseeder – 3000 Gallon Tank). A hydroseeder/hydromulcher machine consists of a water tank equipped with a motor that operates a hydraulic agitation system. The top of the machine contains a turret or gun where the seed is discharged (See photo #23: Hydroseeder with Gun Operator). The operator will mix the seed and a small amount of hydromulch in the tanker. The green dyed hydromulch will help the operator see the sprayed area during the seeding operation. The objective of using the hydraulic pressure of the machine is to use enough force from the engine RPM's to shoot or push the seed into the ground. If the seed is not adequately covered with soil, hand raking of the area or slope harrowing should be employed.

6.0 Seed Planting Rates and Species Selection for Individual Seed Mixtures

Establishing seed mixtures and planting rates for different native grass, forbs, and shrub seeds is normally done by a revegetation specialist, soil scientist, plant ecologist, or agronomist. These professionals have several years of experience in knowing how many pounds of each type of seed are needed to increase the chances of revegetation success. Any expert in the revegetation industry knows that there are no absolutes in designing a seed mixture. Designing a seed mixture combines both an "Art and a Science".

The consultant takes into account what vegetation species are currently growing by vegetation zone on the site. A native vegetation zone or community is controlled by several environmental factors including elevation, degree of slope, aspect of slope (East, west, north, or south facing), soil type (for example sandy or clayey), and the amount of precipitation that the area receives each year. Vegetation communities will typically have at least two grass species to as many as eight species. Shrub and forbs species will also typically be present. There should be at least three grass species in a revegetation seed mixture. Having a number of species in the mixture will promote diversity in the final vegetative cover and will reduce the risk of revegetation failure if one or more of the species does not adapt to site conditions.

Typically a consultant will base the poundage of each species on several factors. Some species are hard to establish and may require higher poundage of seed to have a chance to establish. Some species may be easy to establish and are seeded at a higher rate to ensure some initial vegetation cover after seeding. Some vegetation species are very aggressive and should represent a small percentage of the seed mixture or they will dominate the site. Each vegetation species has a different number of seeds per pound. For example, Western Wheat Grass has approximately 110,000 seeds per pound while Blue Grama has 825,000 seeds per pound. There are different opinions with scientist as to how much seed to plant on an acre or square foot basis. Typically, the number of seeds planted per square foot is a consideration.

Chenoweth & Associates believes that 30 to 75 seeds per square foot should be planted on any site. Others believe that 144 seeds per square foot should be planted on any site, especially steeper windblown slopes. The higher number of seeds per square foot could be based on the risk of loosing seed to water erosion on steep hill sides or wind erosion in high wind prone areas. Higher seeding rates could also be based on very good topsoil replacement that will allow a site to support more vegetation.

The general role of thumb for hydroseeding and broadcast seeding is to double the drill seed rate of seed. This rule was established since broadcast and hydroseeding does not typically provide for optimum seed placement and planting depth as compared to drill seeding.

A seed mixture at a minimum will consist of native grasses and forbs. As previously mentioned at least three grass species should be in any revegetation seed mixture. The operator (such as EnCana), landowner (either private landowner or federal agencies such as the Forest Service or BLM), and Revegetation Specialist typically consult with one another to determine what the seed mixture should contain. These individuals or organization will determine if the seed mixture should contain only grasses or whether shrub and forbs seed should be added to the seed mixture as well. Typically cost of seed is a driving factor on deciding if these species are added to a seed mixture.

7.0 Seed Quality

Seed purchased from a reputable seed dealer should contain a seed tag that provides the germination and purity of each species in the bag. The seed tag should also indicate the Lot number of the seed (See photo #24: Seed Tag). The lot number is to document where and when the seed was harvested. The seed supplier should supply seed that has been tested within one year of the purchase date.

8.0 Seed Storage

Seed should be properly stored until it is used. Seed should be kept in a cool dark environment. The temperature in the storage area should never exceed 85ºF for enclosed containers and 90ºF for good ventilated storage. Seed is not typically impacted by freezing temperatures and in fact some seeds benefit from cold and heat scarification in order to germinate. Seed which becomes wet for any period of time exceeding 48 hours should not be used. If seed is stored over winter or for any extended period of time should be retested. Some seed species will decrease in germination percentage faster than others. Additional seed of some species may have to be purchased and reblended into the original seed mixture to bring the mixture back up to the proper PLS rate desired.

9.0 Seeding Dates for Colorado Oil & Gas Fields

Desirable seeding dates are typically tied to periods when precipitation will closely follow the actual seed planting. Moisture in the Colorado oil & gas fields typically comes during the summer monsoon period which occurs in July and winter rain or snow which is highest in January, February and March. Seeding needs to be completed when the soil is not frozen or wet. Therefore, consultants feel that optimum seeding dates are early in the spring until May 1, mid-July until September 1, and after the first heavy frost until permanent ground freeze. These dates do not always coincide with construction schedules and the urgency to seed after earth work is completed to help control erosion. There are times that seeding a cover crop during a poor seeding period may be beneficial. There are several sterile hybrid seeds on the market today that germinate easily as long as there is some degree of soil moisture available. They are considered sterile since they will not reseed themselves. These hybrids are called treticale. They are typically a cross between winter wheat and a wheatgrass.

10.0 Seed Germination

Depending on the vegetation species, germination can occur as soon as 10 days after seeding. Germination is dependent on adequate soil moisture and soil temperature. Normally grass seed needs at least 54ºF surface soil temperature to germinate. These temperatures should exist from late April until late August in the Colorado oil & gas fields depending on elevation and soil shading. Germination of all species can often times take several days or weeks depending on the number of species in the seed mixture. Again, this assumes there is adequate soil moisture in addition to proper soil temperatures for seed germination. At the time of peak germination flush as many as 10 to 20 seedlings per square foot may be present. Approximately 75% of the seedlings die off shortly after germination as the plants reach equilibrium of what the soils moisture and nutrient levels will support. If hot dry periods follow germination, some or all of the grasses and forbs may die. A further discussion of this situation is provided in the following section.

11.0 Seeding Success

After germination occurs, new seedlings are very dependent on continued available soil moisture to survive. Some grass species are more susceptible to desiccation and die back than others. Thus, if adequate and timely precipitation does not occur during the first growing season failure of the revegetation may occur. This is why it is very important to use the proper materials and procedures identified throughout this report.

There are at least two university research units that agree on determining revegetation success after the first growing season. Typically, 3 to 4 live healthy seedlings per square foot after the first growing season will yield long term revegetation success. These seedlings will ultimately yield approximately 40% to 60% canopy cover after the plants mature.

12.0 Seed Mixtures for the Colorado Oil & Gas Fields

Seed mixtures will have to be prepared for use in the Colorado oil & gas fields of EnCana Oil & Gas (USA), Inc. well pads, road cut and fill slopes, pipelines and borrow pits. These seed mixtures will be site specific to the ecosystems present. See Appendix A – Seed Mixture Charts with geographic photos for the seven zones of the Colorado oil & gas fields.

13.0 Mulching and Erosion Control

Conserving soil moisture and controlling surface erosion are very important during seedling establishment. Lack of proper erosion control can result in seed being washed away before it germinates. Mulch materials can help conserve soil moisture and reduce erosion. Mulch materials also provide other beneficial functions. They include increasing moisture infiltration from rain and snow, cooling the soil surface, and providing valuable soil organic matter to increase soil structure.

Several different types of mulch materials can be used for revegetation purposes. The most common ones used are hay/straw mulch, hydromulch, Flexible Growth Medium and Bonded Fiber Matrix. There are also several types of roll out erosion control blankets that are available to be used in place of mulches on steep slope areas, drainage areas, and stream channels.

Erosion control is now required by federal and state laws on most disturbed construction sites and falls under what is called Storm Water Management Permitting. A separate report was prepared for EnCana Oil & Gas (USA), Inc. dealing with education on Storm Water Management Planning and Permitting. An extensive list of mulching and erosion control products is discussed in this report.

14.0 Maintenance of Seeded Areas

Maintenance of seeded areas includes weed control, erosion control, and touch up seeding. Most newly seeded sites require these maintenance operations during the first growing season to help insure successful revegetation. In general weed control should be employed anytime weed cover exceeds 20% canopy cover. Site specifics will vary; sometimes 20% weed canopy cover may be desirable. Mechanical weed control must be used immediately after seeding is completed and most likely until the second growing season. Mechanical weed control consists of mowing or hand pulling weeds. Herbicide applications will kill new seedlings and seed in the ground. Herbicides can only be used after the vegetation becomes established at mature height. Reseeding or touch up seeding should occur after adequate time for germination and when bare spots greater than 10 square feet exist. A more extensive discussion of maintenance of seeded areas and weed control can be found in Oil & Gas Field Specific Revegetation Plans.

APPENDIX A: SEED MIXTURE CHARTS WITH GEOGRAPHIC PHOTOS

APPENDIX A: SEED MIXTURE CHARTS WITH GEOGRAPHIC PHOTOS

Seed Mixture # 1 = to be developed per field area
Seed Mixture # 2 = to be developed per field area
Seed Mixture # 3 = to be developed per field area
Seed Mixture # 4 = to be developed per field area
Seed Mixture # 5 = to be developed per field area
Seed Mixture # 6 = to be developed per field area
Seed Mixture # 7 = to be developed per field area

APPENDIX B: EQUIPMENT PHOTOS

Photo 1: Three Point Spreader

Photo 2: Fertilizer Buggy Wagon

Photo 3: Tandem Disk

Photo 4: Rhome Offset Construction Disk

Photo 5: Chisel Plow – Brillion 8'

Photo 6: Chisel Plow – John Deere

Photo 7: Subsoiler – John Deere

Photo 8: Spike Tooth Harrow

Photo 9: Flex-tine Tooth Harrow

Photo 10: Spring Tooth Harrow

Photo 11: Cultipacker – Brillion

Photo 12: Truax Brand Drill Seeder

Photo 13: Horizon Brand Drill Seeder

Photo 14: Close-up of Double Disk Furrow Openers and Depth Bands

Photo 15: Press Wheels

Photo 16: Drag Chains in Transport Position

Photo 17: Trashy Seed Box Picker Wheels

Photo 18: Small Grain Standard Seed Box/Seed Cups

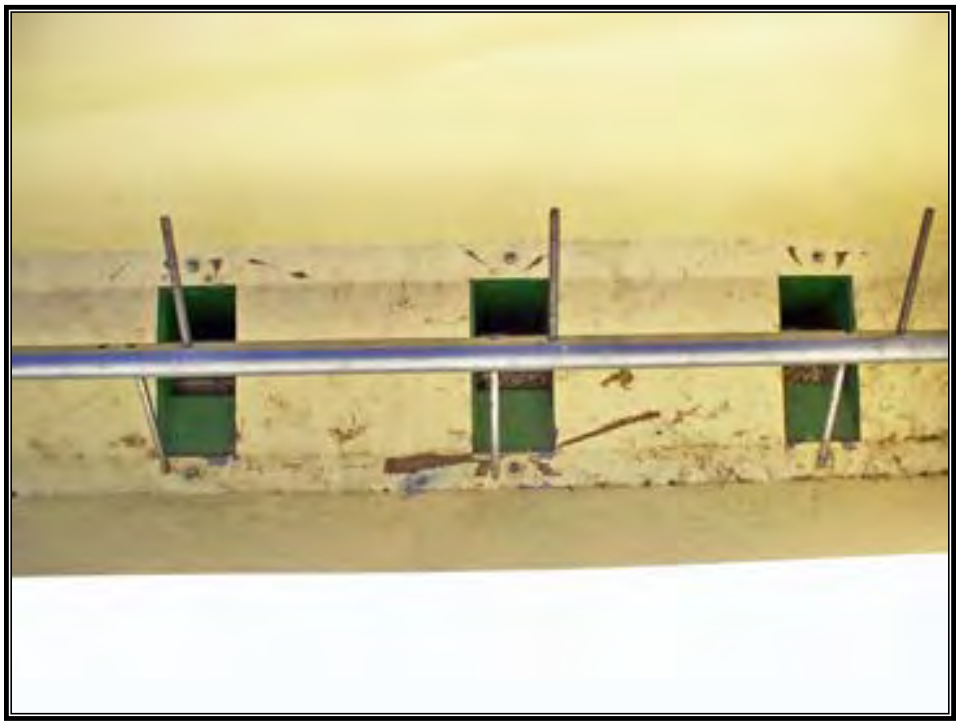


Photo 19: Seed Drill Gear Assembly

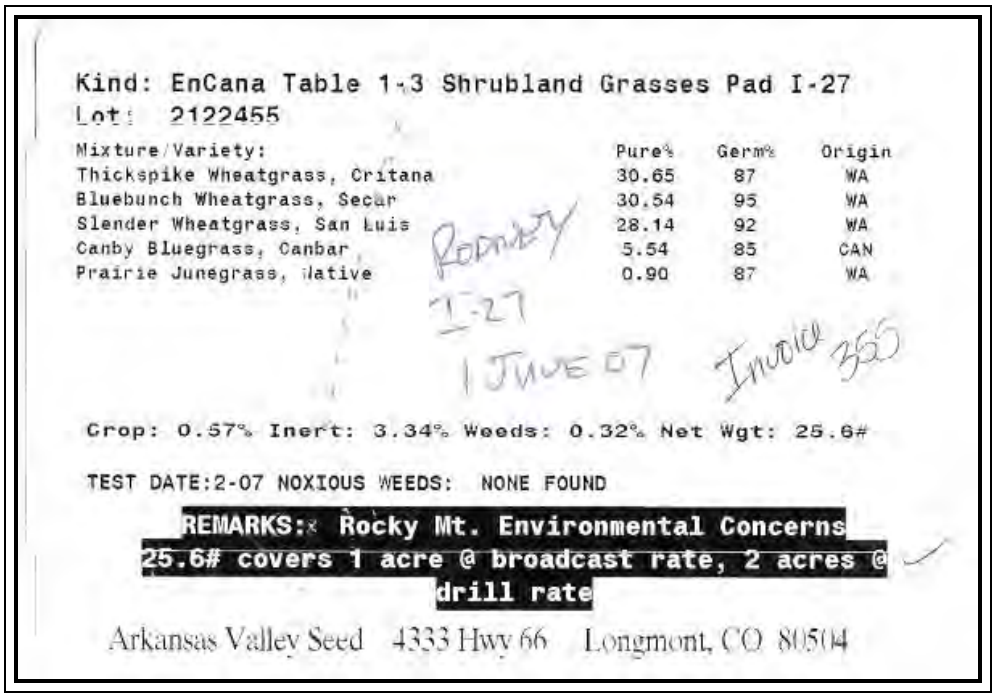
Photo 20: Seed Tubes

Photo 21: Hand Broadcast Seeder

Photo 22: Hydroseeder – 3000 Gallon Tank

Photo 23: Hydroseeder with Gun Operator

Photo 24: Seed Tag



Kind: EnCana Table 1-3 Shrubland Grasses Pad I-27
Lot: 2122455

Mixture/Variety:	Pure%	Germ%	Origin
Thickspike Wheatgrass, Critana	30.65	87	WA
Bluebunch Wheatgrass, Secar	30.54	95	WA
Slender Wheatgrass, San Luis	28.14	92	WA
Canby Bluegrass, Canbar	5.54	85	CAN
Prairie Junegrass, Native	0.90	87	WA

RODNEY
I-27
1 JUNE 07 Invoice 355

Crop: 0.57% Inert: 3.34% Weeds: 0.32% Net Wgt: 25.6#

TEST DATE:2-07 NOXIOUS WEEDS: NONE FOUND

REMARKS: Rocky Mt. Environmental Concerns
25.6# covers 1 acre @ broadcast rate, 2 acres @ drill rate

Arkansas Valley Seed 4333 Hwy 66 Longmont, CO 80504

Appendix C

Existing Soil and Vegetation Data

APPENDIX C
Soils Table - North Piceance SWMP
Page 1 of 3

Map Unit Number - Soil Name	Soil Description	Surface Runoff (slow/ medium/ rapid)	Erosion Potential (slight/ moderate/ severe)	Soil Depth Inches	USDA Texture(s)	Unified Classification	Permeability (inch/hour)	Available Water Capacity (inch/inch)	Organic Matter (%)	Characteristic Plant Communities	Suitability For: Small Commercial Buildings	Local Roads & Streets	Roadfill	Topsoil	Pond Reservoir Areas	Embankments, Dikes, & Levees	Drainage	Irrigation	Terraces and Diversions	Grassed Waterways
Rio Blanco Area																				
RB6- Barcuschannery loamy sand, 2 to 8% slopes	Deep, somewhat excessively drained soils on alluvial fans and in narro valleys.	Slow	Moderate	0-6	Channery Loamy Sand	SM,GM	6.0-20.0	0.06-0.10	.5-1	Western wheatgrass, basin wildrye, Indian ricegrass, and Big sagebrush.	Severe: Flooding.	Moderate: Flooding.	Not Available.	Not Available.	Severe: seepage.	Severe: seepage.	Deep to water	Percs slowly, depth to rock.	Too sandy	Droughty
				6-16	Channery Sand	GM,SM	6.0-20.0	0.04-0.06												
				16-60	Stratified very channery sand to very channery loamy fine sand.	GP-GM	6.0-20.0	0.05-0.07												
RB15- Castner channery loam, 5 to 50% slopes	Shallow, well drained soils on mountainsides, ridgetops, and uplands.	Medium-Rapid	Moderate-Very High	0-7	Channery Loamy Sand	ML,CL-ML,SM,GM	0.60-6.0	0.12-0.16	2-4	Pinyon and Juniper with beardless wheatgrass, dryland sedges, streambank wheatgrass, muttongrass and Indian ricegrass.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Not Available.	Not Available.	Severe: depth to rock, slope.	Severe: seepage.	Deep to water	Large stones, droughty.	Slope, large stones, depth to rock.	Large stones, slope, droughty.
				7-11	Very channery loam, very cobbly loam, very channery sandy loam.	GM,GM-GC	0.60-6.0	0.06-0.10												
				11-17	Very channery loam, very channery sandy loam, very flaggy loam.	GM,GM-GC,GP-GM	0.60-6.0	0.05-0.08												
				17	Unweathered bedrock.	N/A	N/A	N/A												
RB29- Dollard silty clay loam, 3 to 8% slopes	Moderately deep, well drained soils on foot slopes and low ridges.	Medium	Moderate	0-3	Silty clay loam	CL,CH	0.06-0.2	0.17-0.19	1-2	Western wheatgrass, prairie junegrass, big sagebrush, and low rabbitbrush.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Not Available.	Not Available.	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Depth to rock, erodes easilly.	Erodes easily, depth to rock.
				3-26	Silty clay, silty clay loam, clay.	CH,CL	0.06-0.2	0.13-0.18												
				26	Weathered bedrock.	N/A	N/A	N/A												
RB33- Forelle loam, 3 to 8% slopes	Deep, well drained soils on terraces and uplands.	Medium	Moderate	0-4	Loam	CL-ML, ML	0.6-2.0	0.16-0.18	.5-1	Western wheatgrass, prairie junegrass, big sagebrush, Douglas rabbitbrush, streambank wheatgrass, and needleandthread.	Moderate: slope.	Slight	Not Available.	Not Available.	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable
				4-21	Clay loam, loam.	CL	0.6-2.0	0.16-0.21												
				21-60	Loam	CL-ML, ML	0.6-2.0	0.16-0.18												
RB34-n Forelle loam, 8 to 15% slopes	Deep, well drained soils on terraces and uplands.	Medium	Moderate-High	26	Weathered bedrock.	N/A	0.6-2.0	0.16-0.18	.5-1	Western wheatgrass, prairie junegrass, big sagebrush, Douglas rabbitbrush, streambank wheatgrass, and needleandthread.	Severe: slope.	Moderate: slope.	Not Available.	Not Available.	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope	Slope
				0-4	Loam	CL-ML, ML	0.6-2.0	0.16-0.21												
				4-21	Clay loam, loam.	CL	0.6-2.0	0.16-0.18												
				21-60	Loam	CL-ML, ML	N/A	N/A												
RB36- Glendive fine sandy loam	Deep, well drained soils on alluvial valley floors.	Slow	Slight	0-6	Fine sandy loam.	SM, ML	2.0-6.0	0.12-0.18	.5-2	Western wheatgrass, basin wildrye, Indian ricegrass, and Big sagebrush.	Severe: Flooding.	Moderate: Flooding.	Not Available.	Not Available.	Severe: seepage.	Severe: piping.	Deep to water	Slope, excess salt.	Soil blowing	Favorable
				6-60	Stratified loamy fine sand to silt loam.	SM, SM-SC	2.0-6.0	0.12-0.18												
RB40- Hagga loam	Deep, poorly drained soils on flood plains and alluvial valley floors.	Slow	Slight	0-5	Loam	CL-ML	0.6-2.0	0.16-0.18	1-2	Western wheatgrass, Nebraska sedge, slender wheatgrass, and basin wildrye.	Severe: Flooding, wetness.	Severe: low strength, wetness, frost action.	Not Available.	Not Available.	Slight	Severe: wetness.	Frost action, cutbanks cave.	Wetness	Wetness	Wetness
				5-60	Stratified silty clay loam to loamy fine sand.	CL	0.2-0.6	0.14-0.17												
RB41-Havre loam, 0 to 4% slopes	Deep, well drained soils on flood plains and low stream terraces.	Medium	Slight	0-21	Loam	CL-ML	0.6-2.0	0.16-0.20	.5-1	Western wheatgrass, basin wildrye, Streambank wheatgrass, bluegrasses, and Big sagebrush.	Severe: Flooding.	Moderate: Flooding.	Not Available.	Not Available.	Moderate: seepage.	Severe: piping.	Deep to water	Excess salt.	Erodes easily.	Erodes easily.
				21-60	Stratified fine sandy loam to clay loam.	CL-ML, CL	0.6-2.0	0.14-0.18												
RB42Irigul channeryloam, 5 to 50% slopes	Shallow, well drained soils on ridges and mountain sides.	Medium-Rapid	Very High	0-5	Channery loam	GM-GC	0.6-2.0	0.09-0.11	1-3	Beardless wheatgrass, westernwheatgrass, serviceberry, big sagebrush, and low rabbitbrush.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Not Available.	Not Available.	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Droughty, depth to rock, slope.	Erodes easily.	Erodes easily.
				5-12	Very channery loam, very channery clay loam, extremely channery loam.	GM-GC	0.6-2.0	0.05-0.10												
				12	Unweathered bedrock.	N/A	N/A	N/A												
RB43- Irigul- Parachute complex, 5 to30% slopes	This unit is on ridges and mountainsides.	Medium-Rapid	Slight-High	0-5	Channery loam	GM-GC	0.6-2.0	0.09-0.11	1-3	Beardless wheatgrass, westernwheatgrass, serviceberry, big sagebrush.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Not Available.	Not Available.	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Droughty, depth to rock, slope.	Slope: depth to rock.	Slope, droughty, depth to rock.
				5-12	Very channery loam, very channery clay loam, extremely channery loam.	GM-GC	0.6-2.0	0.05-0.10												
				12	Unweathered bedrock.	N/A	N/A	N/A												
RB58- Parachute loam, 25 to 75% slopes	Moderatly deep, well drained soils on ridges and mountainsides.	Medium	Very High	0-4	Loam	CL-ML	0.6-2.0	0.16-0.18	3-6	Letterman needlegrass, elk sedge, serviceberry, Columbia needlegrass, big sagebrush, and Idaho fescue.	Severe: slope.	Severe: slope.	Not Available.	Not Available.	Severe: seepage, slope.	Severe: seepage.	Deep to water	Depth to rock, slope.	Slope: depth to rock.	Slope: depth to rock.
				4-24	Loam, channery loam.	CL-ML, SM-SC, GM-GC	0.6-2.0	0.14-0.16												
				24-38	Very channery loam, very channery sandy loam, extremely channery sandy loam.	GM-GC, GM	2.0-6.0	0.03-0.06												
				38	Unweathered bedrock.	N/A	N/A	N/A												
RB59- Parachute- Rhone loams, 5 to 30% slopes	This unit is on mountainsides and upland ridges.	Medium	Moderate-High	0-4	Loam	CL-ML	0.6-2.0	0.16-0.18	3-6	Letterman needlegrass, elk snowberry, serviceberry, Columbia needlegrass, big sagebrush, and Idaho fescue.	Severe: slope.	Severe: slope.	Not Available.	Not Available.	Severe: seepage, slope.	Severe: seepage.	Deep to water	Depth to rock, slope.	Slope: depth to rock.	Slope: depth to rock.
				4-32	Loam, channery loam.	CL-ML, SM-SC, GM-GC	0.6-2.0	0.14-0.16												
				32-38	Very channery loam, very channery sandy loam, extremely channery sandy loam.	GM-GC, GM	2.0-6.0	0.03-0.06												
				38	Unweathered bedrock.	N/A	N/A	N/A												
RB64- Piceance fine sandy loam, 5 to 15% slopes	Moderatly deep, well drained soils on uplands and broad ridgetops.	Slow-Medium	Moderate-High	0-4	Fine sandy loam.	ML,SM	2.0-6.0	0.13-0.15	1-1	Bluebunch wheatgrass, western wheatgrass, big sagebrush, serviceberry, prairie junegrass, and sand lupine.	Severe: slope.	Moderate: slope.	Not Available.	Not Available.	Severe: slope.	Severe: seepage.	Deep to water	Soil blowing, depth to rock, slope.	Slope: depth to rock, soil blowing.	Slope: depth to rock.
				4-22	Loam, sandy clay loam, clay loam.	CL, CL-ML, SC, SM-SC	0.6-2.0	0.15-0.17												
				22-30	Channery sandy loam, channery loam, channery sandy clay loam.	GM, GM-GC, SM, SM-SC	0.6-2.0	0.04-0.07												
				30	Weathered bedrock.	N/A	N/A	N/A												
RB66- Potts- Begay fine sandy loams, 2 to 7% slopes	This map unit is on fans and uplands.	Slow-Medium	Moderate	0-3	Fine sandy loam.	SM	2.0-6.0	0.11-0.13	1-2	Galleta, indian ricegrass, thickspike wheatgrass, big sagebrush, and low rabbitbrush.	Moderate: slope.	Slight.	Not Available.	Not Available.	Moderate: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Erodes easily, soil blowing.	Erodes easily.
				3-17	Clay loam, loam.	CL	0.6-2.0	0.19-0.21												
				17-60	Loam, clay loam.	ML	0.6-2.0	0.16-0.18												
				0-9	Fine sandy loam.	SM	2.0-6.0	0.09-0.14												
				9-30	Very fine sandy loam, fine sandy loam.	ML, CL-ML	2.0-6.0	0.13-0.18												
				30-60	Very fine sandy loam, loamy fine sand, fine sandy loam.	ML, SM	2.0-6.0	0.10-0.15												
RB69- Razorba channery sandy loam, 30 to 75%	Deep, well drained soils on mountainsides.	Medium	Very High	0-35	Channery sandy loam.	SM, GM	2.0-6.0	0.10-0.13	2-4	Thin stands of spruce and fir trees with serviceberry, snowberry, mountain brome, and slender wheatgrass.	Severe: slope.	Severe: slope.	Not Available.	Not Available.	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope	Slope, droughty.
				35-60	Channery sandy loam, very channery sandy loam.	SM, GM	2.0-6.0	0.07-0.09												
RB70- Redcreek- Rentsac complex, 5 to 30% slopes	This map unitis on mountainsides and ridges.	Medium	Moderate-High	0-11	Sandy loam.	SM-SC	2.0-6.0	0.12-0.16	.5-1	Pinyon and juniper with bearless wheatgrass, indian ricegrass, serviceberry, mountainmahogany, sedges, and big sagebrush.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Not Available.	Not Available.	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Soil blowing, depth to rock, slope.	Slope: depth to rock, erodes easilly.	Slope: depth to rock, erodes easilly.
				11-16	Channery sandy loam.	GM, SM	2.0-6.0	0.09-0.11												
				16	Weathered bedrock.	N/A	N/A	N/A												
				0-5	Channery loam.	SM, ML, GM	2.0-6.0	0.12-0.16												
				5-16	Very channery loam, very channery sandy loam, very flaggy loam.	SM, GM	2.0-6.0	0.06-0.10												
				16	Unweathered bedrock.	N/A	N/A	N/A												
RB73- Rentsac channery loam, 5 to 50% slopes	Deep, somewhat poorly drained soils on alluvial valley floors, low terraces, and flood plains.	Rapid	Moderate-Very High	0-5	Channery loam.	SM, ML, GM	2.0-6.0	0.12-0.16	.5-2	Pinyon and Utah juniper with Indian ricegrass, beardless wheatgrass, mountainmahogany, and prarie junegrass.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Not Available.	Not Available.	Severe: depth to rock, slope.	Severe: seepage, large stones.	Deep to water	Large stones, droughty, depth to rock.	Slope, large stone, depth to rock.	Large stones, slope, droughty.
				5-16	Very channery loam, very channery sandy loam, very flaggy loam.	SM, GM	2.0-6.0	0.06-0.10												
				16	Unweathered bedrock.	N/A	N/A	N/A												
RB75- Rentsac- Piceance complex, 2 to 30% slopes	This map unit is on uplands, broad ridges, and foothills.	Medium	Moderate-High	0-5	Channery loam.	SM, ML, GM	2.0-6.0	0.12-0.16	.5-2	Pinyon and juniper with Indian ricegrass, beardless wheatgrass, mountainmahogany, big sagebrush, bitterbrush, and prarie junegrass.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Not Available.	Not Available.	Severe: depth to rock, slope.	Severe: seepage, large stones.	Deep to water	Large stones, droughty, depth to rock.	Slope, large stone, depth to rock.	Large stones, slope, droughty.
				5-16	Very channery loam, very channery sandy loam, very flaggy loam.	SM, GM	2.0-6.0	0.06-0.10												
				16	Unweathered bedrock.	N/A	N/A	N/A												
				0-4	Fine sandy loam.	ML, SM	2.0-6.0	0.13-0.15												
				4-22	Loam, sandy clay loam, clay loam.	CL, CL-ML, SC, SM-SC	0.6-2.0	0.15-0.17												
				22-30	Channery sandy loam, channery loam, channery sandy clay loam.	GM, GM-GC, SM, SM-SC	0.6-2.0	0.04-0.07												
				30	Weathered bedrock.	N/A	N/A	N/A												
RB76- Rhone loam, 30 to 75% slopes	Deep, well drained soils on mountainsides, upland ridges, and side slopes..	Medium	Very High	0-24	Loam	CL, CL-ML, SC, SM-SC	0.6-2.0	0.19-0.21	3-6	Columbia needlegrass, elk sedge, serviceberry, and gambel oak.	Severe: slope.	Severe: slope.	Not Available.	Not Available.	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope	Slope
				24-50	Channery sandy clay loam, very channery sandy clay loam, very channery loam.	GM-GC	0.6-2.0	0.08-0.10												
				50	Unweathered bedrock.	N/A	N/A	N/A												
RB80- Shawa loam, 3 to 8% slopes	Deep, well drained soils on alluvial valley floors, fans and low terraces along concave drainageways..	Medium	Slight-Moderate	0-16	Loam.	CL-ML, SM-SC, GM-GC	0.6-2.0	0.14-0.16	2-4	Western wheatgrass, muttongrass, basin wildrye, low rabbitbrush, big sagebrush, and serviceberry.	Moderate: shrink-swell, slope.	Moderate: Frost action, shrink-swell.	Not Available.	Not Available.	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable
				16-60	Loam, clay loam.	CL	0.6-2.0	0.14-0.16												
RB82- Silas loam, 0 to 8% slopes	Deep, well drained soils on the bottoms of narrow mountain valleys.	Medium	Slight-Moderate	0-24	Loam.	ML	0.6-2.0	0.14-0.16	1-3	Basin wildrye, slender wheatgrass, letterman needlegrass, and western wheatgrass.	Moderate: slope.	Moderate: Frost action.	Not Available.	Not Available.	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable
				24-60	Stratified loam to sandy clay loam.	ML	0.6-2.0	0.14-0.16												

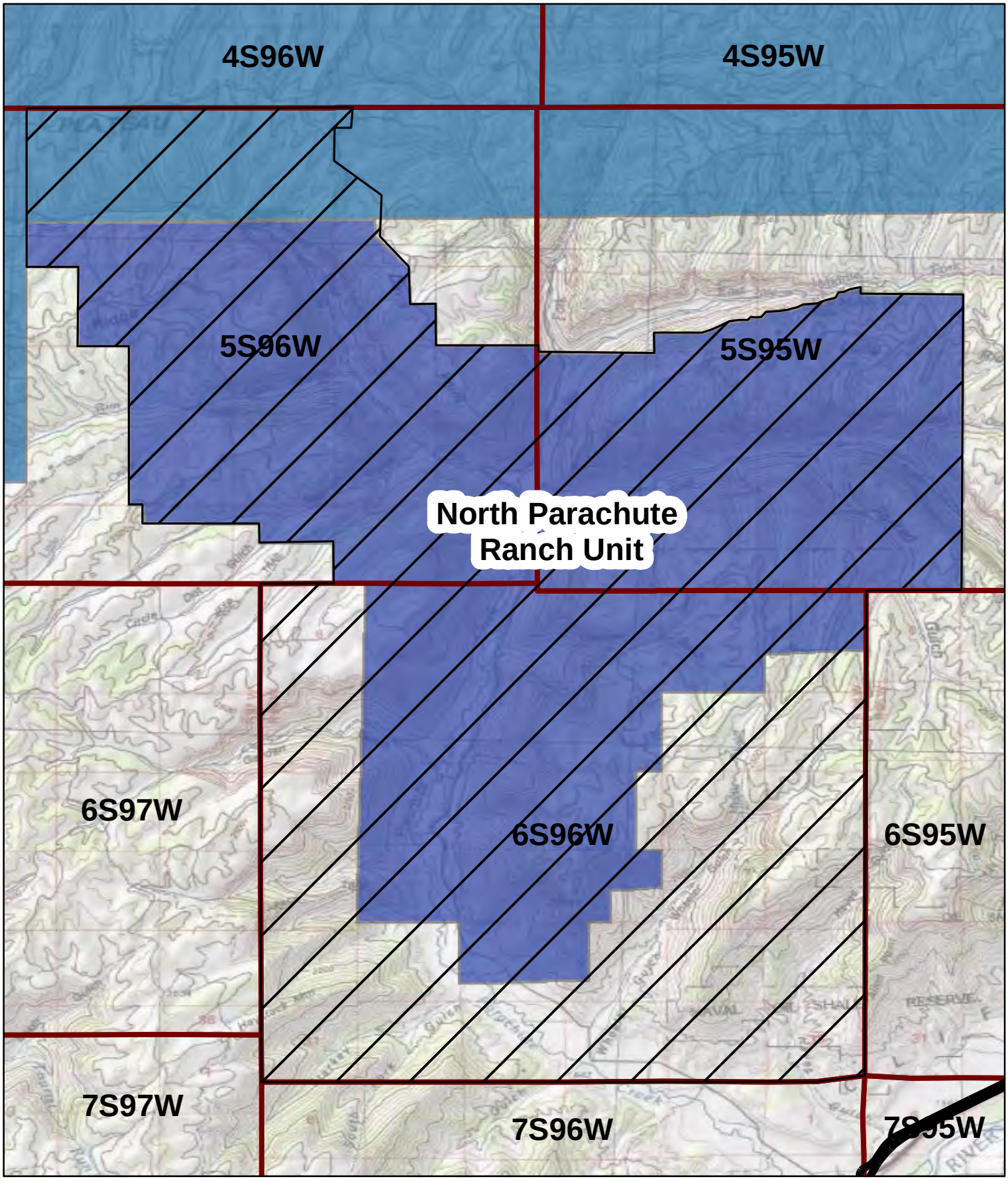
RB83- Silas loam, 8 to 12% slopes	Deep, welll drained soils on the bottoms and side slopes of narrow mountain valleys.	Medium	Moderate	0-24	Loam.	ML	0.6-2.0	0.14-0.16	1-3	Basin wildrye, slender wheatgrass, letterman needlegrass, and big sagebrush.	Severe: slope.	Moderate: slope, frost action.	Not Available.	Not Available.	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope	Slope
				24-60	Stratified loam to sandy clay loam.	ML	0.6-2.0	0.14-0.16												
RB87- Starman-Vandamore complex, 5 to 40% slopes	This unit is on rolling ridges and windswept ridgetops.	Medium	Moderate-Very High	0-2	Chanery loam.	GM	0.6-2.0	0.09-0.11	1-2	Beardless wheatgrass, streambank wheatgrass, fringed sagebrush, mat penstemon, mat laco, and Colorado buckwheat.	Severe: slope, depth to rock.	Severe: depth to rock.	Not Available.	Not Available.	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Droughty, depth to rock, slope.	Slope: depth to rock.	Slope, droughty, depth to rock.
				2-17	Gravelly loam, channery loam, very channery loam.	GM	0.6-2.0	0.09-0.11												
				17	Unweathered bedrock.	N/A	N/A	N/A												
				0-4	Channery loam.	CL-ML, GM-GC	0.6-2.0	0.12-0.14												
				4-25	Very channery loam, extremely channery loam.	GM, GM-GC, SM, SM-SC	2.0-6.0	0.06-0.08												
				25	Unweathered bedrock.	N/A	N/A	N/A												
RB91- Torriorthents-Rock outcrop complex, 15 to 90% slopes	This map unit is in extremely rough and eroded areas on mountains, hills, ridges, and canyon.	Very Rapid	Very High	NOT AVAILABLE			N/A	N/A	N/A	Pinyon and Juniper with Indian ricegrass, beardless wheatgrass, prarie junegrass, low rabbitbrush, and some forbs.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.
RB96- Veatch channery loam, 12 to 50% slopes	Moderately deep, well drained soils on mountainsides.	Medium	Moderate-Very High	0-8	Channery Loam	SM, ML, GM	0.6-2.0	0.14-0.16	N/A	Bluebunch wheatgrass, western wheatgrass, muttongrass, big sagebrush, mountainmohogany, and serviceberry.	Severe: slope.	Severe: slope.	Not Available.	Not Available.	Severe: seepage, slope.	Severe: seepage.	Deep to water	Depth to rock, slope.	Slope: depth to rock.	Slope: depth to rock.
				8-18	Channery loam, channery sandy loam.	SM, GM	0.6-2.0	0.13-0.15												
				18-32	Very channery sandy loam, extremely channery loam.	GM, SM	2.0-6.0	0.06-0.08												
				32	Unweathered bedrock.	N/A	N/A	N/A												
RB104- Yamac loam, 2 to 15% slopes	Deep, well drained soils on rolling uplands, terraces, and fans.	Medium	Slight-Moderate	0-4	Loam	CL-ML	0.6-2.0	0.16-0.20	1-2	Big sagebrush, western wheatgrass, streambank wheatgrass, prairie junegrass, Douglas rabbitbrush, and winterfat.	Severe: slope.	Moderate: slope, shrink-swell.	Not Available.	Not Available.	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
				4-22	Loam, clay loam, silt loam.	CL, CL-ML	0.6-2.0	0.14-0.18												
				22-60	Loam, clay loam, silt loam.	CL, CL-ML	0.6-2.0	0.14-0.18												
RB129- Water	Not available.	Not Available.	Not Available.	NOT AVAILABLE			N/A	N/A	N/A	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.	Not Available.
Douglas Area																				
D44-Happle very channery sandy loam, 3 to 12% slope	Deep, well-drained very channery sandy loam and very channery sandy clay loam formed in alluvium derived from shale residuum found on alluvial fans.	moderate	severe	0-7	Very channery sandy loam	GC	0.60-6.00	0.05-0.07	0.5-1	Western wheatgrass, Wyoming big sagebrush, Bottlebrush squirreltail, Sandberg bluegrass, Indian ricegrass, Needleandthread, other perennial grasses, Western wheatgrass, True mountain Mahogany.	Very limited: slope.	Somewhat limited: frost action.	Good	Poor: hard to reclaim, rock fragments.	Very limited: seepage.	Somewhat limited: seepage.	Limitation: deep to water.	Limitation: slope, droughty.	Favorable.	Limitation: too arid, droughty.
				7-14	Very channery sandy loam	GC-GM, GW-GC	0.60-6.00	0.05-0.07	0-0.5											
				14-32	Very channery sandy clay loam	GC, GC-GM, GW-GC	0.57-2.00	0.07-0.09	0-0.5											
				32-60	Extremely channery sandy loam	GW, GW-GM	0.60-6.00	0.03-0.04	0-0.5											
D46-*Happle* -Rock outcrop association, 25 to 65% slope	On side slopes and canyon rims.	rapid	severe	0-7	Very channery sandy loam, unweathered bedrock	GC, GC-GM, GW-GC	0.60-6.00	0.05-0.07	0.5-1	Indian ricegrass, Shadscale saltbush, Bottlebrush squirreltail, Other perennial grasses, Western wheatgrass, Wyoming big sagebrush, other perennial forbs.	Very limited: slope.	Very limited: slope, frost action.	Poor: slope.	Poor: slope, hard to reclaim, rock fragment content.	Severe: seepage, slope.	Severe: seepage.	Limitation: deep to water.	Limitation: slope, droughty.	Limitation: slope.	Limitation: slope, too arid, droughty.
				7-14	Very channery sandy clay loam, unweathered bedrock	GC, GC-GM, GW-GC	0.60-6.00	0.05-0.07	0-0.5											
				14-32	Very channery sandy clay loam, unweathered bedrock	GC, GC-GM, GW-GC	0.60-2.00	0.07-0.09	0-0.5											
				32-60	Extremely channery sandy loam, unweathered bedrock	GW, GW-GM	0.60-6.00	0.03-0.04	0-0.5											
D50-*Irigul* -Starman channery loams, 5 to 35% slopes.	Shallow and well drained, found on mountain ridges and on the crests and sides of hills.	medium to rapid	moderate to very severe	0-6	Channery Loam	GC-GM, GC, SC, SC-SM	0.6-2.0	0.10-0.13	1-3	Saskatoon serviceberry, Bluebunch wheatgrass, Mountain big sagebrush, Prairie Junegrass, Western wheatgrass.	Very limited: Depth to hard bedrock, slope.	Very limited: Depth to hard bedrock, slope.	Poor: depth to bedrock, slope.	Poor: slope, depth to bedrock, rock fragment content.	Severe: Slope, depth to rock.	Severe: thin layer.	Limitation: deep to water.	Limitation: slope, depth to rock, droughty.	Limitation: slope, depth to rock.	Limitation: slope, depth to rock, droughty.
				6-13	Very channery loam	GC, GC-GM	0.6-2.0	0.07-0.09	0-0.5											
				13-17	Unweathered bedrock		0.06-0.2													
D52- *North* -Adel complex, 5 to 50% slopes.	Deep well drained, found on mountainsides and foot slopes and in swales.	medium to rapid	severe to very severe	0-28	Loam	CL, CL-ML	0.60-6.00	0.14-0.17	3-6	Slender wheatgrass, Columbia needlegrass, Mountain snowberry, Nodding brome, Blue wildrye.	Very limited: slope.	Very limited: slope, frost action.	Poor: slope.	Poor: slope, hard to reclaim.	Severe: seepage, slope.	Slight	Limitation: deep to water.	Limitation: slope.	Limitation: slope.	Limitation: slope.
				28-48	Very channery loam	GC, GC-GM	0.60-2.00	0.07-0.09	1-3											
				48-60	Extremely channery loam	GC, GC-GM	0.60-2.00	0.07-0.09	0.5-1											
D55-*Parachute* -Irigul complex, 5 to 30% slopes.	Moderately deep and is well drained, found on mountain ridges and on the crests and sides of hills.	medium to rapid	moderate to very severe	0-10	Loam	CL, CL-ML	0.6-2.0	0.14-0.17	3-6	Letterman's needlegrass, Slender wheatgrass, Arizona fescue, Columbia needlegrass, Mountain big sagebrush, Saskatoon serviceberry, Big bluegrass, Mountain snowberry, Yellow rabbitbrush	Very limited: slope.	Very limited: slope, frost action.	Poor: depth to bedrock, slope.	Poor: rock fragment content, slope, depth to rock.	Severe: slope.	Severe: thin layer.	Limitation: deep to water.	Limitation: slope, depth to rock, droughty.	Limitation: slope, depth to rock.	Limitation: slope, depth to rock, droughty.
				10-25	Extremely channery loam, very channery loam	GC, GC-GM	0.6-2.0	0.07-0.09	1-2											
				25-29	Unweathered bedrock		0.06-0.2													
D56-*Parachute* -Irigul-Rhone association, 25 to 50% slope	On tops of mountains and ridges and on the crests and sides of hills.	rapid	very severe	0-10	Loam, channery loam	CL, CL-ML, GC, GC-GM, SC, SC-SM	0.6-2.0	0.14-0.17	3-6	Saskatoon serviceberry, Elk sedge, Mountain brome, Western wheatgrass, Columbia needlegrass, Letterman's needlegrass, Mountain big sagebrush, Mountain snowberry.	Very limited: slope.	Very limited: slope, frost action.	Poor: depth to bedrock, slope.	Poor: rock fragment content, slope, depth to rock.	Severe: slope.	Severe: thin layer.	Limitation: deep to water.	Limitation: slope, depth to rock, droughty.	Limitation: slope, depth to rock.	Limitation: slope, depth to rock, droughty.
				10-39	Extremely channery loam, very channery loam, channery loam, unweathered bedrock	GC, GC-GM, SC-SM, SC	0.6-2.0	0.07-0.09	1-2											
				39-55	Very channery loam	GC, GC-GM	0.06-0.2													
				55-59	Unweathered bedrock	N/A														
D57-*Parachute* -Rhone loams, 5 to 30% slope	On ridge crests, mountainsides, upland slopes and side slopes.	medium to rapid	moderate to very severe	0-10	loam	CL, CL-ML	0.6-2.0	0.14-0.17	3-6	Letterman's needlegrass, Arizona fescue, Columbia needlegrass, Elk sedge, Mountain big sagebrush, Slender wheatgrass, Saskatoon serviceberry, Big bluegrass, Mountain snowberry.	Very limited: slope.	Very limited: slope, frost action.	Poor: depth to bedrock, slope.	Poor: rock fragment content, slope, depth to rock.	Severe: slope.	Severe: thin layer.	Limitation: deep to water.	Limitation: slope, depth to rock, droughty.	Limitation: slope, depth to rock.	Limitation: slope, depth to rock, droughty.
				10-39	Very channery loam, channery loam, unweathered bedrock	GC, GC-GM, SC, SC-SM	0.6-2.0	0.07-0.09	1-2											
				39-55	Very channery loam, unweathered bedrock	GC, GC-GM	0.06-0.2													
				55-59	Unweathered bedrock	N/A														
D63-Silas loam, 1 to 12% slopes.	Deep, moderately well drained soil is on alluvial valley floors.	slow	slight to very severe	0-18	Loam	CL, CL-ML	0.60-2.00	0.16-0.18	2-6	Western wheatgrass, Basin wildrye, Mountain big sagebrush, Columbia needlegrass, Slender wheatgrass.	Very limited: flooding, slope.	Somewhat limited: Frost action, flooding.	Good.	Good.	Moderate: slope.	Moderate: piping wetness.	Limitation: deep to water.	Limitation: slope.	Favorable.	Favorable.
				18-60	Clay loam	CL	0.20-0.60	0.16-0.20	1-4											
D65-*Torriorthents* , cool-Rock outcrop complex, 35 to 90% slopes	Very shallow to deep over hard or soft bedrock, soils are well drained to somewhat excessively drained, found on steep, mainly south-facing slopes of mountains, hills, ridges, and canyon sides in extremely rough and eroded areas.	rapid	very severe	0-2	Chanery loam, Unweathered bedrock	GC, GC-GM, SC, SC-SM	0.60-6.00	0.10-0.13	0.5-1	Gambel's oak, other perennial grasses, Indian ricegrass, Mountain big sagebrush, Sasketoon serviceberry, Wyoming big sagebrush, Western wheatgrass.	Very limited: slope, depth to hard bedrock.	Very limited: slope, depth to hard bedrock.	Poor: depth to bedrock, slope.	Poor: slope, depth to bedrock, rock fragments, salinity.	Severe: slope, depth to rock.	Severe: thin layer.	Limitation: deep to water.	Limitation: slope, droughty.	Limitation: slope, depth to rock, large stones.	Limitation: slope, depth to rock, large stones, too arid.
				2-13	Channery loam, Very channery loam, Unweathered bedrock	CL, CL-ML, GC, GC-GM	0.60-6.00	0.05-0.07	0-0.5											
				13-17	Weathered bedrock, Unweathered bedrock		0.06-2.0													
				17-60	Unweathered bedrock															
D67-Tosca channery loam, 25 to 80% slope	Deep, well-drained on mountain side slopes and foot slopes, formed in coluvium derived dominantly from Green River shale.	rapid	very severe	0-8	Channery loam	GC, GC-GM	2.00-6.00	0.10-0.13	1-3	Saskatoon serviceberry, Gambel's oak, Elk sedge, Mountain brome, Mountain snowberry, Slender wheatgrass.	Very limited: slope.	Very limited: slope, frost action.	Poor: slope.	Poor: Hard to reclaim, slope, rock fragments.	Severe: seepage, slope.	Severe: seepage.	Limitation: deep to water.	Limitation: slope, droughty.	Limitation: slope.	Limitation: slope, droughty.
				8-46	Very channery loam	GC-GM, GM	0.06-0.20	0.07-0.09	0.5-1											
				46-60	Very channery loam	GC-GM, GM	2.00-6.00	0.07-0.09	0-0.5											
D71-*Utso* -Rock outcrop complex, 40 to 90% slope	On side slopes.	rapid	very severe	0-4	Channery loam, unweathered bedrock	GC, GC-GM, SC, SC-SM	0.60-2.00	0.10-0.13	2-3	Other perennial forbs, Mountain brome, Mountain snowberry, Nodding brome, Other perennial grasses, Other shrubs, Common chokecherry, Elk sedge, Kinnikinnick.	Very limited: slope.	Very limited: slope, frost action.	Poor: slope.	Poor: Hard to reclaim, slope, rock fragments.	Severe: slope.	Slight	Limitation: deep to water.	Limitation: slope, droughty.	Limitation: slope.	Limitation: slope, droughty.
				4-11	Very channery loam, unweathered bedrock	GC, GC-GM	0.60-2.00	0.07-0.09	1-2											
				11-60	Extremely channery loam, very channery loam, unweathered bedrock	GC, GC-GM	0.60-2.00	0.07-0.09	0.5-1											
Rifle Area																				
R3-Arvada loam, 1 to 6% slope	Deep, well drained, sloping soil on fans and high terraces.	medium	moderate	0-3	Loam	CL-ML	0.60-2.00	0.16-0.18	0.5-1	Western wheatgrass, Alkali sacaton, Inland saltgrass, Winterfat, Bottlebrush Squirreltail, Gardner saltbrush, Greasewood	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Poor: shrink-swell, low strength.	Poor: too clayey, excess sodium.	Favorable	Excess sodium	Percs slowly, excess sodium, slope.	Slope, percs slowly, excess sodium.	Percs slowly.	Percs slowly, excess sodium.
				3-17	Clay, Silty clay loam	CL, CH	0.06-0.20	0.07-0.09												
				17-60	Clay loam, Silty clay loam	CL	0.06-0.20	0.09-0.11												
R4-Arvada loam, 6 to 20% slope	Deep, well drained, sloping soil on fans and high terraces.	moderate/rapid	severe	0-3	Loam	CL-ML	0.60-2.00	0.16-0.18	0.5-1	Big sagebrush, Greasewood, Galleta, Shadscale, Bottlebrush Squirreltail, Western wheatgrass	Severe: slope, shrink-swell.	Severe: shrink-swell, low strength.	Poor: shrink-swell, low strength.	Poor: too clayey, excess sodium.	Slope	Excess sodium	Percs slowly, excess sodium, slope.	Slope, percs slowly, excess sodium.	Slope, percs slowly.	Slope, percs slowly, excess sodium.
				3-17	Clay, Silty clay loam	CL, CH	0.06-0.20	0.07-0.09												
				17-60	Clay loam, Silty clay loam	CL	0.06-0.20	0.09-0.11												
R9-Badland	Steep and very steep, nearly barren land dissected by many intermittent drainage channels.	rapid	severe	NA	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
R27-Halaquepts, nearly level	Broadly defined unit consists of deep, somewhat poorly drained to poorly drained, nearly level and gently sloping, salt-affected soils in narrow foothill valleys, on fans, and on low terraces.	Not Available	Not Available	0-8	Clay Loam	CH- CL	Not available.	Not available.	Not Available	Not Available	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.
				8-24	Loam	ML														
				24-60	Gravelly cobbly sand	GM, SM														
R36-Irigul channery loam, 9 to 50% slopes.	Shallow, well drained, rolling to steep, soil is on upland ridges and mountainsides.	medium	Slight	0-6	Channery loam	GM-GC, CL-ML	0.6-2.0	0.09-0.11	1-3	Wheatgrass, bluegrass, mountainmahogany, and serviceberry.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Poor: slope, thin layer, area reclaim.	Poor: slope, small stones, area reclaim.	Slope, depth to rock.	Thin layer.	Depth to rock.	Slope, rooting depth, droughty.	Depth to rock, slope.	Slope, rooting depth, droughty.
				6-17	Very channery sandy clay loam.	GM-GC	0.6-2.0	0.05-0.07												
				17	Unweathered bedrock	Not Available														
R37- Irigul channery loam, 50 to 75% slopes.	Shallow, well drained, steep soil is on north-facing ridges and mountainsides.	rapid	severe	0-6	Channery loam	GM-GC, CL-ML	0.6-2.0	0.09-0.11	1-3	Douglas-fir with elk sedge, wildrye, Oregon grape, snowberry, serviceberry, rose, and chokecherry.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Poor: slope, thin layer, area reclaim.	Poor: slope, small stones, area reclaim.	Slope, depth to rock.	Thin layer.	Depth to rock.	Slope, rooting depth, droughty.	Depth to rock, slope.	Slope, rooting depth, droughty.
				6-17	Very channery sandy clay loam.	GM-GC	0.6-2.0	0.05-0.07												
				17	Unweathered bedrock	Not Available														
R38- Irigul-Starman channery loams, 5 to 50% slopes.	Complex on ridge crests and mountainsides.	medium	Slight	0-6	Channery loam	GM-GC, CL-ML	0.6-2.0	0.09-0.11	1-3	Wheatgrass, bluegrass, mountainmahogany, and serviceberry.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Poor: slope, thin layer, area reclaim.	Poor: slope, small stones, area reclaim.	Slope, depth to rock.	Thin layer.	Depth to rock.	Slope, rooting depth, droughty.	Depth to rock, slope.	Slope, rooting depth, droughty.
				6-17	Very channery sandy clay loam.	GM-GC, GP-GC	0.6-2.0	0.05-0.07												
				17	Unweathered bedrock	Not Available														

APPENDIX C
Soils Table - North Piceance SWMP
Page 3 of 3

R46-Nihill channery loam, 1 to 6% slope	Deep, well drained, gently sloping soil is on alluvial fans and side of valleys derived from Green River shale and sandstone	slow	severe	0-11	Channery loam	GM, GM-GC, SM, ML	0.60-2.00	0.12-0.16	0-1	Western wheatgrass, Bluebunch wheatgrass, Big sagebrush, Needleandthread grass, Indian ricegrass, Low rabbitbrush	Slight	Slight	Good	Poor: small stones, area reclaim.	Seepage.	Seepage.	Slope.	Slope, droughty.	Favorable.	Droughty.
				11-60	Very channery loam, very channery sandy loam.	GM, GM-GC	2.00-6.00	0.06-0.09												
R47-Nihill channery loam, 6 to 25% slope	Deep, well drained, moderately sloping to hilly soil on alluvial fans and sides of valleys.	slow	severe	0-11	Channery loam	GM, GM-GC, SM, ML	0.60-2.00	0.12-0.16	0.5-1	Western wheatgrass, Bluebunch wheatgrass, Big sagebrush, Needle and thread grass, Indian ricegrass	Severe: slope.	Severe: slope.	Fair: slope.	Poor: slope, small stones, area reclaim.	Seepage, slope.	Seepage.	Slope.	Slope, droughty.	Slope.	Droughty, slope.
				11-60	Very channery loam, very channery sandy loam.	GM, GM-GC	2.00-6.00	0.06-0.09	0-0.5											
R48- Northwater loam, 15 to 65 percent slope	Deep, well drained, hilly to very steep soil is on mountainsides.	slow	Slight	0-25	Loam	CL-ML, SM-SC.	0.60-2.00	0.13-0.18	3-6	Aspen with mountain brome, elk sedge, slender wheatgrass, aspen peavine, aspen fleabane, snowberry, serviceberry, and chokecherry.	Severe: slope.	Severe: slope.	Poor: slope.	Poor: slope.	Slope, seepage.	Thin layer.	Slope.	Slope.	Slope.	Slope.
				25-50	Very channery clay loam, very channery loam.	GC,GM-GC	0.60-2.00	0.08-0.10												
				50	Unweathered bedrock															
R49- Olney loam, 1 to 3% slopes.	Deep, well drained, nearly level soil is on alluvial fans and sides of valleys.	slow	severe	0-12	Loam	CL-ML, ML	0.60-2.00	0.15-0.18	1-2	Western wheatgrass, Bluebunch wheatgrass, Big sagebrush, Needleandthread grass, Indian ricegrass, Rabbitbrush	Slight	Slight	Fair: low strength.	Fair: small stones.	Slope, seepage.	Favorable.	Slope.	Slope.	Slope.	Slope.
				12-33	Sandy clay loam	SC, SM-SC	0.60-2.00	0.14-0.16												
				33-43	Gravelly sandy clay loam, gravelly sandy loam	SC, SM-SC, GC, GM-GC	0.60-2.00	0.10-0.15												
				43-60	Very gravelly sandy loam, very gravelly sandy clay loam	GM, GM-GC, GC	0.60-2.00	0.07-0.10												
R50-Olney loam, 3 to 6% slope	Deep, well drained, gently sloping soil is on alluvial fans and side of valleys	slow	severe	0-12	Loam	CL-ML, ML	0.60-2.00	0.15-0.18	1-2	Western wheatgrass, Bluebunch wheatgrass, Big sagebrush, Needleandthread grass, Indian ricegrass, Rabbitbrush	Slight	Slight	Fair: low strength.	Fair: small stones.	Slope, seepage.	Favorable.	Slope.	Slope.	Slope.	Slope.
				12-33	Sandy clay loam	SC, SM-SC	0.60-2.00	0.14-0.16												
				33-43	Gravelly sandy clay loam, gravelly sandy loam	SC, SM-SC, GC, GM-GC	0.60-2.00	0.10-0.15												
				43-60	Very gravelly sandy loam, very gravelly sandy clay loam	GM, GM-GC, GC	0.60-2.00	0.07-0.10												
R52- Parachute loam, 25 to 65% slopes.	Moderately deep, well drained, hilly to very steep soil is on north- and east-facing mountainsides.	medium	Moderate	0-5	Loam	CL-ML	0.60-2.00	0.16-0.18	3-6	Gambel oak, serviceberry, Elk sedge, and snowberry	Severe: slope.	Severe: slope.	Poor: slope, thin layer, area reclaim.	Poor: slope, area reclaim.	Depth to rock, slope, seepage.	Thin layer.	Depth to rock, slope.	Slope, droughty, rooting depth.	Depth to rock, slope.	Slope, rooting depth, droughty.
				5-18	Loam	CL, CL-ML, SM-SC, SC	0.60-2.00	0.14-0.16												
				18-29	Very Channery loam, very channery sandy loam.	GM-GC, GM	2.00-6.00	0.03-0.06												
				29	Unweathered bedrock															
R53- Parachute-Rhone loams, 5 to 30% slopes.	Gently sloping to steep soils are on ridge crests and mountainsides.	medium	Moderate	0-5	Loam	CL-ML	0.6-2.0	0.16-0.18	3-6	Needlegrass,, elk sedge, and sagebrush.	Severe: slope.	Severe: slope.	Poor: slope, thin layer, area reclaim.	Poor: slope, area reclaim.	Depth to rock, slope, seepage.	Thin layer.	Depth to rock, slope.	Slope, droughty, rooting depth.	Depth to rock, slope.	Slope, rooting depth, droughty.
				5-18	Loam	CL, CL-ML, SM-SC, SC	0.60-2.00	0.14-0.16												
				18-29	Very Channery loam, very channery sandy loam.	GM-GC, GM	2.00-6.00	0.03-0.06												
				29	Unweathered bedrock															
R60- Rhone loam, 5 to 30% slopes.	Deep, well drained, gently sloping to steep soils on mountainsides and ridges.	slow	slight	0-8	Loam	CL, CL-ML	0.6-2.0	0.19-0.21	3-6	Brome, needlegrass, and sagebrush.	Severe: slope.	Severe: slope.	Fair: slope, thin layer, low strength.	Poor: slope.	Slope, depth to rock.	Thin layer.	Slope, depth to rock.	Slope, rooting depth.	Slope, depth to rock.	Slope, rooting depth.
				8-28	Sandy clay loam	CL, CL-ML, SM-SC, SC	0.6-2.0	0.15-0.17												
				28-52	Channery sandy clay loam, very channery sandy clay loam.	GM-GC	0.6-2.0	0.08-0.10												
				52	Unweathered bedrock															
R61- Rhone loam, 30 to 70% slopes.	Deep, welll drained, hilly to very steep soil is on north- and east-facing slopes.	very rapid/rapid	very severe	0-2	Channery loam, Unweathered bedrock	GC, GC-GM, SC, SC-SM	0.00-2.00	0.00-0.13	0-1	Saline wildrye, Shadscale saltbrush, Indian ricegrass, Bluebunch wheatgrass	Very limited: slope, depth to hard bedrock.	Very limited: depth to hard bedrock, slope.	Poor: depth to bedrock, slope.	Poor: slope, depth to bedrock, rock fragments, salinity.	Very limited: depth to bedrock, slope.	Very limited: thin layer.	Limitation: deep to water.	Limitation: slope, depth to rock, droughty.	Limitation: slope, depth to rock, large stones.	Limitation: slope, depth to rock, large stones, too arid.
				2-13	Channery loam, Very channery loam, Unweathered bedrock	CL, CL-ML, GC, GC-GM	0.00-6.00	0.00-0.07	0-0.5											
				13-17	Weathered bedrock, Unweathered bedrock	N/A	0.00-2.00	0.00-0.00	0											
				17-60	Unweathered bedrock	N/A	0.00-0.00	0.00-0.00	0											
R62- Rock outcrop-Torriorthents complex, very steep.	Broadly defined unit consists of exposed bedrock, very stony areas, soils that are shallow to moderatly deep over bedrock and small pockets of deep soils.	rapid	moderate	N/A	Not Available	Not Available	Not Available	Not Available	Not Available	Serviceberry,bitterbrush, mountainmahogany, big sagebrush, and western wheatgrass.	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
R63- Silas loam, 3 to 12% slopes.	Deep, moderatly well drained soils on bottom land of mountain valleys.	slow	slight	0-60	Loam	ML	0.6-2.0	0.14-0.16	3-5	Wildrye, wheatgrass, needlegrass.	Severe: floods.	Severe: floods.	Fair: low strength.	Good.	Slope, seepage.	Piping	Slope, floods.	Slope, floods.	Favorable.	Favorable.
R65-Torrifluvents, 0 to 6% slope	Broadly defined unit consisting of deep, well drained to somewhat poorly drained, nearly level soils on flood plains adjacent to the Colorado River and its major tributaries.	Not available.	low	Not available	The surface layer ranges from loamy sand and fine sandy loam to silty loam and clay loam. The underlying layers are generally sandy loam or loam stratified with sand, gravel, and cobbles.	Not available.	Not available.	Not available.	Not available.	Cottonwood, Willow, Tamarisk, Water-tolerant grasses, sedges, and rushes.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.
R66-Torriorthents-Camborthids-Rock outcrop complex, 15 to 70% slope	Exposed sandstone and shale bedrock, loose stones, and shallow to deep stony loams and clay found on toe slopes and concave open areas on foothills and mountainsides.	very rapid	very severe	0-4	Variable, Unweathered bedrock	CL-ML, ML, SC-SM, SM	0.00-6.00	0.00-0.18	0.5-1	Not available.	Not rated	Not rated	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.	Not available.
				4-30	Clay loam, Fine sandy loam, Loam, Unweathered bedrock	CL, CL-ML, SC-SM, SM	0.00-2.00	0.00-0.18	0-0.5											
				30-34	Unweathered bedrock	N/A	0.00-0.20	0.00-0.00	0											
R71-Villa Grove-Zoltay loams, 15 to 30% slope	Moderately steep to hilly soils on mountainsides and alluvial fans.	slow/medium	slight/moderate	0-4	Loam	CL	0.20-2.00	0.16-0.19	2-4	Gambel oak, Utah serviceberry, Western wheatgrass, Elk sedge, Mountain brome, Mountain snowberry	Severe: slope, shrink-swell.	Severe: slope, low strength, shrink-swell.	Poor: low strength, shrink-swell.	Poor: slope, small stones.	Slope, seepage.	Favorable.	Slope, excess salt, percs slowly.	Slope, excess salt, percs slowly.	Favorable, slope, percs slowly.	Excess salt, slope, percs slowly.
				4-17	Clay loam, Sandy clay loam, Gravelly clay, Cobbly clay, Cobbly clay loam	CL, SC, GC	0.60-6.00	0.10-0.19												
				17-60	Sandy loam, Loam, Gravelly clay, Cobbly clay, Cobbly clay loam	SM-SC, CL-ML, CL, GC, SC	0.06-2.00	0.13-0.16												

Appendix D

Master SWMP Permit Area Map



North Parachute Ranch Unit
SWMP Boundary
Encana Oil & Gas (USA), Inc.

Legend

SWMP Name

North Parachute Ranch Unit

0 2.5 5 Miles

N
W E
S

Created by: Leslie Booth
Date: 06/07/2012

Appendix E

Stormwater Manual of Best Management Practices (BMPs)

Prepared for:
Encana Oil & Gas (USA) Inc.
Parachute, CO 81635

Stormwater Manual of Best Management Practices (BMPs)

DRAFT

December 2010

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Stormwater Manual of Best Management Practices (BMPs)

DRAFT

December 2010

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Best Management Practices (BMPs)

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Contents (continued)

1.0 Introduction

The primary purpose of this Stormwater Manual of Best Management Practices (BMP Manual) is to provide Encana Oil & Gas (USA) Inc. (Encana) personnel, contractors, and subcontractors with information on the proper selection, design, installation, and maintenance of BMPs to manage oil and gas (O&G) related stormwater and to meet federal and state Stormwater Management Plan (SWMP) implementation requirements. This BMP Manual also satisfies the Colorado Oil and Gas Conservation Commission's (COGCC) requirements for a Post-Construction Stormwater Program.

The BMPs found in this manual are operating practices that may be used to control erosion, drainage, and sedimentation associated with stormwater runoff from areas disturbed by clearing, grading, and excavating activities related to site preparation and construction of oil and gas production facilities. Although the BMPs in this manual were derived from both common industry practices and from practical field experience, they may not be applicable for certain sites and field conditions.

Personnel responsible for stormwater management, whether it is design, construction, maintenance, or environmental compliance, should have a thorough knowledge of the applicable erosion and sediment control measures and the related specifications.

The main objectives of this manual are to:

1. Serve as an easy-to-use guide for selecting, designing, constructing, and maintaining BMPs.
2. Function as a reference for construction plans and specifications.
3. Ultimately lead to the avoidance of any net increase in off-site erosion and sedimentation of waters of the U.S.

In the preparation of this document, emphasis was placed on the selection and practical application of BMPs, given a variety of basic physical circumstances. The series of figures within this document are provided as a tool to quickly evaluate which BMPs may be useful at a given construction site, whether new or existing. This document anticipates that the user will be prudent and exercise good judgment in evaluating site conditions and deciding which BMP or combination of BMPs is to be used at a specific site. If the BMPs selected are not effective to prevent discharges of potentially undesirable quantities of sediment to a regulated water body, different or additional BMPs should be employed.

2.0 Planning

Planning for the inclusion of appropriate BMPs should occur early in the site development process, and can be divided into five separate steps:

1. Site Assessment – Collect the information from the site regarding topography, soils, drainage, vegetation, and other predominant features. Also make note of any existing erosion that is present. Analyze the information to anticipate erosion and sedimentation problems.

2. Avoidance and Minimization – Avoiding or minimizing disturbances on construction sites are the best protection measures against erosion and sedimentation problems. Inclusion of these measures will also decrease the amount of BMPs required during construction.

3. Construction Scheduling and Phasing – Develop a construction schedule and phasing plan that minimizes the amount of area exposed thus minimizing erosion and impacts to the area from development.

4. SWMP and/or Post-Construction SWMP (PCSWMP) – Develop and implement a SWMP and/or PCSWMP that specifies effective BMPs, taking into consideration the information generated from the site assessment and the construction schedule and phasing.

5. Inspections and Maintenance – Inspection and maintenance of BMPs are required by the SWMP and PCSWMP. Evaluate the BMPs that will be implemented and allocate the necessary resources to provide for timely and thorough inspections and maintenance.

3.0 Types of Best Management Practices

BMPs within this manual are classified as one of the following:

Erosion Control – Any source control practice that protects the soil surface and/or strengthens the subsurface in order to prevent soil particles from being detached by rain or wind, thus controlling raindrop, sheet, and/or rill erosion. Erosion controls are always used when adjacent to any waterway. The erosion controls discussed within this BMP Manual include the following:

- Erosion Control Blanket (ECB)
- Gravel Surfacing (GS)
- Landforming (LF)
- Land Grading (LG)
- Low Water Crossing (LWC)
- Mulching (M)
- Retaining Wall (RW)
- Revegetation (RV)
- Riprap (R)
- Soil Stabilizers (SS)
- Subsoil Segregation (SubS)
- Surface Roughening (SR)
- Terracing (T)
- Topsoil Conservation and Segregation (TopS)
- Turf Reinforcement Mat (TRM)
- Vegetated Buffer (VB)

Drainage Control – Any practice that reduces or eliminates gully, channel, and stream erosion by minimizing, diverting, or conveying runoff through engineered systems. The drainage controls discussed within this BMP Manual include the following:

- Berm (B)
- Culvert (C)
- Diversion (D)
- Drainage Dip (DD)
- Pipeline Water Crossing (PWC)
- Roadside Ditches (RSD)
- Slope Drain (SD)
- Swale (S)
- Trench Breaker (TB)
- Water Bar (WB)
- Wing Ditch (WD)

Sediment Control – Any practice that traps the soil particles after they have been detached and moved by wind or water. Sediment control measures are usually passive systems that rely on filtering or settling the particles out of the water or wind that is transporting them prior to leaving the site boundary. The sediment controls discussed within this BMP Manual include the following:

- Check Dam (CD)
- Detention Pond (DP)
- Filter Berm (FB)
- Rumble Strip (RS)
- Sediment Trap (ST)

- Silt Fence (SF)
- Slash (SL)
- Straw Bale Barrier (SBB)
- Wattles (W)

Non-Stormwater Control – Any general site and materials management measure that indirectly aids in minimization of erosion and pollution of water. Types of pollution sources include, but are not limited to, litter, oil and grease, hazardous material spills, and sediment. The non-stormwater controls discussed within this BMP Manual include the following:

- Dewatering (DW)
- Dust Control (DC)
- Material Delivery and Storage (MDS)
- Scheduling (S)
- Spill Prevention and Control (SPC)
- Vehicle and Equipment Maintenance (VEM)
- Waste Management (WM)

BMPs are also be classified as either structural or non-structural controls:

Structural Control – Handles sediment-laden stormwater prior to it leaving each site. Structural BMPs are used to delay, capture, store, treat, or infiltrate stormwater runoff. Some examples of structural BMPs include sediment traps, diversions, and silt fences. Most Drainage Controls and Sediment Controls can also be classified as Structural Controls.

- Berm (B)
- Check Dam (CD)
- Culvert (C)
- Detention Pond (DP)
- Diversion (D)
- Drainage Dip (DD)
- Filter Berm (FB)
- Retaining Wall (RW)
- Riprap (R)
- Roadside Ditches (RSD)
- Rumble Strip (RS)
- Sediment Trap (ST)
- Silt Fence (SF)
- Slope Drain (SD)
- Straw Bale Barrier (SBB)
- Swale (S)
- Terracing (T)
- Trench Breaker (TB)
- Water Bar (WB)
- Wattles (W)
- Wing Ditch (WD)

Non-structural Control – Reduces the generation and accumulation of pollutants, including sediment, by stabilizing disturbed areas and preventing the occurrence of erosion. Some examples of non-structural BMPs include revegetation, mulching, and surface roughening. These types of stabilization techniques are not only the most effective method for reducing soil loss, but they are also normally the most cost effective due to low initial cost and reduced maintenance requirements. Most, but not all, Erosion Controls can also be classified as Non-structural Controls. The non-structural controls discussed within this BMP Manual include the following:

- Dust Control (DC)
- Erosion Control Blanket (ECB)
- Gravel Surfacing (GS)
- Landforming (LF)
- Land Grading (LG)
- Low Water Crossing (LWC)
- Mulching (M)
- Revegetation (RV)
- Riprap (R)
- Slash (SL)
- Soil Stabilizers (SS)
- Surface Roughening (SR)
- Turf Reinforcement Mat (TRM)
- Vegetated Buffer (VB)

4.0 Principles and practices of erosion control

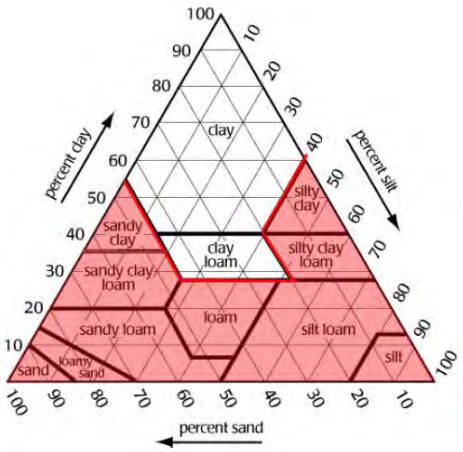
Types of erosion

Splash	Energy from the raindrop dislodges soil particles and initiates the erosion process.
Sheet	Uniform removal of saturated soil particles.
Rill	Long, narrow incisions in the soil caused by increased runoff velocities.
Gully	Deep, wide incisions caused by concentrated flow.
Streambank	Bank sloughing, toe cutting in a natural drainage pattern.

Factors affecting erosion

Soil type

The primary soil property that affects erosiveness is the cohesiveness of the soil. While there are other factors, this is the most dominant factor when considering temporary erosion controls. The generalized soil triangle shows the break between soils that can be considered cohesive or noncohesive soils. This rule of thumb has to be applied with good professional judgment.



Vegetation

Vegetation is the primary permanent erosion control for un-stabilized exposed surfaces. Anytime the existing vegetation is removed, there is immediate potential for wind and water erosion. Therefore, any un-vegetated surface should be treated with an appropriate BMP to prevent surface erosion. The appropriate BMP depends on the other factors affecting erosion.

Climate

The key climatic factors affecting erosion are rainfall intensity, duration, and return frequency, which in turn determine soil particle detachment and transport in runoff. Other climatic properties, such as temperature and growing season, have more to do with reestablishing permanent erosion controls.

Topography

The slope and length of slope have a direct influence on the transport of dislodged sediment and soil particles down slope. Even very erosive soils on flat slopes will not produce large amounts of sediment because there is not sufficient potential gravitational force to accelerate the surface runoff to velocities that will suspend and transport sediments. As slopes become steeper, the velocity of flow of surface runoff increases with a subsequent increase in sediment loads. That is why velocity management is a critical part of any erosion control practice.

5.0 Erosion control concepts

Surface protection

Protecting the soil surface will help minimize the amount of soil that is detached and transported as sediment.

Minimization of concentrated flows

Concentrated flows generate more energy and velocity than sheet flows. Greater depths and velocity generate more erosion and suspension of eroded materials. If concentrated flows develop, BMPs, such as check dams, can be used to reduce the velocity. Where concentrated flows are directed to uniform surfaces, level spreaders can be used to reestablish sheet flows.

Velocity reduction

Velocity reduction is a key component of BMP strategies. Control measures such as rock check dams, wattles, etc., are placed perpendicular to the direction of flow, whether sheet flow or concentrated flow, to slow the velocity of the water. The BMP type must be selected based on the anticipated depth, velocity, and frequency of flows over the surface or in the channel.

Sediment capture

Effective sediment control measures are designed and implemented to slow the runoff velocity and retain the sediment-laden water to allow soil particles to fall from suspension and settle out of the runoff. This will facilitate transport reduction and thereby the quantities of sediment that leave the site.

Runoff management

Runoff management tools are designed to utilize proper grading, diversions, barriers, or interceptor ditches to minimize concentrated flows and divert runoff away from denuded slopes or other critical areas. This can be done by minimizing slope steepness and length through the use of terraces, interceptor berms or ditches or diversion ditches. The concept is to divert clean runoff before it becomes sediment laden.

6.0 Selection and implementation of controls

Implementation of BMPs will be successful if used appropriately, taking into account a number of factors. The following are guidelines recommended in determining the appropriate BMPs for the site:

1. *Determine the limits of clearing and grubbing.* If the entire site will not undergo excavation and grading, the boundaries of cut-and-fill operations should be defined. Buffer strips of natural vegetation may be utilized as a control measure.

2. *Define the layout of buildings and roads.* This will have been decided previously as part of the general development plan. If building layout is not final, the road areas stabilized with pavement and the drainage features related to roads should be defined as they relate to the plan.

3. *Determine permanent drainage features.* The location of permanent channels, storm sewers, roadside swales, and stormwater quality controls such as ponds, wetlands, grassed-lined swales, buffer strips, and areas of porous pavement, if known, should be defined.

4. *Determine extent of temporary channel diversions.* If permanent channel improvements are a part of the plan, the route, sizing, and lining needed for temporary channel diversions should be determined. Location and type of temporary channel crossings can be assessed.

5. *Determine the boundaries of watersheds.* The size of drainage basins will determine the types of sediment controls to be used. Areas located off site that contribute overland flow runoff must be assessed. Measures to limit the size of upland overland flow areas, such as run-on diversions, may be initially considered at this stage.

6. *Select erosion controls.* All areas exposed will require a control measure be defined dependent on the duration of exposure. These can be selected based on the schedule of construction.

7. *Select sediment controls*. Areas greater than 5 acres will require the installation of sediment basins. Consideration can be given to dividing large drainage basins into sub-areas, each served by a sediment basin.

8. *Determine staging areas*. The schedule of construction will determine what areas must be disturbed at various stages throughout the development plan. The opportunity for staging cut-and-fill operations to minimize the period of exposure of soils can be assessed. The sequence for installing sediment controls and erosion controls can also be determined at this time.

9. Identify locations of topsoil and other stockpiles.

10. Identify location of construction roads, access points, and material storage areas.

Once BMPs have been selected, each control should be incorporated into a site-specific plan drawing as a requirement of the SWMP or PCSWMP. Each of the following BMPs includes design criteria (to properly locate and size each control) and construction specifications (to properly install the control with the appropriate materials and methods), if applicable.

7.0 Inspection and maintenance

All BMPs must be properly inspected and maintained throughout the life of the entire operation according to the “Maintenance Considerations” section in each of the following BMPs. In general, the maintenance program should provide for inspection of BMPs on a regular basis in accordance with the SWMP or PCSWMP. Inspection of BMPs should also occur as soon as possible after major rainfall events, particularly at sensitive areas in proximity to a perennial drainage. The inspection should include repair or replacement of the BMPs, where needed, to ensure effective and efficient operation.

8.0 References

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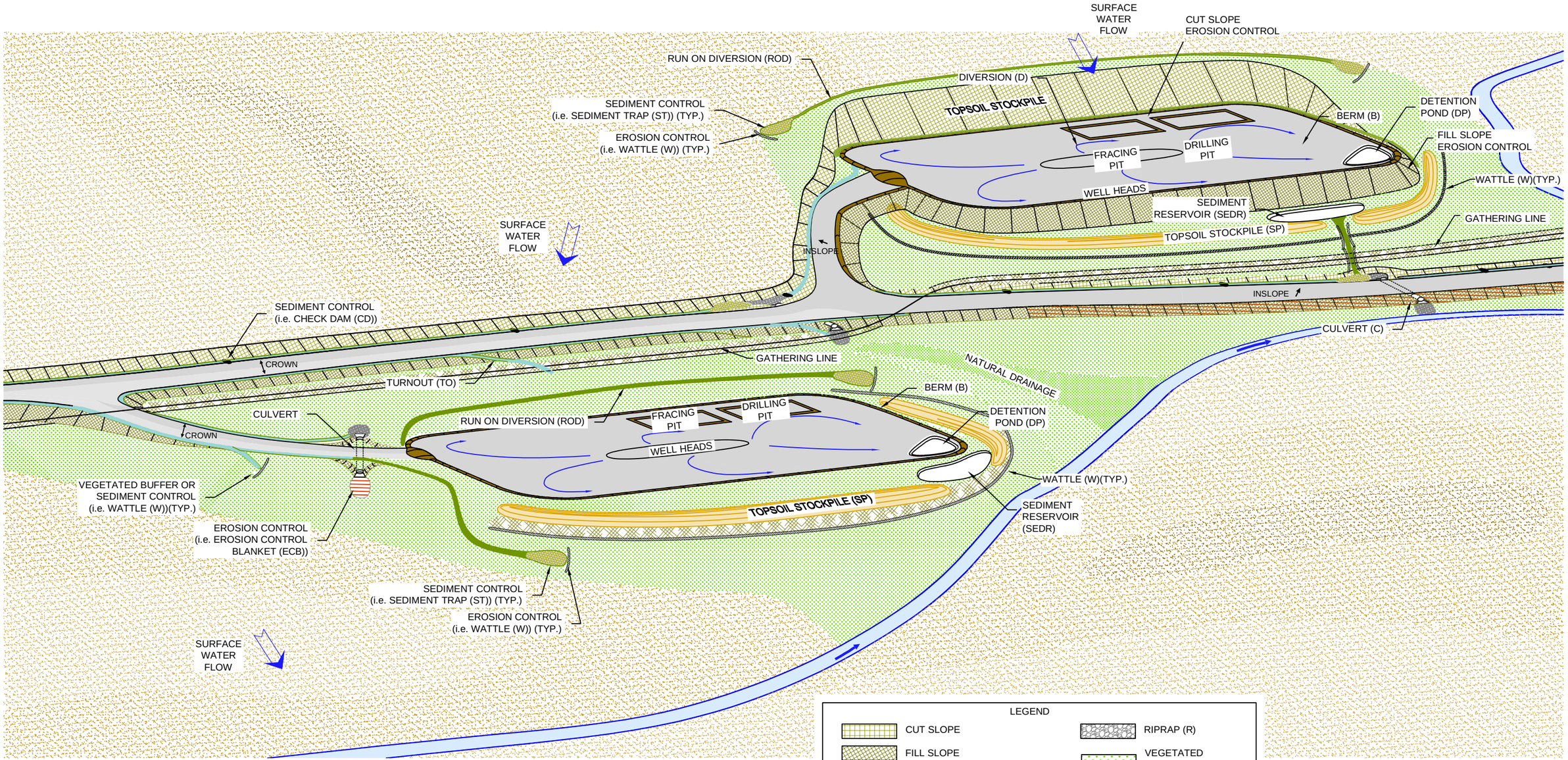

LEGEND

- CUT SLOPE
- FILL SLOPE
- ROADSIDE DITCH (RSD)
- DIVERSION (D) OR (ROD)
- BERM (B)
- TOPSOIL STOCKPILE (TS)
- EROSION CONTROL BLANKET (ECB)
- WATTLE (W)
- RIPRAP (R)
- VEGETATED BUFFER (VB)
- CHECK DAM (CD)
- SEDIMENT TRAP (ST)
- GROUND SURFACE CONTOUR (BEFORE CONSTRUCTION)
- FLOW

SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
SILT FENCE (SF)	RETAINING WALL (RW)
WATTLE (W)	REVEGETATION (RV)
	RIPRAP (R)
	SURFACE ROUGHENING (SR)
	TERRACING (T)
	WATTLE (W)

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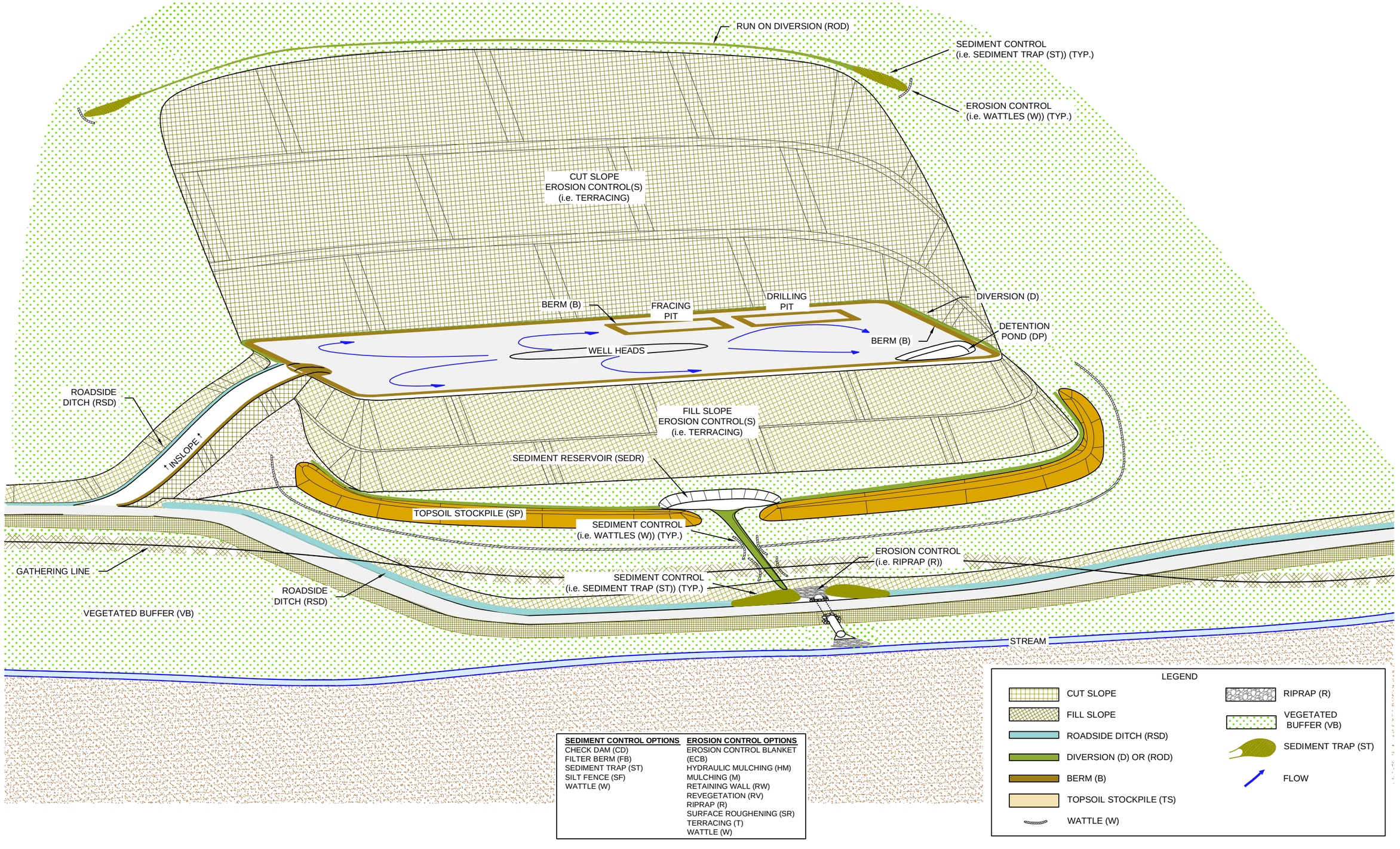
SITE ISOMETRIC
FLAT AND GENTLY SLOPING TERRAIN

DATE: 05/30/08 | DRWN: E.S.S./GOL | **FIGURE SI-1**



SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
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SITE ISOMETRIC
STEEP TERRAIN

DATE: 06/06/08 | DRWN: E.S.S./GOL | **FIGURE SI-2**

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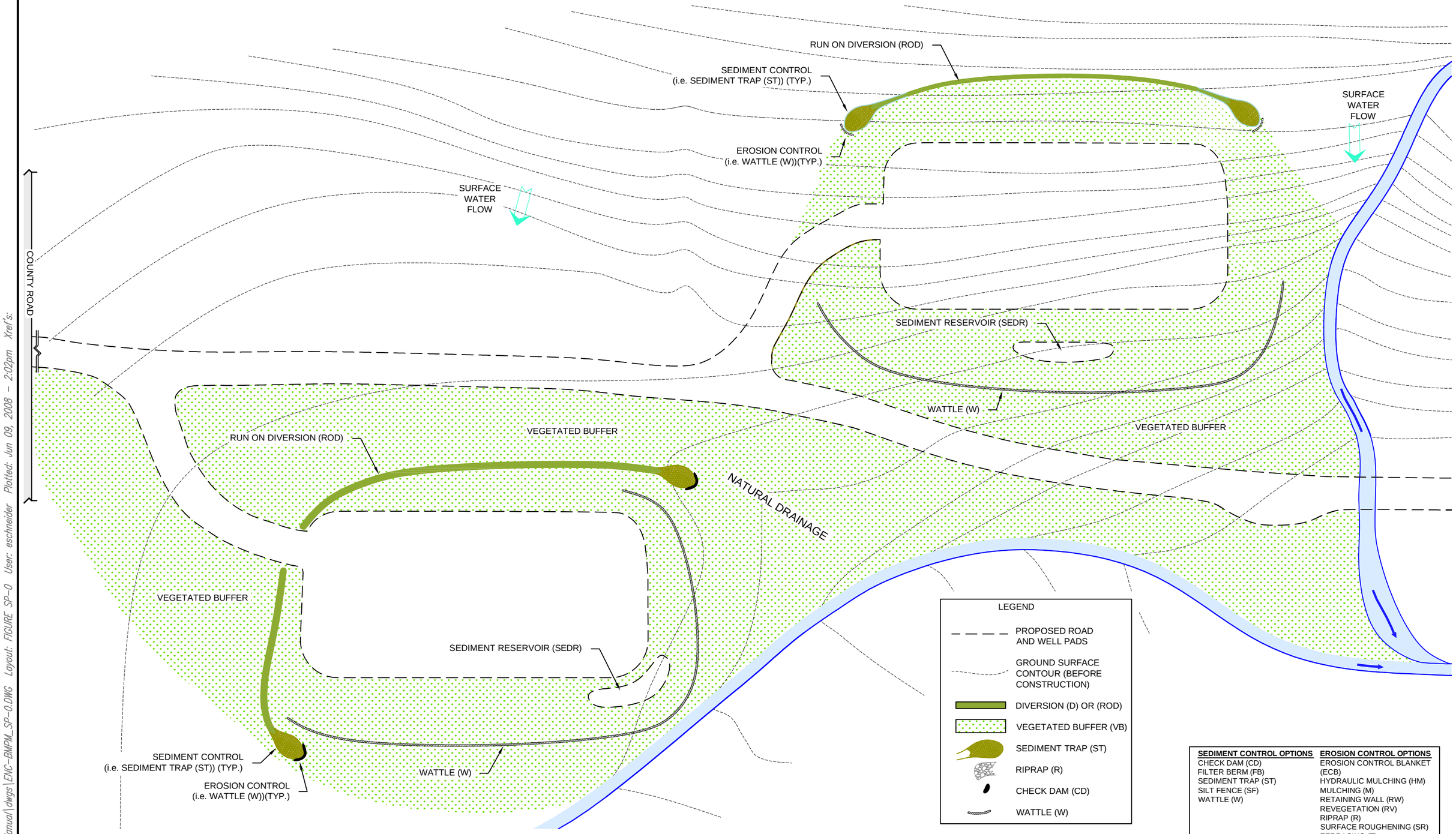

SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
SILT FENCE (SF)	RETAINING WALL (RW)
WATTLE (W)	REVEGETATION (RV)
	RIPRAP (R)
	SURFACE ROUGHENING (SR)
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SITE PLAN
PRECONSTRUCTION

FIGURE SP-0

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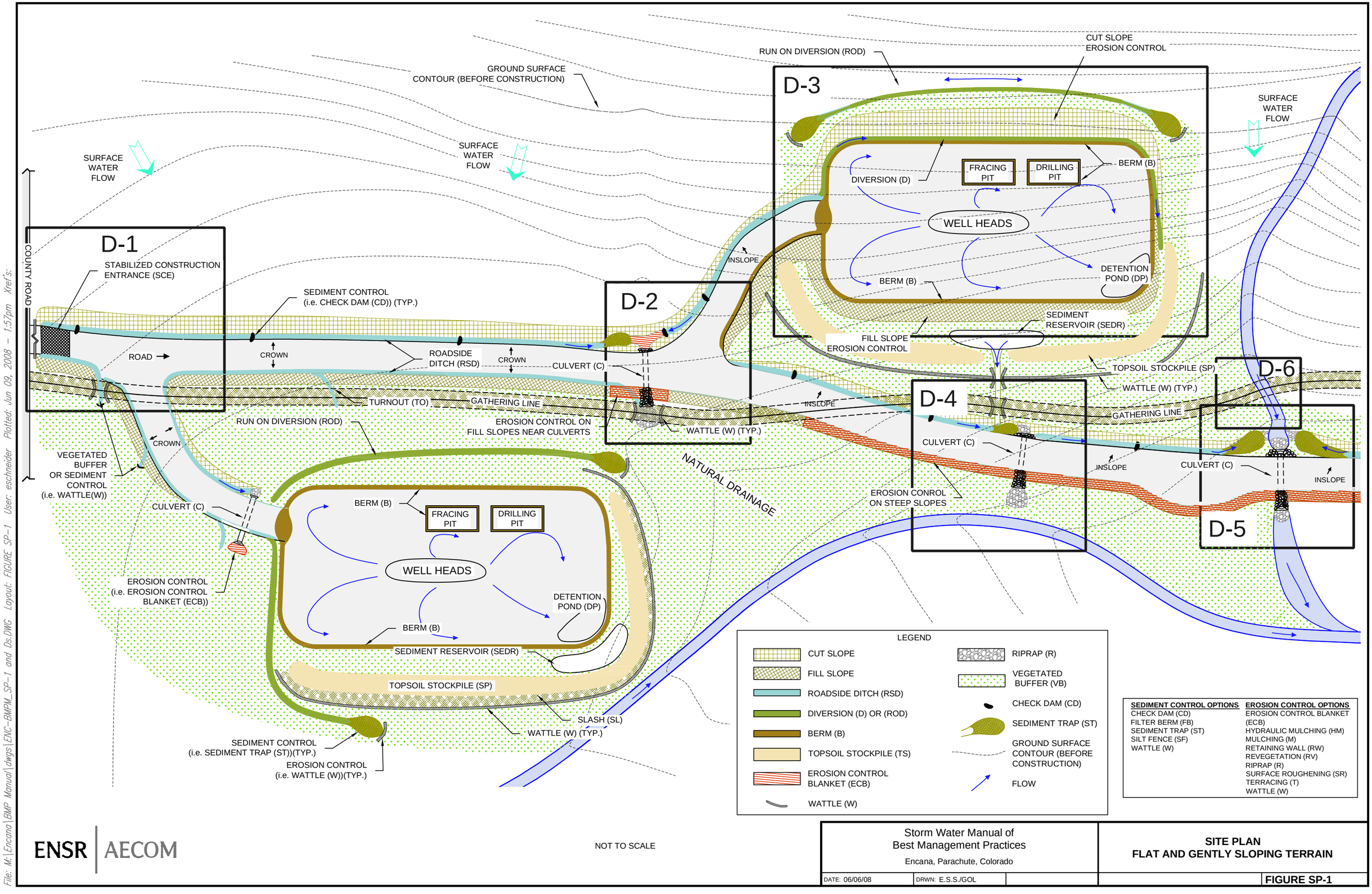

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SITE PLAN
FLAT AND GENTLY SLOPING TERRAIN

FIGURE SP-1

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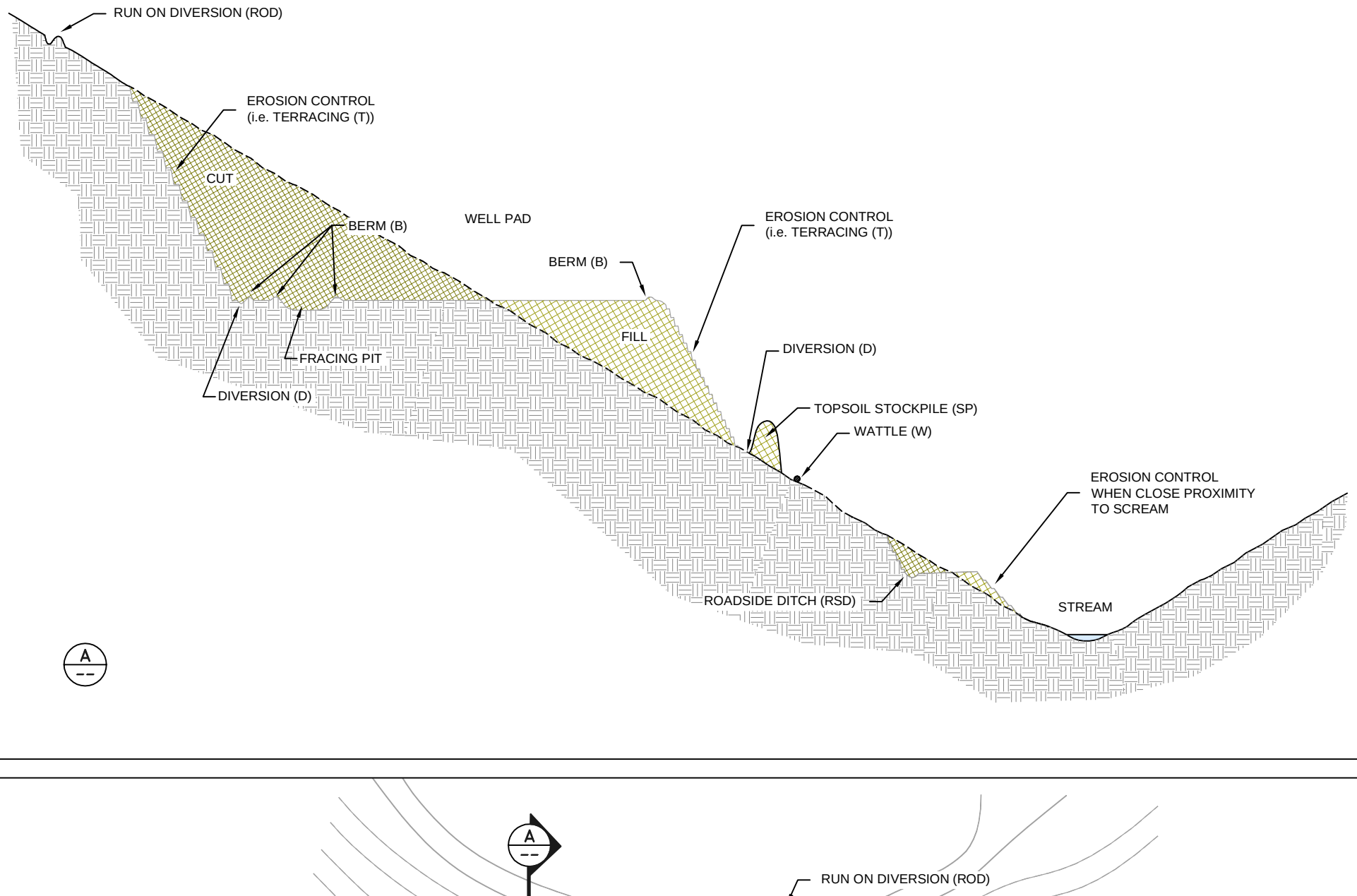

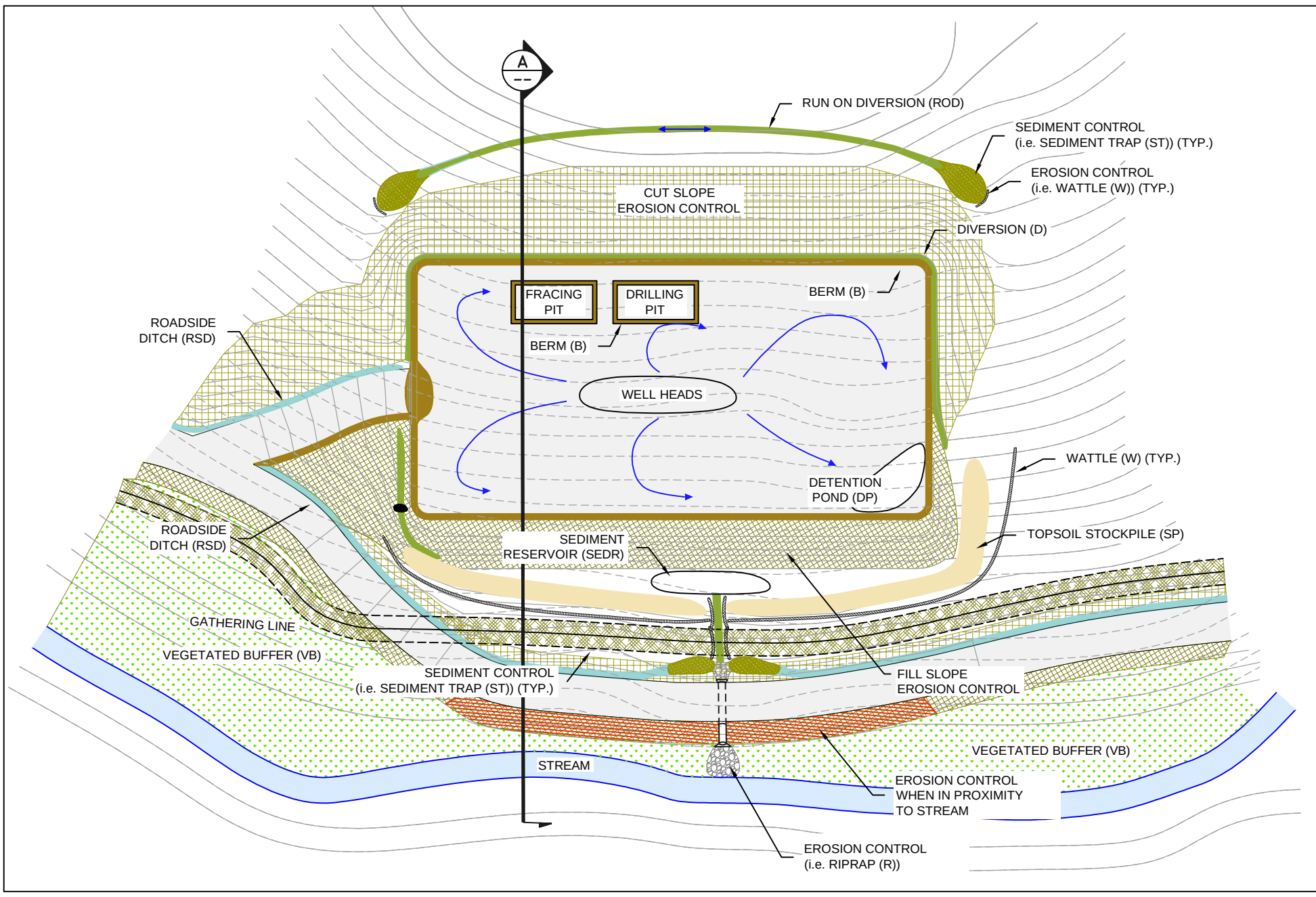

LEGEND

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- ROADSIDE DITCH (RSD)
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SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
SILT FENCE (SF)	RETAINING WALL (RW)
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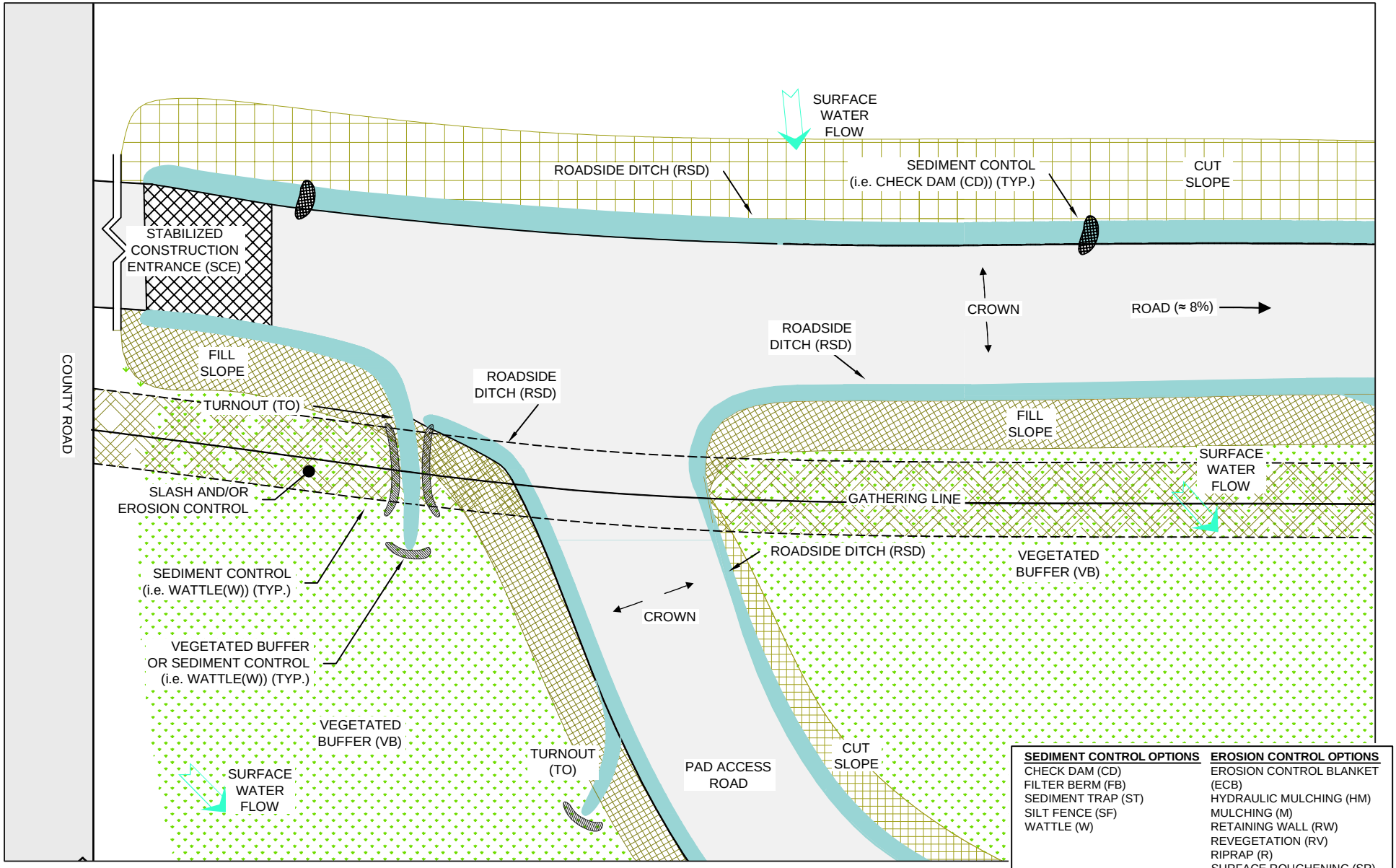
SITE PLAN
STEEP TERRAIN

DATE: 06/06/08 | DRWN: E.S.S./GOL | **FIGURE SP-2**



SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
SILT FENCE (SF)	RETAINING WALL (RW)
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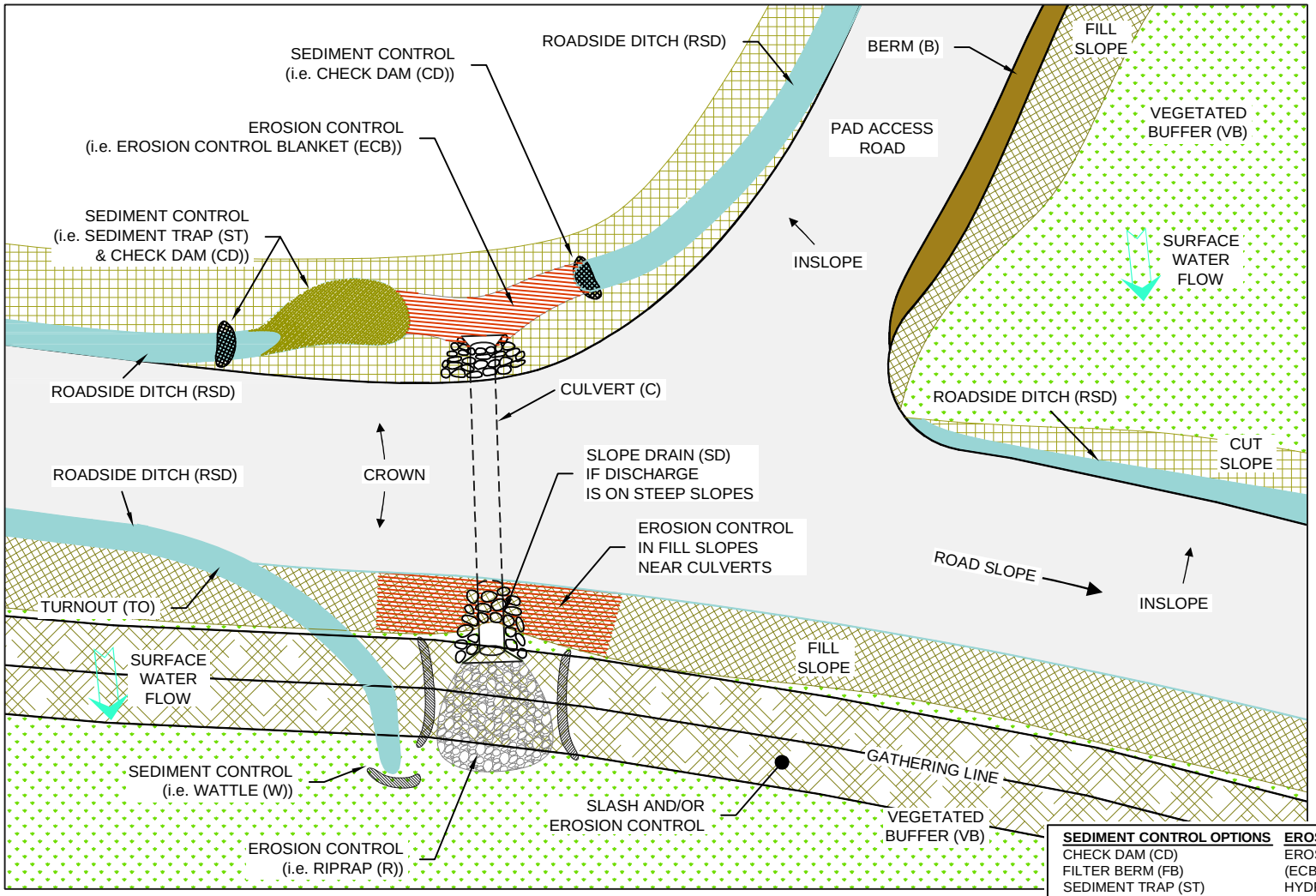
ACCESS ROAD INTERSECTION
WELL PAD BELOW ROAD

FIGURE D-1



SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
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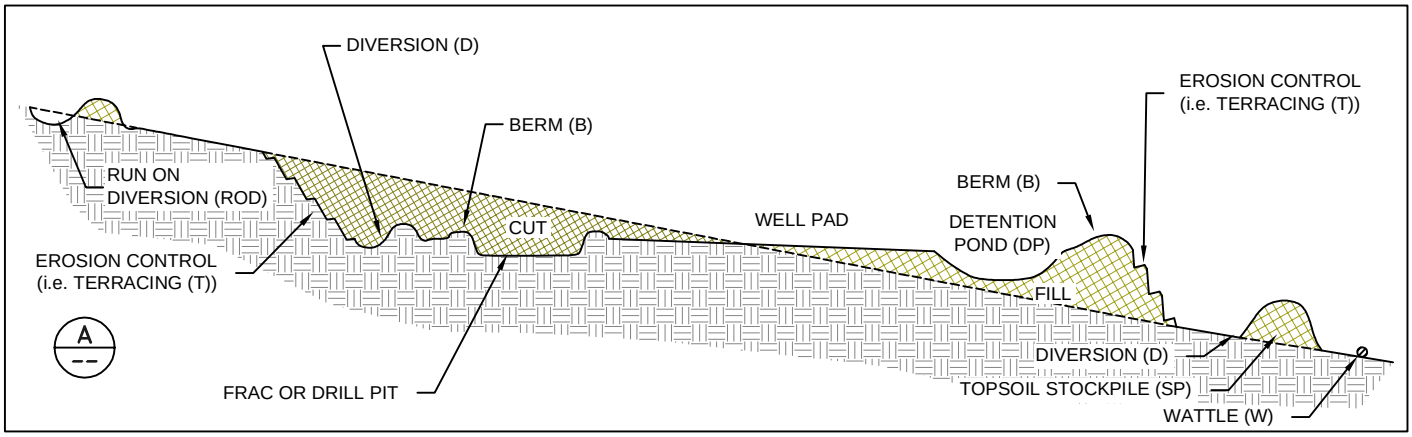
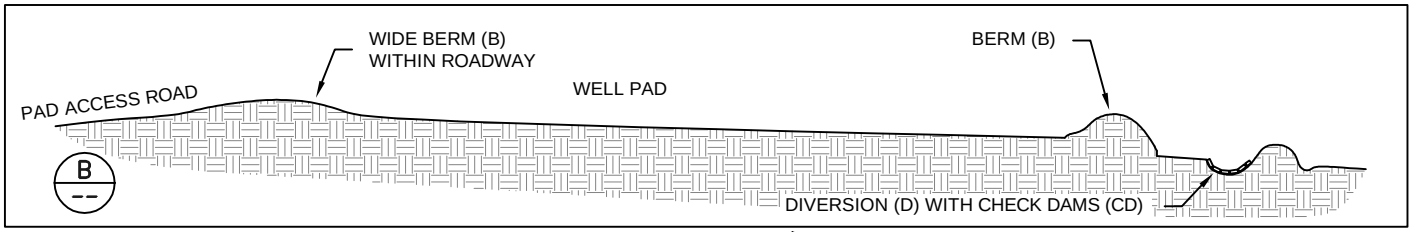
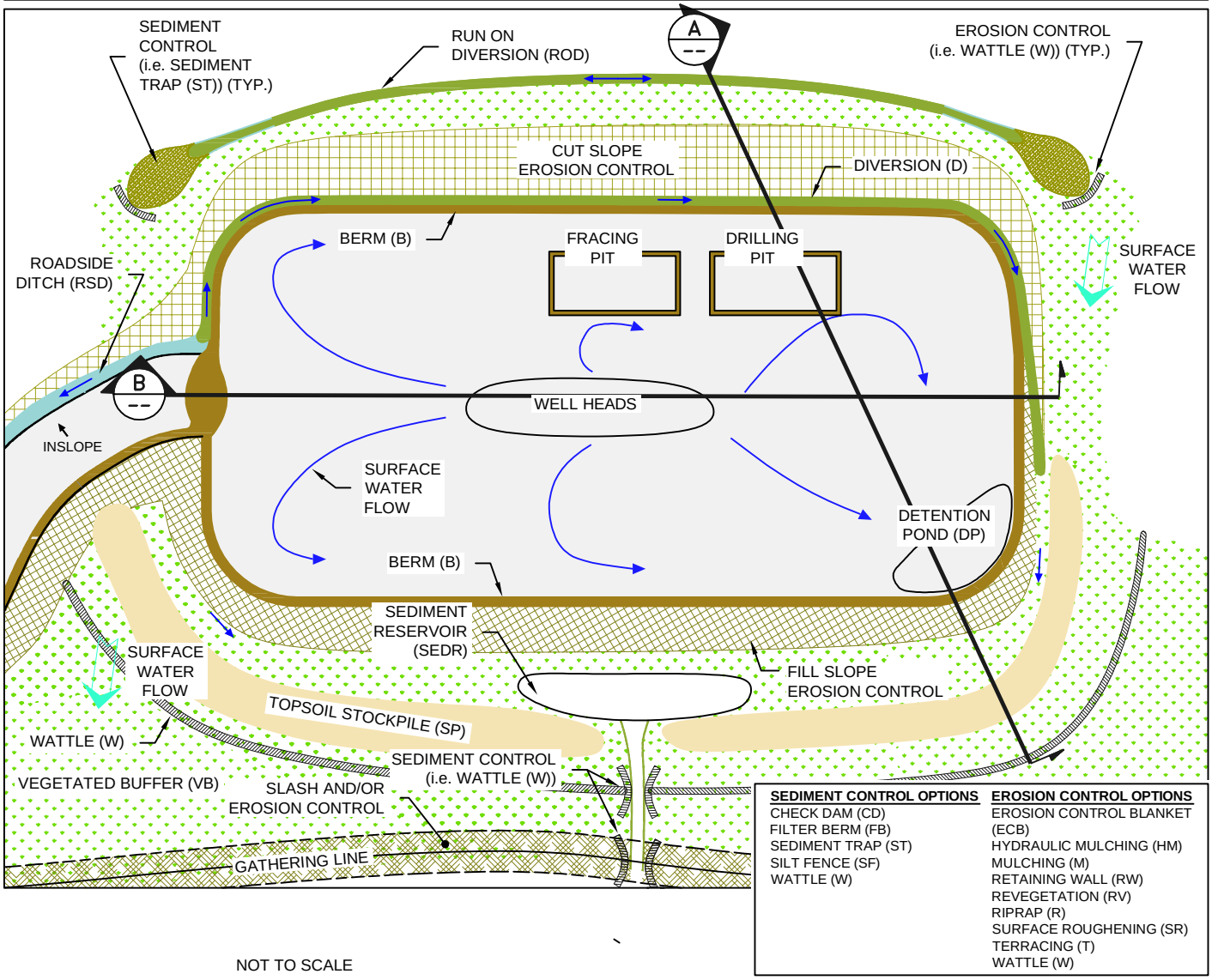
ACCESS ROAD INTERSECTION
WELL PAD ABOVE ROAD

DATE: 06/06/08 | DRWN: E.S.S./GOL

FIGURE D-2







SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
SILT FENCE (SF)	RETAINING WALL (RW)
WATTLE (W)	REVEGETATION (RV)
	RIPRAP (R)
	SURFACE ROUGHENING (SR)
	TERRACING (T)
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WELL PAD

DATE: 06/06/08 | DRWN: E.S.S./GOL | **FIGURE D-3**

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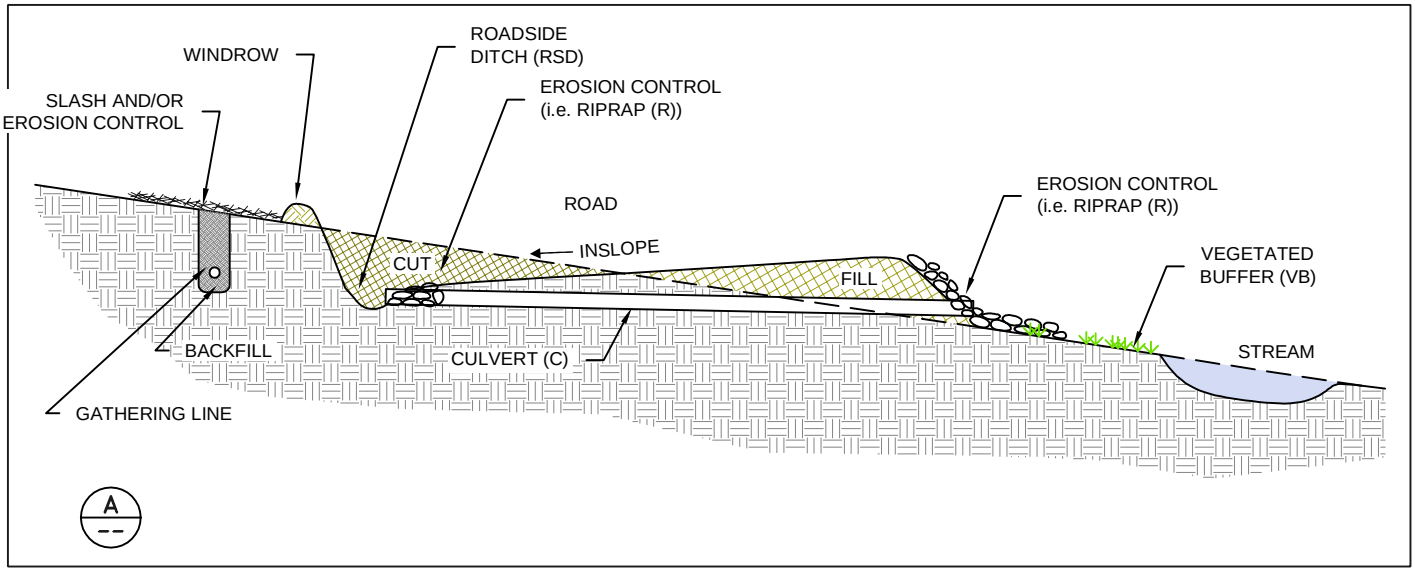

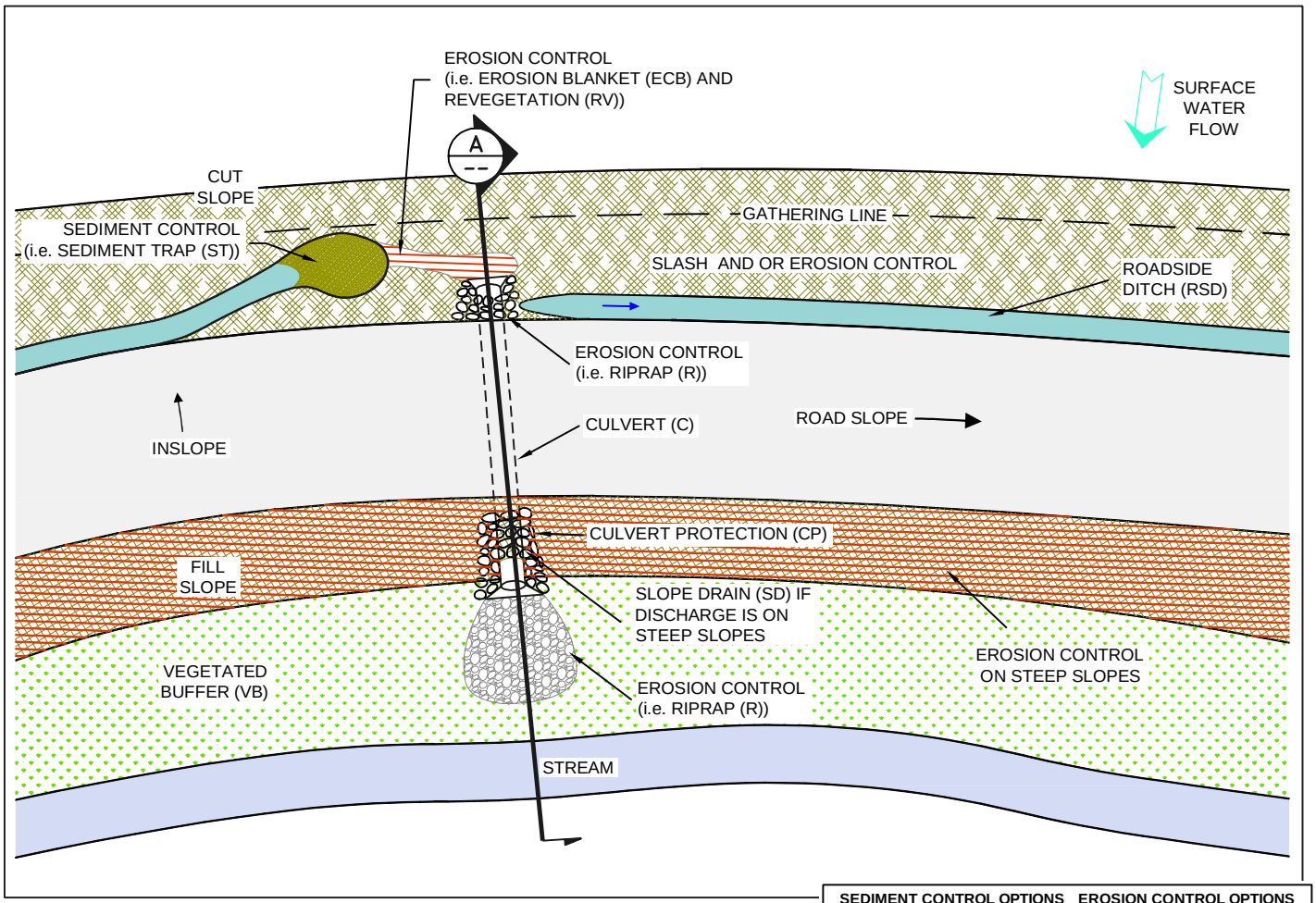

SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
SILT FENCE (SF)	RETAINING WALL (RW)
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ROAD PARALLEL TO GATHERING LINE AND STREAM

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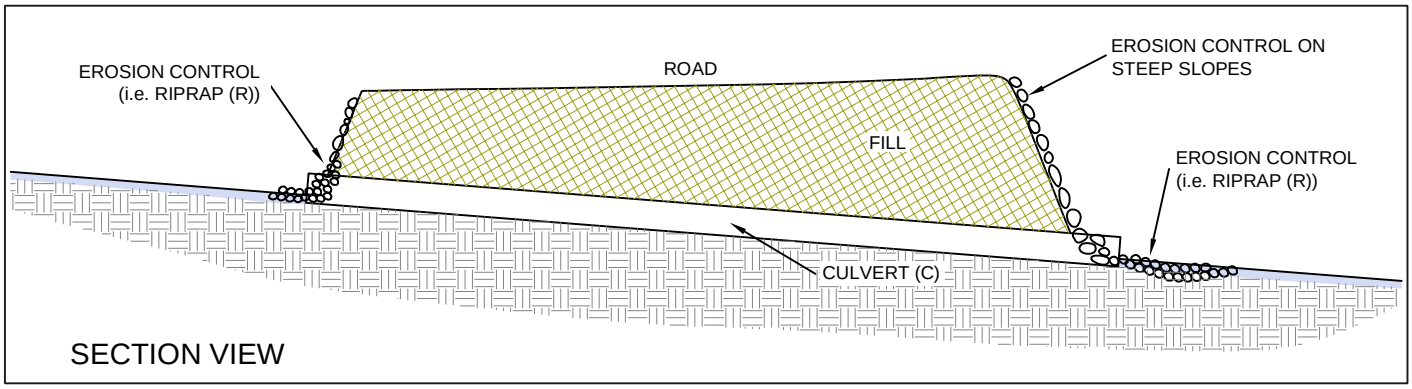
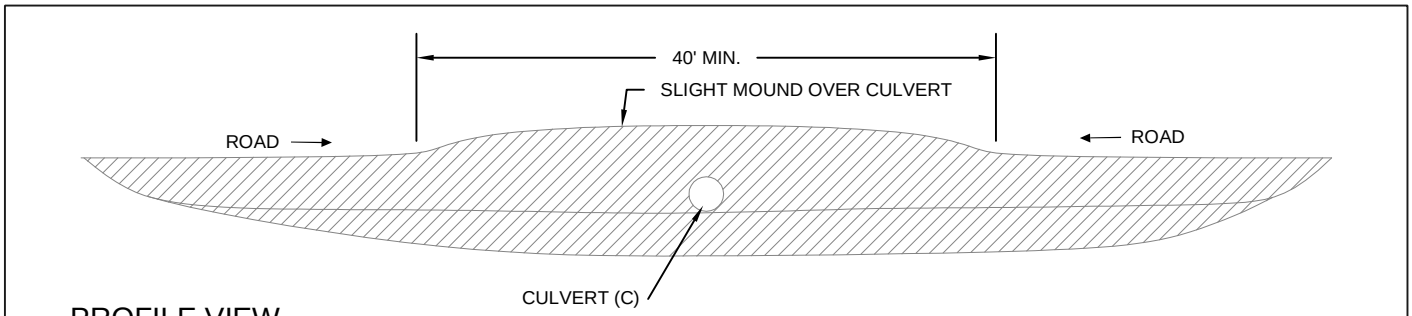
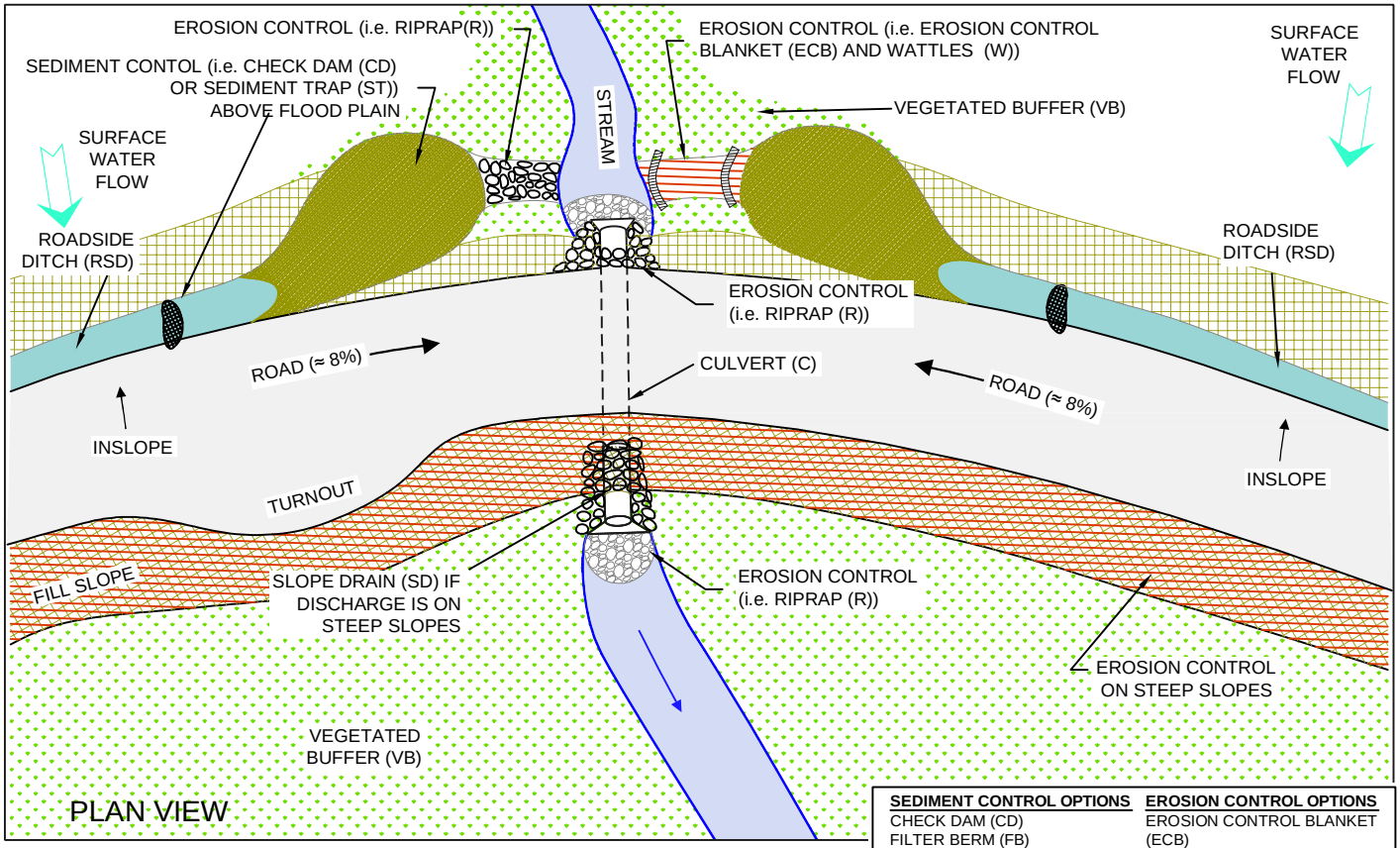


SECTION VIEW



PROFILE VIEW



PLAN VIEW

SEDIMENT CONTROL OPTIONS	EROSION CONTROL OPTIONS
CHECK DAM (CD)	EROSION CONTROL BLANKET (ECB)
FILTER BERM (FB)	HYDRAULIC MULCHING (HM)
SEDIMENT TRAP (ST)	MULCHING (M)
SILT FENCE (SF)	RETAINING WALL (RW)
WATTLE (W)	REVEGETATION (RV)
	RIPRAP (R)
	SURFACE ROUGHENING (SR)
	TERRACING (T)
	WATTLE (W)

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404 STREAM CROSSING

DATE: 06/06/08 | DRWN: E.S.S./GOL | **FIGURE D-5**

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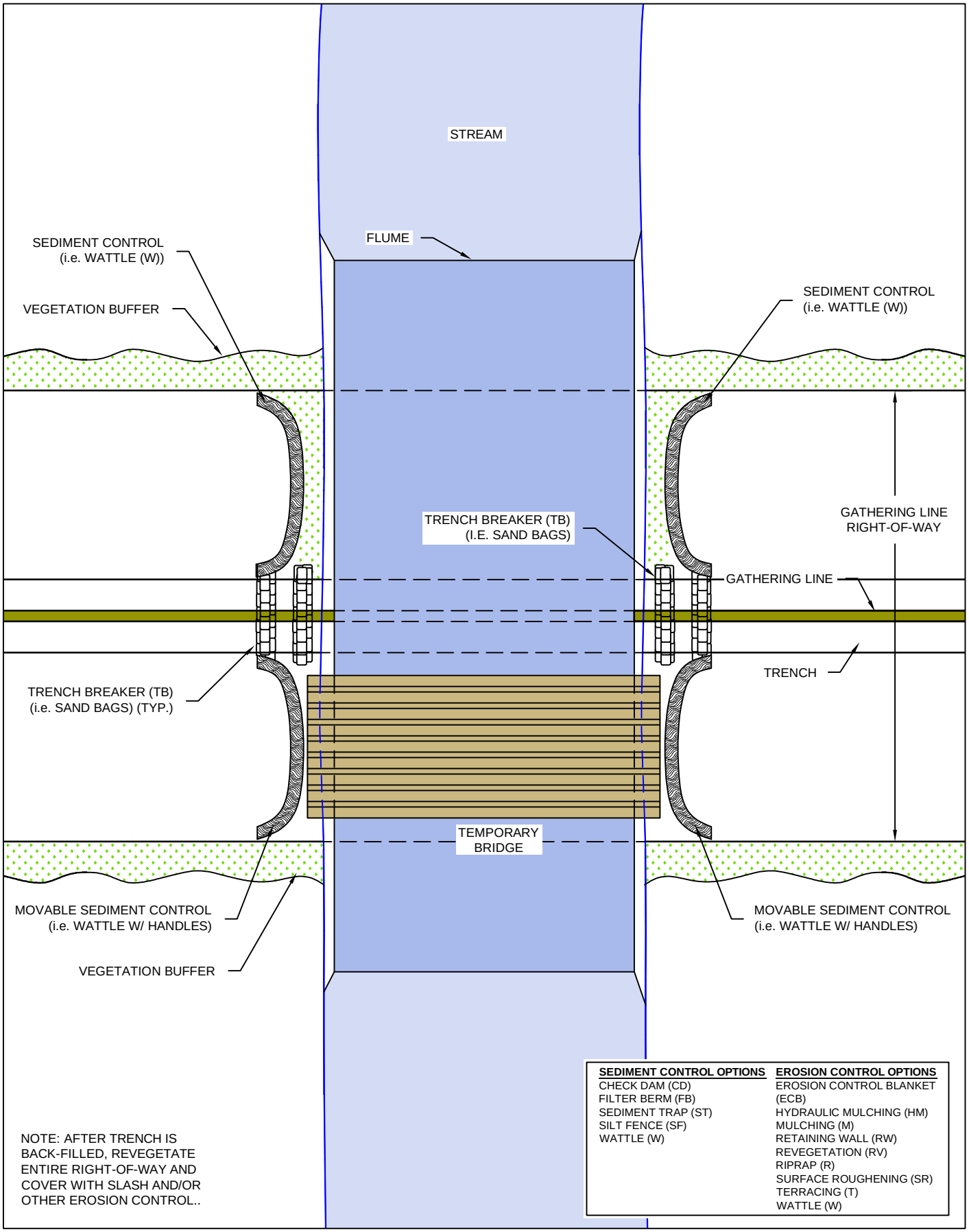

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DATE: 06/06/08 | DRWN: E.S.S./GOL

GATHERING LINE CROSSING STREAM (DURING CONSTRUCTION CONDITION)

FIGURE D-6

File: M:\Encana\BMP Manual\dwgs\ENC-BMPM_SP-1 and Ds.DWG Layout: FIGURE D-6 User: eschneider Plotted: Jun 09, 2008 - 2:01pm Xref's:

Erosion Control BMPs

Erosion Control Blanket (ECB)
Gravel Surfacing (GS)
Landforming (LF)
Land Grading (LG)
Low Water Crossing (LWC)
Mulching (M)
Retaining Wall (RW)
Revegetation (RV)
Riprap (R)
Soil Stabilizers (SS)
Subsoil Segregation (SubS)
Surface Roughening (SR)
Terracing (T)
Topsoil Conservation and Segregation (TopS)
Turf Reinforcement Mat (TRM)
Vegetated Buffer (VB)

Erosion Control Blanket (ECB)

Specification Section 02370

Description

Erosion control blankets are porous fabrics and are manufactured by weaving or bonding fibers made from organic or synthetic materials. Erosion control blankets are installed on steep slopes, over berms, or in channels to prevent erosion until final vegetation is established. However, blankets can also be used as separators or to aid in plant growth by holding seeds, fertilizers, and topsoil in place.

Applicability

Erosion control blankets may be used in the following applications:

- To control erosion on steep slopes and to promote the establishment of vegetation.
- To stabilize channels against erosion from concentrated flows.
- To protect berms and diversions prior to the establishment of vegetation.
- To protect exposed soils immediately and temporarily, such as when active piles of soil are left overnight.
- As a separator between riprap and soil to prevent soil from being eroded from beneath the riprap and to maintain the riprap's base.
- May be used on slopes as steep as 1:1.

Limitations

- Blankets used on slopes should be 100% biodegradable, or photodegradable, non-toxic to vegetation or germination of seed, and non-toxic or injurious to humans.
- Should not be used on slopes where vegetation is already established.
- Some blankets might promote increased runoff and might blow away if not firmly anchored.
- If the fabric is not properly selected, designed, or installed, the effectiveness may be reduced drastically. Manufacturer's specifications should be followed.

Design criteria

There are many types of erosion control blankets available. Therefore, the selected fabric should match its purpose. Effective netting and matting require firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil, and erosion will occur underneath the material. Fabric should be purchased at an appropriate width to cover the whole width of the channel, if possible. Table ECB-1 indicates some recommended criteria for the selection of erosion control blankets.

Construction specifications

1. Smooth soil prior to installation and apply seed prior to fabric installation for stabilization of construction sites.
2. Select the appropriate fabric type. North American Green products are listed in Table ECB-1. However, other products may also be used. Site specifics shall dictate blanket selection and use.
3. Select the appropriate seed mix according to the specification in Revegetation (RV).
4. Installation of the blankets shall be in accordance with the manufacturer's recommendations or according to Figure ECB-1. For blankets being placed in channels, the fabric should be rolled out parallel to the channel if the width is sufficient to cover the entire width of the channel. The fabric needs to be in continuous contact with exposed soil.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspections should determine if cracks, tears, or breaches have formed in the fabric. If the effectiveness of the BMP has been reduced, the fabric should be repaired or replaced immediately. Re-anchor loosened matting and replace missing matting and staples as required. It is necessary to maintain contact between the ground and the blanket at all times.

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Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

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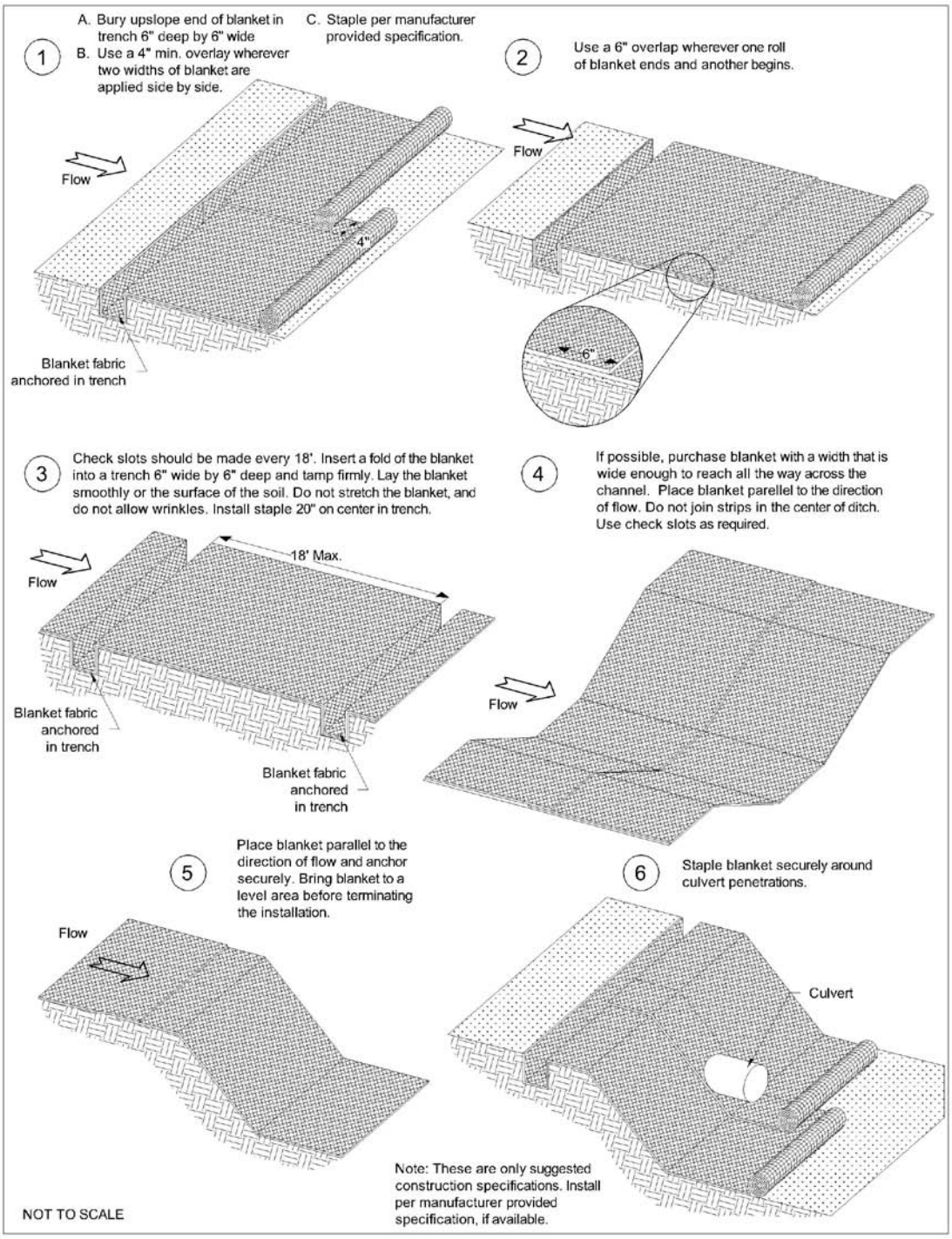
North American Green, 2004. <http://www.nagreen.com>

Table ECB-1

Suggested Blanket Types

Description (North American Green Product #)	**Longevity**	**Applications**	**Max. Flow Velocity (feet/sec.)**
Single Net Straw Blanket (S75)	12 months	4:1 - 3:1 Slopes Low Flow Channels	5
Rapid Degrading Net (DS75)	45 - 60 Days		
Double Net Straw Blanket (S150)	12 months	3:1 - 2:1 Slopes Moderate Flow Channels	6
Rapid Degrading Nets (DS150)	45 - 60 Days		
Double Net Blanket 70% Straw/30% Coconut (SC150)	24 months	2:1 - 1:1 Slopes Medium Flow Channels	8
Double Net Blanket 100% Coconut (C125)	36 months	1:1 & Greater Slopes High Flow Channels	10
Double Net Blanket Polypropylene Fiber (P300)		1:1 Slopes Extended Flow Areas High Flow Channels	9 (unveg.) 16 (veg.)
Organic Net (S75BN)	12 months	4:1 - 3:1 Slopes Low Flow Channels	5
Organic Net (S150BN)	12 months	3:1 - 2:1 Slopes Moderate Flow Channels	6
Organic Net (SC150BN)	18 months	2:1 - 1:1 Slopes Medium Flow Channels	8
Organic Net (C125BN)	24 months	1:1 & Greater Slopes High Flow Channels	10

Figure ECB-1
Erosion Control Blanket Installation



Gravel Surfacing (GS)

Specification Section 02730

Description

Gravel is used to stabilize the surface of roads, well pads, or other facilities by reducing erosion, limiting dust from passing vehicles, and reducing the amount of mud that may develop during wet weather. This is the primary method of creating a stabilized unpaved surface. A stabilized unpaved surface includes the surface of dirt roads and those areas used during operation of wells or other facilities that are prepared in such a way as to prevent ongoing erosion issues (i.e. with gravel surfacing). Areas developed as stabilized unpaved surfaces as needed for operation of the facility will qualify, according to the SWMP, as "finally stabilized."

Applicability

Gravel may be used for any road, well pad, or other facility, particularly "soft" sections, steep grades, highly erosive soils, or locations where all-weather access is needed. Gravel may be used as "fill" material in ruts or as a full structural section over the entire road or well pad.

Limitations

- Rutting and wash-boarding may develop if the surface gravel is too thin, has poor gradation, has little or no binding characteristic, or has a low percentage of fractured stone.
- Flat-blading to maintain the roadway must be done properly to avoid changes in gravel thickness, road slope, and road grade.

Design criteria

No formal design is required.

Construction specifications

1. Maintain a road cross-slope with in-sloping, out-sloping, or a crown to rapidly move water off the road surface. Also maintain a slight slope on well pads or around other facilities.
2. Gradation of gravel shall be in accordance with applicable specifications (BLM, forest service, private landowner, etc…) or may be as shown in Figure GS-1. This figure shows the typical gradation ranges of aggregates used in construction, how the materials, ranging from coarse to fine, best perform, and the approximate limitations to the desirable gradation ranges. Ideally, aggregate surfacing material is (1) hard, durable, and crushed or screened to a minus 2 inch size; (2) well graded to achieve maximum density; and (3) contains clayey binder to prevent raveling.

3. Gravel may be placed with a minimum thickness of four inches; however any amount of gravel is often useful. Geotextile or geogrid sub-grade reinforcement is sometimes used over soft soils to separate the gravel from the soil, keep it uncontaminated, and extend the useful life of the gravel.
4. The same gravel used to surface roadways may also be used to surface roadside ditches and create small check dams within those roadside ditches.
5. Gravel may be compacted during construction and maintenance to achieve a dense, smooth surface and thus reduce the amount of water that can soak into the ground.
6. "Spot" stabilize local wet areas and soft areas with coarse rocky material as needed.
7. Stabilize the surface in sensitive areas near streams and at drainage crossings if necessary to minimize surface erosion.
8. Control excessive dust.
9. Blend coarse aggregate and fine clay-rich soil (when available) to produce a desirable composite surface material that is coarse yet well-graded with fines for binder.

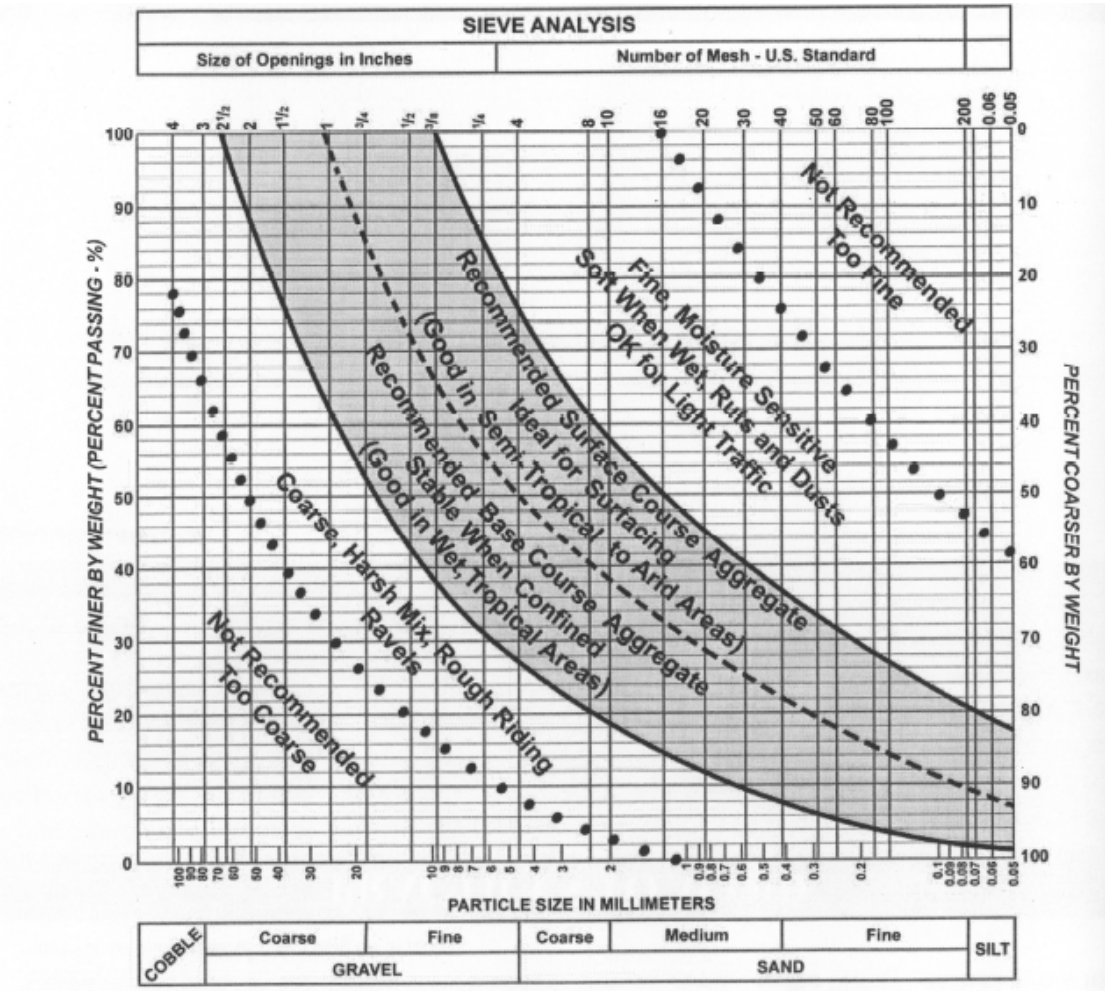
Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. The gravel applied to the surface must be maintainable in order to prevent and control rutting and erosion. The surface should be periodically smoothed and reshaped with a grader blade (flat-blading). This should be done when the gravel is moist. Maintain the proper slope and grade while flat-blading. Also be sure to avoid plugging roadside ditches or altering adjacent drainage structures, as this may cause them to not function properly. Flat-blading may also cause road gravel to be pushed off the main roadway and onto the shoulders. To avoid this, blade toward the center of the road.

References

Keller, Gordon, and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

Figure GS-1
Gradation and Performance of Surfacing Materials



NOTE: Gradation Ranges Shown Are Approximate.

Landforming (LF)

Description

The concept of landforming (landform grading) is construction of landforms based on natural patterns. Landform grading mimics stable natural slopes. Landformed slopes offer a diversity of concave and convex, shaded and sunny, exposed and sheltered habitats. The resulting slopes are carefully engineered but look natural. Landform grading entails modifying surface topography and drainage so that slopes are stable against erosion and mass wasting. Landform grading has been shown to decrease erosion and respects geomorphologic processes of natural slopes.

Applicability

Landforming applies to all graded areas of a site, including the design and construction of diversions, swales, and berms.

Limitations

- Adequate space may not be available for proper landforming, especially in steeply sloping areas.
- Landforming may increase the amount of disturbed area.

Design criteria

As discussed within the Land Grading BMP, a grading plan should be prepared that establishes the extent to which grading will occur, how drainage patterns will be directed, and how runoff velocities will affect receiving waters. The grading plan also includes information regarding when earthwork will start and stop, establishes the degree and length of finished slopes, and dictates where and how excess material will be disposed of (or where borrow materials will be obtained if needed). Practices must be developed for erosion control, slope stabilization, and safe disposal of runoff water and drainage, such as ditches and culverts, grade stabilization

structures, retaining walls, and surface drains. Berms, roadside ditches, and other stormwater practices that require excavation and filling also should be incorporated into the grading plan.

Construction specifications

1. Land grading should occur in accordance with the Land Grading BMP or in accordance with other applicable BMPs (i.e. Berm (B), Diversion (D), Swale (S), etc…).
2. Instead of using angular shapes and planer faces with unvarying slope gradients, use compound shapes and variable slope gradients characteristic of natural landforms, as shown in Figure LF-1 and Figure LF-2.
3. Where room permits and where compatible with regional topography, create slopes with a concave form with steeper gradients near the top and with gradually decreasing, flatter inclinations near the bottom.
4. Preserve and/or restore natural drainage features where possible.
5. If possible, drainage should follow natural drop lines on a slope in a manner that minimizes gradients.
6. Where runoff discharge is greater than acceptable and the soils more erosive, swale sections can be reinforced with geofabrics such as erosion control blankets or turf reinforcement mats.
7. Construct berms and swales in a curvilinear fashion across the slope face.
8. Sensitive site resources should be protected when landforming is used and erosion and sediment control practices should be used until disturbed areas are stabilized.
9. Select and plant vegetation in such a way that it is compatible with hillside hydrogeology. Grasses and groundcovers should be planted in drier, convex-shaped slopes or interfluves, while trees and shrubs should be planted in wetter, concave-shaped valleys, swales, and depressions.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect landforms for rills or other indications of erosion. Maintain all slopes, vegetation, and associated erosion and sediment controls.

References

Schor, Horst J., and Donald H. Gray, Landforming: An Environmental Approach to Hillside Development, Mine Reclamation and Watershed Restoration. John Wiley & Sons, Inc., 2007.

Figure LF-1
Landforming Concept

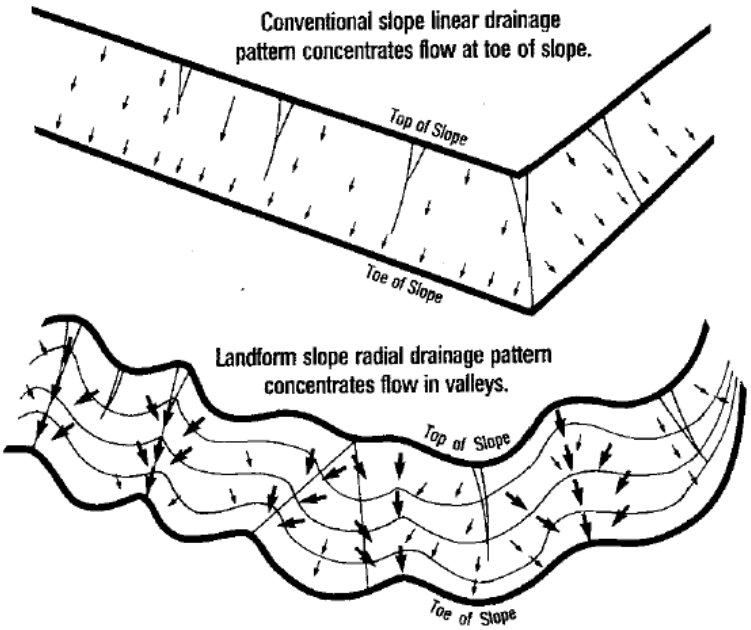
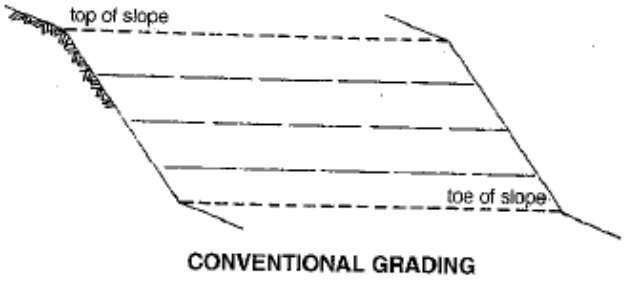
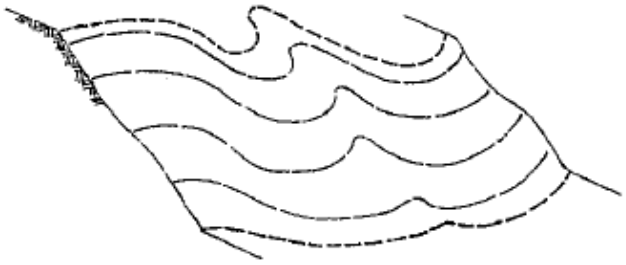


Figure LF-2
Slope Definitions



CONVENTIONAL GRADING

CONTOUR GRADING



LANDFORM GRADING

Land Grading (LG)

Specification Section 02310

Description

Land grading involves reshaping the ground surface to planned grades as determined by an engineering survey, evaluation, and layout. Land grading provides more suitable topography for well pads and pipelines and helps to control surface runoff, soil erosion, and sedimentation during and after construction in these areas. This BMP shall include the following:

- Proper road cut and fill techniques to ensure road remains stable over time.
- Road crowning or sloping to properly route runoff off the roadway.

Applicability

- Land grading is applicable to sites with uneven or steep topography or easily erodible soils, because it stabilizes slopes and decreases runoff velocity.
- This BMP is applicable to the construction and maintenance of any road, but particularly those located on steep topography or easily erodible soils.
- This BMP is applicable to the construction and maintenance of well pads and pipelines, including stockpiles, borrow areas, and spoil.

Limitations

- Improper cut and fill slopes that disrupt natural stormwater patterns might lead to poor drainage, high runoff velocities, and increased peak flows during storm events.
- Clearing and grading of the entire site without vegetated buffers or other controls promotes off-site transport of sediments and other pollutants.
- Grading must be designed with erosion and sediment control and storm water management goals in mind.

Design criteria

Grading plan

A grading plan should be prepared that establishes the extent to which the road will be graded, how drainage patterns will be directed, and how runoff velocities will affect receiving waters. The grading plan also includes information regarding when earthwork will start and stop, establishes the degree and length of finished slopes, and dictates where and how excess material will be disposed of (or where borrow materials will be obtained if

needed). Practices must be developed for erosion control, slope stabilization, and safe disposal of runoff water and drainage, such as ditches and culverts, grade stabilization structures, retaining walls, and surface drains. Berms, roadside ditches, and other stormwater practices that require excavation and filling also should be incorporated into the grading plan.

The grading plan should incorporate landforming techniques, as described in the Landforming BMP.

Land grading should be based upon well pad and pipeline layouts that fit and utilize existing topography and desirable natural surroundings to avoid extreme grade modifications. Clearing and grading should only occur at those areas necessary for well pad activities and equipment traffic. Maintaining undisturbed temporary or permanent buffer zones in the grading operation provides a low-cost sediment control measure that will help reduce runoff and off-site sedimentation.

Slope failures

Landslides and failed road cuts and fills can be a major source of sediment, they can close the road or require major repairs, and they can greatly increase road maintenance costs. Slope failures, or landslides, typically occur where a slope is over-steep, where fill material is not compacted, or where cuts in natural soils encounter groundwater or zones of weak material. Good road location can often avoid landslide areas and reduce slope failures. When failures do occur, the slide area should be stabilized by removing the slide material, flattening the slope, adding drainage, or using structures, as discussed below. Designs are typically site specific and may require input from geotechnical engineers and engineering geologists. Failures that occur typically impact road operations and can be costly to repair. Failures near streams and channel crossings have an added risk of impact to water quality.

Road slope

See Figure LG-1. All roads should be designed with one of the following three slope types:

- Outsloped roads minimize the concentration of water and minimize road width by avoiding the need for an inside ditch, but may require roadway surface and fill slope stabilization. Outsloped roads with clay rich, slippery road surface materials often require surface stabilization with gravel or limited use during rainy periods to assure traffic safety. On road grades over 10 to 12 percent and on steep hill slope areas, outsloped roads are difficult to drain and can feel unsafe.
- Insloped roads are the best method to control surface water. However, insloped roads also concentrate water and require a system of ditches and turnouts or cross-draining culverts.
- Crowned roads are appropriate for higher standard, two lane roads on gentle grades. They may or may not require roadside ditches, turnouts, and/or cross-drains. It is difficult to create and maintain a crown on a narrow road, so generally insloped or outsloped road drainage is more effective.

Construction specifications

Cut and fill slopes

1. All applicable perimeter erosion and sediment control practices and measures (berms, diversions, silt fence, vegetated buffer, or wattles) shall be constructed prior to any road grading activities, and maintained in accordance with this BMP and the Stormwater Management Plan (SWMP). Perimeter controls should remain in place until all graded or disturbed areas, including slopes, are adequately stabilized.
2. All areas to be disturbed (both cut and fill) shall be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, or other objectionable material.
3. Fill material shall be free of brush, logs, stumps, roots, or other objectionable materials that would interfere with, or prevent, construction of satisfactory fills. This material can be set aside and later

used at the toe of fill slopes as filter berms. Frozen material shall not be placed in the fill nor shall the fill material be placed on a frozen foundation.

4. Table LG-1 presents a range of commonly used cut and fill slope ratios appropriate for the soil and rock types described. Figures LG-2 and LG-3 present typical cut slope and fill slope design options for varying slope and site conditions. Vertical cut slopes should not be used unless the cut is in rock or very well cemented soil. Ideally, both cut and fill slopes should be constructed with a 2:1 or flatter slope to promote growth of vegetation, but cut slopes in dense, sterile soils or rocky material are often difficult to vegetate.
5. All fills shall be compacted as required to reduce erosion, slippage, settlement, subsidence, or other related problems.
6. Topsoil required for the establishment of vegetation shall be stockpiled in the amount necessary to complete finished grading of all exposed areas. Areas that are to be topsoiled shall be scarified to a minimum depth of 4 inches prior to placement of topsoil.
7. Terraces or contour trenches (see Terracing (T)) shall be provided whenever the vertical interval (height) of any 2:1 cut or fill slope exceeds 20 feet; for 3:1 slope it shall be increased to 30 feet and for 4:1 to 40 feet.
8. All graded cut and fill areas shall be stabilized, either structurally or vegetatively, immediately following finished grading. Some common slope stabilization options include hydroseeding, hydromulching, erosion control blankets, riprap, and retaining walls.

Road slope

1. See Figure LG-1. Compact soil or road base material to direct runoff.
2. If crowning a road, runoff is directed to both sides of the road requiring two roadside ditches, unless runoff will drain directly to well-stabilized areas.
3. If using an inslope design, runoff is directed toward the hillside and requires a roadside ditch with periodic turnouts or cross drain culvert installation.
4. If using an outslope design, ensure a moderate road slope with dense vegetative cover.
5. When a pipeline crosses a road, the road should be re-compacted and re-sloped according to the original design and applicable road specifications.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect cut and fill slopes for rills or other indications of erosion. If any erosion, washouts or breaks occur, it should be repaired as soon as possible. Prompt maintenance of small-scale eroded areas is essential to prevent these areas from becoming significant gullies. Maintain all crowns, out-slopes, in-slopes, and surface gravel.

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

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United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book." BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Table LG-1

Stable Slope Ratios for Various Conditions

Soil/Rock Condition	Slope Ratio (Hor:Vert)
Most rock	¼:1 to ½:1
Very well cemented soils	¼:1 to ½:1
Most in-place soils	¾:1 to 1:1
Very fractured rock	1:1 to 1 ½: 1
Loose coarse granular soils	1 ½: 1
Heavy clay soils	2:1 to 3:1
Soft clay rich zones or wet seepage areas	2:1 to 3:1
Fills of most soils	1 ½:1 to 2:1
Fills of hard, angular rock	1 1/3 :1
Low cuts and fills (<10 ft high)	2:1 or flatter (for revegetation)

Figure LG-1
Typical Road Surface Drainage Options

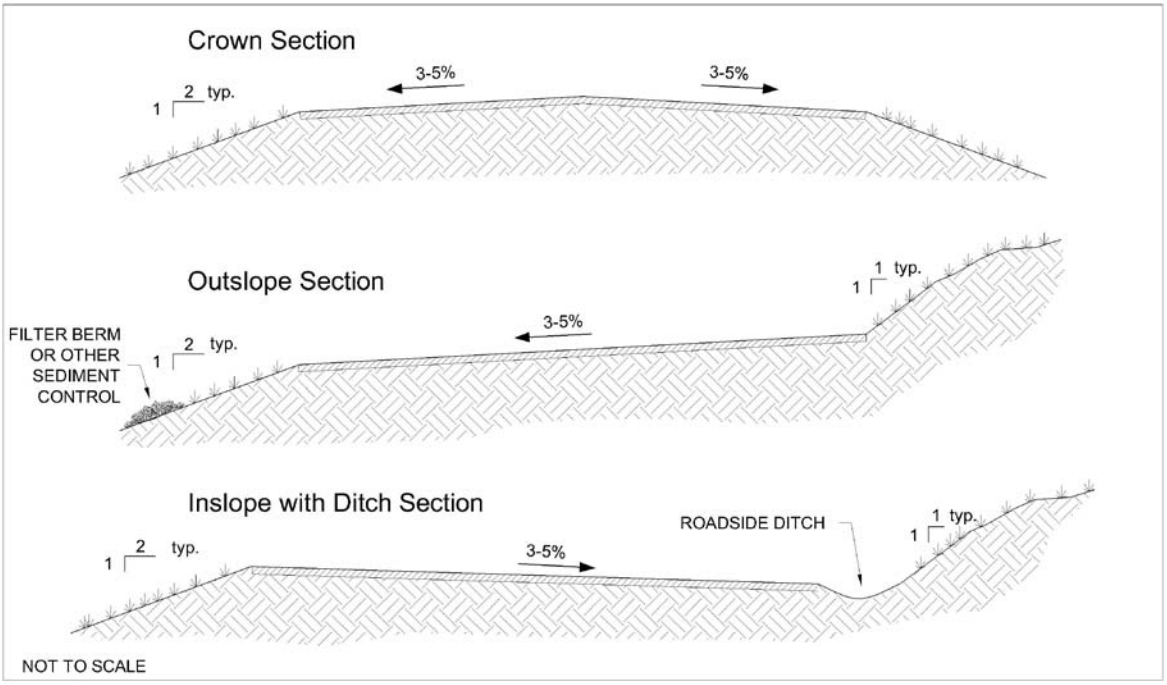


Figure LG-2
Typical Cut Slope Design Options

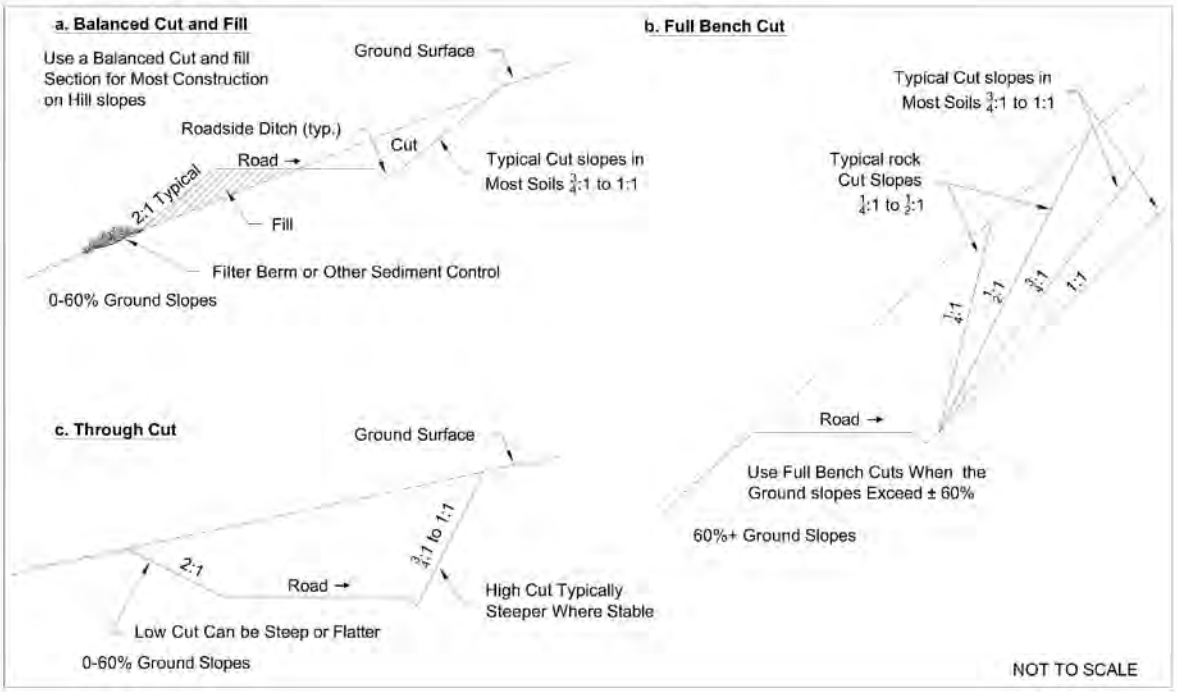
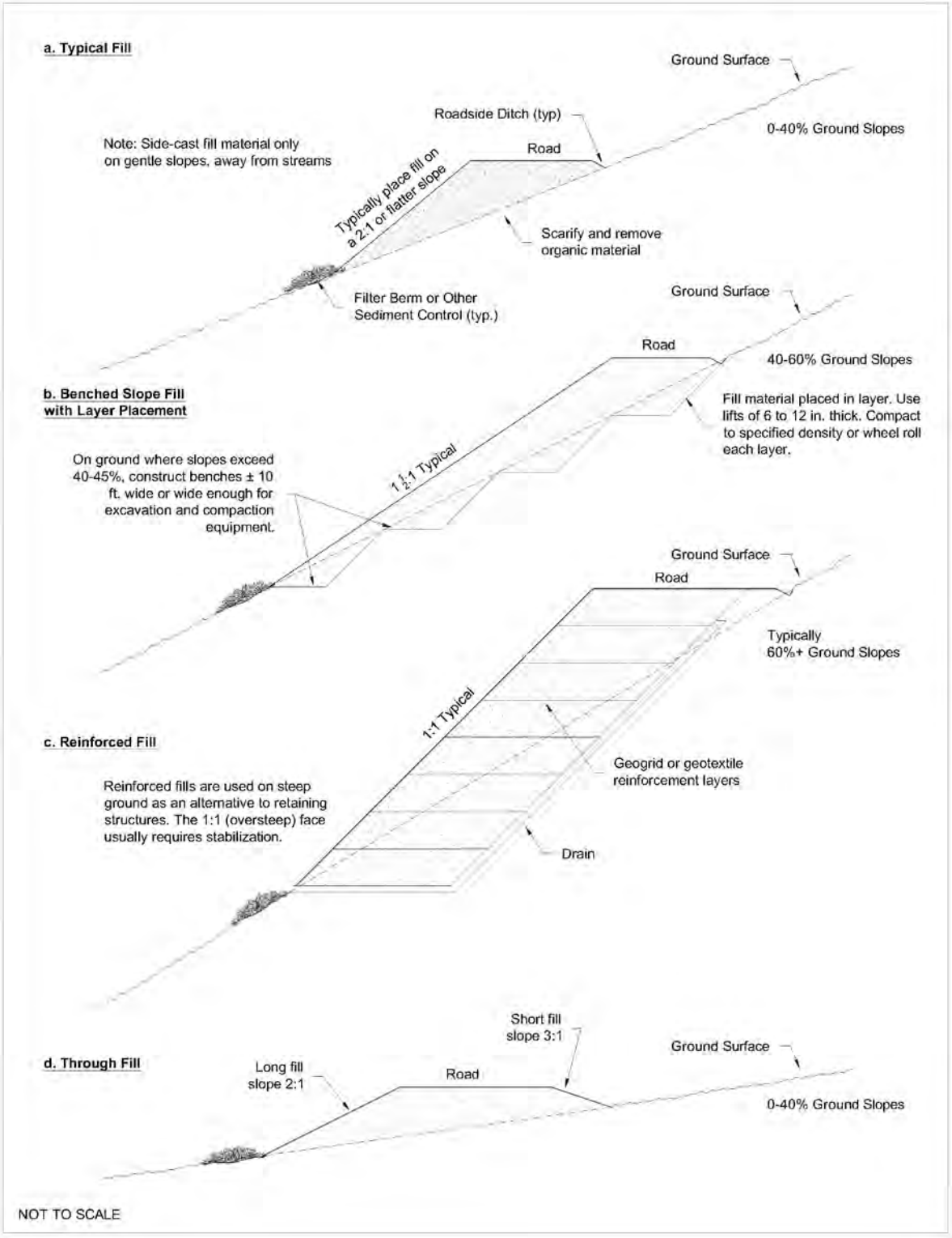


Figure LG-3
Typical Fill Slope Design Options



Low Water Crossing (LWC)

Specification Section 01570/02370

Description

A low water crossing is a temporary structure erected to provide a safe and stable way for construction vehicle traffic to cross waterways. The primary purpose of such a structure is to provide streambank stabilization, reduce the risk of damaging the streambed or channel, and reduce the risk of sediment loading from construction traffic. A low water crossing may be a bridge, a culvert, or a ford surfaced with gravel, rip rap, or concrete.

Applicability

Low water crossings may be used for the following applications:

- Wherever heavy construction equipment must be moved from one side of a stream channel to the other, or where lighter construction vehicles will cross the stream a number of times during the construction period.
- Bridges are ideal to pass the year-round flows associated with perennial drainages.
- Vented fords can be used to pass drainages with low flows and keep vehicles out of the water, avoiding water quality degradation.
- Fords can be designed as a broadcrested weir in order to pass larger flow.
- Fords can be "forgiving" and accommodate uncertainties in the design flow and thus are ideal for ephemeral and intermittent drainages with unknown or variable flow characteristics.

Limitations

- Low-water crossings that are not surfaced should not be used in wet conditions.
- Installation may require dewatering or temporary diversion of the stream.
- Bridges can be a safety hazard if not properly designed and constructed. Bridges might also prove to be more costly in terms of repair costs and lost construction time if they are washed out or collapse.
- The construction and removal of culverts are usually very disturbing to the surrounding area and erosion and downstream movement of soils is often great.
- The approaches to fords often have high erosion potential. In addition, excavation of the streambed and approach to lay riprap or other stabilization material causes major stream disturbance. Mud and other debris are transported directly into the stream unless the crossing is used only during periods of low flow.
- Ford-type structures may imply some periodic or occasional traffic delays during periods of high flow.

Design Criteria

Site location

Locate the crossing where there will be the least disturbance to the soils of the existing waterway banks. When possible, locate the crossing at a point receiving minimal surface runoff.

Elimination of fish migration barriers

Bridges pose the least potential for creating barriers to aquatic migration. The construction of any specific crossing method shall not cause a significant water level difference between the upstream and downstream water surface elevations.

Crossing alignment

Where possible, the low water crossing shall be at right angles to the stream.

Road approaches

The centerline of both roadway approaches shall coincide with the crossing alignment centerline for a minimum distance of 50 feet from each bank of the waterway being crossed. If physical or right-of-way restraints preclude the 50 feet minimum, a shorter distance may be provided. All fill materials associated with the roadway approach shall be limited to a maximum height of 2 feet above the existing flood plain elevation.

Bridges

Over-stream bridges are generally the preferred low water crossing structure. The expected load and frequency of the stream crossing, however, will govern the selection of a bridge as the correct choice for a temporary stream crossing. Bridges usually cause minimal disturbance to a stream's banks and cause the least obstruction to stream flow and fish migration. They should be constructed only under the supervision and approval of a qualified engineer.

Culverts

Temporary culverts are used where a) streams are perennial or intermittent, b) the channel is too wide for normal bridge construction, or c) anticipated loading may prove unsafe for single span bridges. Culverts are normally preferred over a ford type of crossing, since disturbance to the waterway is only during construction and removal of the culvert.

Fords

Fords are appropriate in steep areas subject to flash flooding, where normal flow is shallow or intermittent across a wide channel. Fords should be used for crossing seasonally dry streambeds (ephemeral or intermittent drainages) or streams with low flows during most periods of road use. Use fords in place of culverts when there is a high possibility of plugging by debris or vegetation. Use improved (vented) fords with pipes or concrete box culverts to pass low water flows and keep vehicles out of the water.

Construction specifications

Bridges

See Figure LWC-1.

1. Clearing and excavation of the stream shores and bed should be kept to a minimum.
2. A temporary bridge structure shall be constructed at or above bank elevation to prevent the entrapment of floating materials and debris.

3. Abutments should be parallel to the stream and on stable banks.
4. If the crossing is to extend across a channel wider than 8 feet (as measured from top of bank to top of bank), the bridge should be designed with one in-water support for each 8 feet of stream width. No footing, pier, or bridge support will be permitted within the channel for waterways less than 8 feet wide.
5. Stringers shall either be logs, saw timber, pre-stressed concrete beams, metal beams, or other approved materials.
6. Decking shall be of sufficient strength to support the anticipated load. All decking members shall be placed perpendicular to the stringers, butted tightly, and securely fastened to the stringers. Decking materials must be butted tightly to prevent any soil material tracked onto the bridge from falling into the waterway below.
7. Run planking (optional) shall be securely fastened to the length of the span. One run plank shall be provided for each track of the equipment wheels. Although run planks are optional, they may be necessary to properly distribute loads.
8. Curbs or fenders may be installed along the outer sides of the deck. Curbs or fenders are an option, which will provide additional safety.
9. Bridges shall be securely anchored at only one end using steel cable or chain. Anchoring at only one end will prevent channel obstruction in the event that floodwaters float the bridge. Acceptable anchors are large trees, large boulders, or driven steel anchors. Anchoring shall be sufficient to prevent the bridge from floating downstream and possibly causing an obstruction to the flow.
10. All areas disturbed during installation shall be stabilized in accordance with Revegetation (RV).

Culverts

See Culvert (C).

Fords

See Figure LWC-2.

1. Locate fords where stream banks are low and where the channel is well confined.
2. Clearing and excavation of the stream shores and bed should be kept to a minimum.
3. Excavate streambed as necessary and place a riprap or crushed aggregate as necessary based on site-specific conditions. This type of simple low water crossing is ideal for ephemeral drainages.
4. If possible, the approach roads the cut banks shall be no steeper than 5:1. The road approach shall be a minimum distance of 50 feet from each bank. Spoil material from the banks shall be stored out of the floodplain and stabilized.
5. Use an adequately long aggregate surface to protect the “wetted perimeter” of the natural flow channel. Add protection above the expected level of the high flow. Allow for some freeboard, typically a minimum of 12 inches in elevation, between the top of the reinforced driving surface and the expected high water level.
6. The downstream edge of a ford is a particularly critical location for scour and may need energy dissipaters or riprap protection.
7. Use well-placed, sturdy depth markers at fords (if necessary) to advise traffic of dangerous water depths.
8. All areas disturbed during ford installation shall be stabilized in accordance with Revegetation (RV).

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP.

Bridges

Inspection shall ensure that the bridge, streambed, and streambanks are maintained and not damaged. If any structural damage is reported, construction traffic should stop use of the structure until appropriate repairs are made. Evidence of streambank erosion should be repaired immediately. Any trapped sediment or debris shall be removed and disposed of outside of the floodplain and stabilized.

Culverts

Inspection shall ensure that the culverts, streambed, and streambanks are not damaged, and that sediment is not entering the stream or blocking fish passage or migration. Evidence of structural or streambank erosion should be repaired immediately. Any trapped sediment or debris shall be removed and disposal of outside of the floodplain and stabilized.

Fords

Inspections shall ensure that stabilization material (aggregate) remains in place. If the material has moved downstream during periods of peak flow, the lost material should be replaced immediately.

Removal/Abandonment

All low water crossings shall be removed when the structure is no longer needed.

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

United States Department of the Interior, Bureau of Land Management (BLM), United States Department of Agriculture (USDA), Forest Service, Surface Operating Standards for Oil and Gas Exploration and Development “Gold Book”. Fourth Edition, 2005.

Figure LWC-1
Bridge Installation

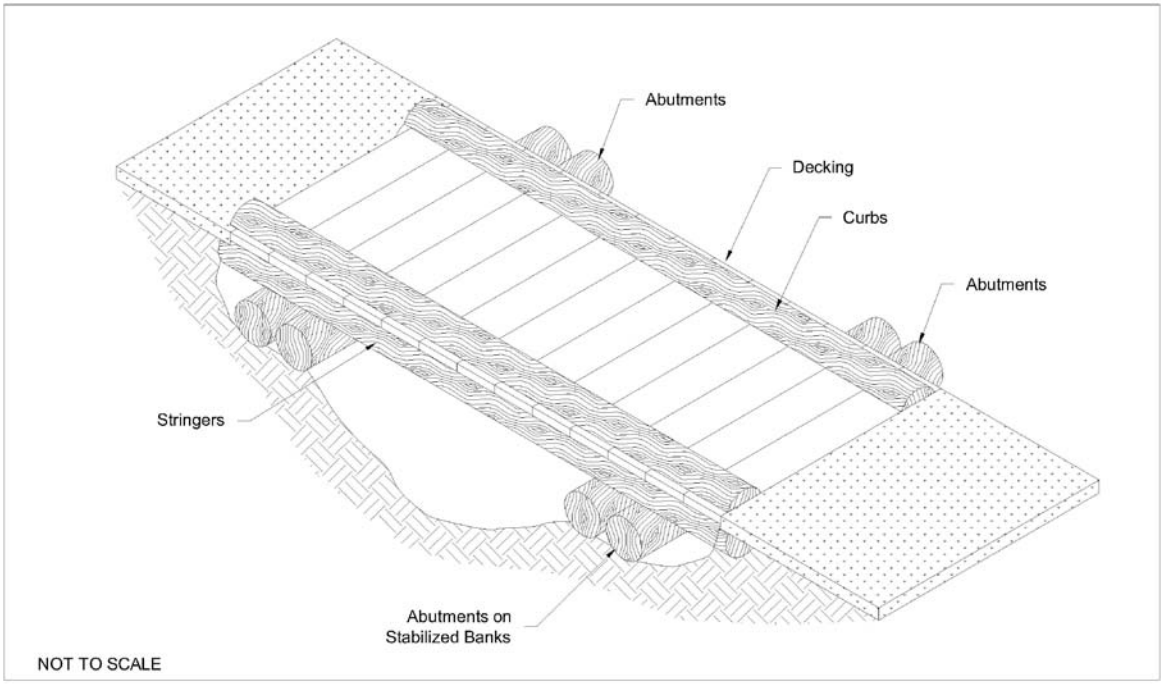
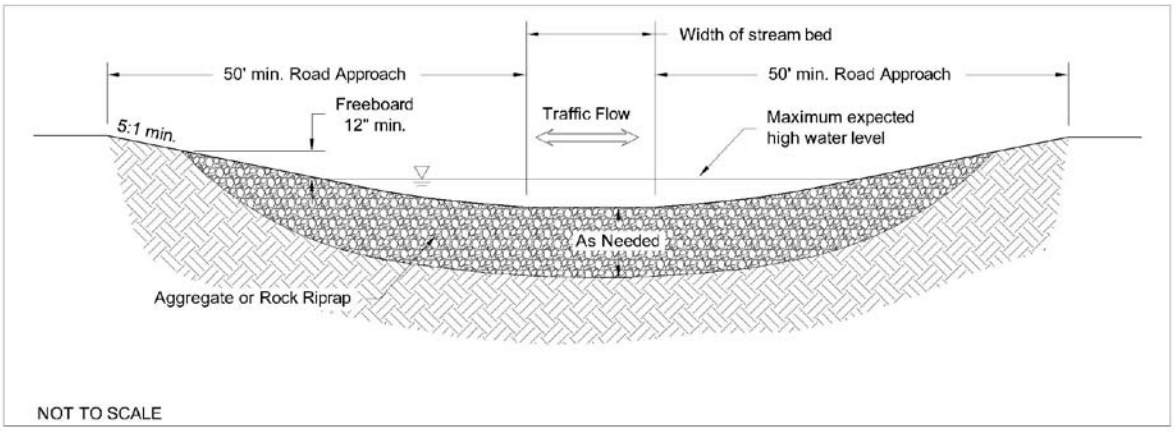


Figure LWC-2
Ford Installation



Mulching (M)

Specification Section 02910/02920

Description

Mulching is a temporary erosion control practice in which materials such as grass, hay, wood chips, wood fibers, straw, or slash are placed on exposed or recently planted soil surfaces. Mulching stabilizes soils by minimizing rainfall impact and reducing stormwater runoff velocity. When used in combination with seeding or planting, mulching can aid plant growth by holding seeds, fertilizers, and topsoil in place, preventing birds from eating seeds, retaining moisture, and insulating plant roots against extreme temperatures.

Mulch mattings are materials such as jute or other wood fibers that are formed into sheets and are more stable than loose mulch. Jute and other wood fibers, plastic, paper, or cotton can be used individually or combined into mats to hold mulch to the ground. Netting can be used to stabilize soils while plants are growing, although netting does not retain moisture or insulate against extreme temperatures. Mulch binders consist of asphalt or synthetic materials that are sometimes used instead of netting to bind loose mulches.

Hydraulic mulching is a temporary erosion control practice in which materials such as grass, hay, wood chips, wood fibers, straw, or gravel are hydraulically applied to exposed or recently planted soil surfaces.

Applicability

Mulching is often used in areas where temporary seeding cannot be used because of environmental constraints. On steep slopes and critical areas such as waterways, mulch matting is used with netting or anchoring to hold it in place. Hydraulic mulches can be used on seeded and planted areas where slopes are

as steep as 1:1. Non-hydraulic mulches can be used on seeded and planted areas where slopes are steeper than 2:1 or where sensitive seedlings require insulation from extreme temperatures or moisture retention. Mulch can last for 1 to 2 years.

Limitations

- Mulching, matting, and netting might delay seed germination because the cover changes soil surface temperatures.
- The mulches themselves are subject to erosion and may be washed away in a large storm.
- Straw mulch must be free of any weeds and any unwanted seed. Seed heads need to be cut off of straw mulch.
- Maintenance is necessary to ensure that mulches provide effective erosion control.
- Hydraulic application of mulch must be done when no rainfall is expected, preferably within a 24-hour time period.

Design criteria

No formal design is required.

Construction specifications

1. Site preparation:
   a. Prior to mulching, install the necessary temporary or permanent erosion control practices and drainage systems within or adjacent to the area to be mulched.
   b. Slope, grade, and smooth the site to fit needs of selected mulch products.
   c. Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

2. Mulching & anchoring for relatively flat slopes:
   a. Select the appropriate mulch and application rate that will best meet the need and availability of material. When possible, organic mulches should be used for erosion control and plant material establishment. See Table M-1 for suggested materials and application rates. Other materials include hydraulic mulch products with 100-percent post-consumer paper content and yard trimming composts. All materials should be free of weed and seed.
   b. Apply mulch immediately after soil amendments and planting is accomplished or simultaneously if hydroseeding is used. See Table M-1 for installation guidelines.
   c. Mulch before seeding if construction or restoration activity is interrupted for extended periods, such as when seeding cannot be completed due to seeding period restrictions. If mulching before seeding, increase mulch rate of application on all slopes within 100 feet of waterbodies and wetlands.
   d. Use a mulch crimper to apply and anchor mulch. Crimper should have approximately 6 inch cleats with perpendicular, dull, disc blades. If a crimper is unavailable the Contractor shall apply mulch and anchor it to the soil using one of the methods described in Table M-2. The mulch should be anchored the same day as mulch application. Materials that are heavy enough to stay in place (for example, bark or wood chips on flat slopes) do not need anchoring. Mulches may or may not require a binder, netting, or tacking. Mulch binders should be applied at rates recommended by the manufacturer. Effective use of netting and matting material requires firm, continuous contact between the materials and the soil.

3. Hydraulic mulching for steeper slopes:

    a. For steep slopes an Erosion Control Mulch (ECM) consisting of a hydraulic matrix such as a Bonded Fiber Matrix (BFM) or Flexible Growth Medium (FGM) may be used. A BFM refers to a continuous layer of elongated wood fiber strands that are held together by a water-resistant bonding agent to form a water-absorbing crust. A FGM refers to a three-dimensional composite of wood fibers, crimped man-made fibers, and performance enhancing additives.

    b. The ECM shall be a hydraulically-applied, flexible erosion control blanket composed of long strand, thermally refined wood fibers, crimped, interlocking fibers, and performance enhancing additives. The ECM shall require no curing time period and upon application shall form an intimate bond with the soil surface to create a continuous, porous, absorbent and erosion resistant blanket that allows for rapid germination and accelerated plant growth.

    c. The ECM shall conform to the property values in Table M-3 when uniformly applied at a rate of 3500 pounds per acre (3900 kilograms/hectare) under laboratory conditions. Composition shall be as follows:

        Thermally Processed Wood Fibers: 74.5% ± 2.5%
        Crosslinked Hydro-Colloid Tackifier: 10% ± 1%
        Crimped, Interlocking Fibers: 5% ± 1%
        Moisture Content: 10.5% ± 1.5%

    d. Strictly comply with manufacturer's installation instructions and recommendations. Use approved hydro-spraying machines with fan-type nozzle (50-degree tip) whenever possible to achieve best soil coverage. Apply ECM from opposing directions to soil surface to assure 95% soil surface coverage. Slope interruption devices or water diversion techniques are recommended when slope lengths exceed 100 ft (30m).

    e. Step One: Apply seed, fertilizer and other soil amendments with tackifier and a small amount of ECM for visual metering (see Revegetation (RV) for application rates).

    f. Step Two: Mix 50 lb of ECM per 125 gallons (23 kg/475 liters) of water; confirm loading rates with equipment manufacturer (different manufacturers rates may vary slightly).

    g. Install materials at the typical application rates in Table M-4.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Areas should be identified where mulch has loosened or been removed. Such areas should be reseeded (if necessary) and the mulch cover replaced. If washout, breakage, or erosion occurs, surfaces should be repaired, reseeded, and re-mulched, and new netting should be installed. Inspections should be continued until vegetation is firmly established.

Removal/Abandonment

Mulch and anchoring material should be 100% biodegradable and should not require removal. However, any artificial anchor netting or other artificial mulch material should be removed when protection is no longer needed and disposed of in a landfill.

References

California Stormwater Quality Association, Stormwater Best Management Practice (BMP) Handbook – Construction. January, 2003. <http://www.cabmphandbooks.com/Construction.asp>

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

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Table M-1

Typical Mulching Materials and Application Rates

Material	Rate per Acre	Requirements	Notes
Organic Mulches			
Straw	1 - 2 tons	Dry, unchopped, unweathered; certified weed free.	Spread by hand or machine; must be tacked or tied down.
Wood fiber or wood cellulose	½ - 1 ton		Use with hydroseeder; may be used to tack straw. Do not use in hot, dry weather.
Wood chips	5 - 6 tons	Air dry. Add fertilizer N, 12 lb/ton.	Apply with blower, chip handler, or by hand. Not for fine turf areas.
Bark	35 yd^3	Air dry, shredded, or hammermilled, or chips	Apply with mulch blower, chip handler, or by hand. Do not use asphalt tack.
Nets and Mats			
Jute net	Cover area	Heavy, uniform; woven of single jute yarn. Used with organic mulch.	Withstands water flow.
Excelsior (wood fiber) mat	Cover area		

Table M-2

Mulch Anchoring Guide

Anchoring Method or Material	Kind of Mulch to be Anchored	How to Apply
1. Mulch netting	Hay or straw	Staple the light-weight paper, jute, wood fiber, or plastic nettings to soil surface according to manufacturer's recommendations. Should be biodegradable. Most products are not suitable for foot traffic.
2. Wood cellulose fiber	Hay or straw	Apply hydroseeder immediately after mulching. Use 500 lbs. Wood fiber per acre. Some products contain an adhesive material, possibly advantageous.
3. Mulch anchoring tool/Crimper	Hay or straw	Apply mulch and pull a mulch anchoring tool (blunt, straight discs) over mulch as near to the contour as possible. Mulch material should be "tucked" into soil surface about 3".
4. Chemical	Hay or straw	Apply Terra Tack AR 120 lbs./ac. In 480 gal. of water (#156/ac.) or Aerospray 70 (60 gal/ac.) according to manufacturer's instructions. Avoid application during rain. A 24-hour curing period and a soil temperature higher than 45 deg. Fahrenheit are required.

Table M-3

Property Values for Erosion Control Hydromulch

Property	Test Method[1]	English	SI
Physical			
Mass Per Unit Area	ASTM D-6566	11.5 oz/yd^2	390 g/m^2
Thickness	ASTM D-6525	0.19 in	4.8 mm
% Ground Cover	ASTM D-6567	99%	99%
Flexural Rigidity (wet)	ASTM D-6575	0.138 oz-in	10,000 mg-cm
Color (fugitive dye)	Observed	Green	Green
Endurance			
Functional Longevity	Observed	Up to 18 months	Up to 18 months
Performance			
Cover Factor[3] (6 in/hr event)	ECTC Test Method #2	0.0066	0.0066
% Effectiveness[3]	ECTC Test Method #2	99.34%	99.34%
Shear Stress	ECTC Test Method #3	1 lb/ft^2	48 Pa
Vegetation Establishment	ECTC Test Method #4	800%	800%

1. ASTM and ECTC (Erosion Control Technology Council) test methods developed for Rolled Erosion Control Products.
2. Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.
3. % Effectiveness = 1 minus Cover Factor multiplied by 100%.

Table M-4

Typical Hydromulch Application Rates

Slope Gradient/Condition	English	SI
≤3H to 1V	3000 lb/ac	3400 kg/ha
>3H to 1V and ≤2H to 1V	3500 lb/ac	3900 kg/ha
>2H to 1V and ≤1H to 1V	4000 lb/ac	4500 kg/ha
>1H to 1V	4500 lb/ac	5100 kg/ha
Below ECB or TRM	1500 lb/ac	1700 kg/ha
As infill for TRM	3500 lb/ac	3900 kg/ha

Slope Gradient/Condition	Performance Specification
≤3H	70-80% soil coverage, minimum 0.16 inch depth
≤3H to 1V	90-100% soil coverage, ≤2" rocks uncovered, minimum 0.19 inch depth
>3H to 1V and ≤2H to 1V	95-100% soil coverage, ≤6" rocks uncovered, minimum 0.22 inch depth
>2H to 1V and ≤1H to 1V	100% soil coverage, ≤12" boulders uncovered, minimum 0.22 inch depth
>1H to 1V	All exposed surfaces including rock outcrops shall be covered at a minimum of 0.24 inch depth
Below ECB or TRM	1500-2500 lb/ac slope dependent, minimum 0.08 inch depth
As infill for ECB	1500-3500 lb/ac, minimum 0.19 inch depth
As infill for TRM	Perpendicular application with 100% infill, minimum 0.19 inch depth

Retaining Wall (RW)

Specification Section 02370/02830

Rock Retaining Wall

Gabion Retaining Wall

Description

Retaining walls are structures that are used to stabilize and hold soil in place, gain space on roadways or well pads, or to keep soil contained within a site boundary. This BMP will cover retaining walls constructed with rock, boulders, or gabions. Gabions are rectangular, rock-filled wire baskets that are pervious, semi-flexible building blocks which can be used to armor the bed and/or banks of channels or to divert flow away from eroding channel sections.

Several different retaining wall types are:

1. **Rigid gravity and semi-gravity walls.** These walls may be constructed of concrete or stone masonry. The rigid gravity and semi-gravity walls develop their capacity from their dead weights and structural resistance, and are generally used for permanent applications.
2. **Non-gravity cantilevered walls.** These walls develop lateral resistance through the embedment of vertical wall elements and support retained soil with wall facing elements. Vertical wall elements are normally extended deep in the ground to provide lateral and vertical support. The vertical wall elements can be piles, drilled shafts, steel sheet piles, etc. Wall faces can be reinforced concrete, metal, or timber. Cantilevered walls are generally limited to a maximum height of about 15 feet.
3. **Anchored walls.** These walls typically consist of the same elements as the non-gravity cantilevered walls but derive additional lateral resistance from one or more tiers of anchors. The anchored walls are typically used in the cut situation, in which the construction proceeds from the top to the base of the wall.

Applicability

Retaining walls should be used when sites have very steep slopes or loose, highly erodible soils that cause other methods, such as vegetative stabilization or regrading, to be ineffective. The preconstruction drainage pattern should be maintained to the extent possible. Retaining walls may be used for the following applications:

- Near the toe of a cut or fill slope to mechanically stabilize steep slopes and so that a flatter slope can be constructed to prevent or minimize slope erosion or failure. Particularly useful along access road cut slopes.
- Along a stream bank or drainage channel, to keep a toe of a slope from encroaching into a stream and thus prevent potential undercutting of the toe by flowing water.
- As headwalls at culvert inlets and outlets to prevent scour and undercutting.

Limitations

- Some retaining walls are a structural element that must be professionally designed.
- To be effective, retaining walls must be designed to handle expected loads. Non-engineered walls should not be used where traffic is expected near the top of the wall.
- Retaining walls must be properly installed and maintained to avoid failure.
- Some types of retaining walls must be placed on a good foundation, such as bedrock or firm, in-place soil.
- Some walls have height restrictions and backfill may be required to meet specific material property requirements.
- Materials costs and professional design requirements may make use of gabions impractical.
- When used in channels with high sediment loads, the galvanizing wire on gabion cages quickly wears off, causing rusting and the premature failure of the cages.

Design criteria

Most retaining walls require a site-specific design. Wall heights, requirements for drainage, and suitable materials must be determined through on-site investigation. An engineered retaining structure is a designed structure that is supported by plans and specifications signed and sealed by a Professional Engineer. Non-engineered retaining structures may be designed by an engineer; however, if the design is not supported by the seal and signature, the retaining structure is not considered engineered.

Gabions

Gabions should be designed and installed in accordance with manufacturer's standards and specifications and must be able to handle expected storm and flood conditions.

Design velocity

The design water velocity for channels utilizing gabions should not exceed those listed as follows:

Gabion Thickness (feet)	Maximum Velocity (feet per second)
0.5	6
0.75	11
1.0	14

Construction specifications

Rock retaining wall guidelines

See Figure RW-1.

1. Excavate a footing trench at the location of the proposed wall.
2. Place the largest rocks in the footing trench with their longitudinal axis normal to the wall face. Arrange subsequent rock layers so that each rock above the foundation course has a firm seating on the underlying rocks.
3. The batter of the wall face shall be between ½H:1V and vertical, depending upon the height of the wall, the height of the slope, the width of the right-of-way, or other limitations on space.

4. Place fill material behind the rock wall. Slope above the wall should be maintained at 2H:1V or flatter. Backfill the footing trench with excavated material. If a roadway is located at the toe of the wall, pave the roadway up to the base of the rock wall and provide roadway curb for water transport. If a roadway is not located at the toe of the retaining wall, slope the backfilled material away from the wall.
5. Revegetate the stabilized slope with a method applicable to the particular site.

Gabion retaining wall guidelines

See Figure RW-2. Gabions shall be fabricated in such a manner that the sides, ends, and lid can be assembled at the construction site into a rectangular basket of the specified sizes. Gabions shall be of single unit construction and shall be installed according manufacturer's recommendations. General specifications are listed below.

1. Clear and grade the area of trees, brush, vegetation, and unsuitable soils. Compact subgrade firmly to prevent slumping or undercutting.
2. Install a filter fabric or granular filter according to the Riprap (R) BMP to maintain separation of rock material with the underlying soil, if required.
3. Place empty gabion baskets. Each row, tier, or layer of baskets should be reasonably straight and should conform to the specified line and grade (see Figure RW-2 for details). The empty gabion baskets should be fastened to the adjacent baskets along the top and vertical edges. If using more than one layer of gabions, each layer should be fastened to the underlying layer along the front, back and ends. Fastening should be performed in the same manner as provided for assembling the gabion units.
4. Unless otherwise indicated on the plans, the vertical joints between basket units of adjacent tiers or layers, along the length of the structure, should be staggered by at least one cell (if more than one layer is used).
5. Before filling each gabion with rock, all kinks and folds in the wire mesh should be removed and all baskets should be properly aligned. A standard fence stretcher, chain fall or steel rod may be used to stretch the wire baskets and hold alignment.
6. The gabion cells should be carefully filled with appropriately sized rock placed by hand/machine in such a manner that the alignment of the structure will be maintained and so as to avoid bulges and to minimize voids. Rock should be sound, durable, and well graded. All exposed rock surface should have a reasonably smooth and neat appearance. No sharp rock edges should project through the wire mesh.
7. The gabion cells in any row or layer should be filled in stages so that local deformations may be avoided.
8. At no time should any cell be filled to a depth exceeding 12 inches more than any adjacent cell.
9. The layer of rock should completely fill the gabion basket so that the lid will bear on the rock when it is secured. The lid should be joined to the sides, ends, and diaphragms in the same manner as specified for joining the vertical edges. The gabion basket lid should be secured so that no more than 1-inch gap remains at any connection.
10. Gabion rows or layers not completed at the end of each shift should have the last gabion filled with rock tied internally as an end gabion.
11. The area behind the gabion structure should be backfilled with granular material. Geotextile, if required, should be spread uniformly over the back of the gabion structure. Joining edges of the geotextile should be overlapped a minimum of 12 inches and should be anchored in position with approved anchoring devices. The Contractor should place the backfill material in a manner that will not tear, puncture, or shift the geotextile.

All other retaining walls should be constructed as designed by a Professional Engineer.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Check for structural failure, erosion, damage, instability, or other signs of deterioration. In stream bank installations and culvert inlets and outlets also inspect for signs of undercutting. Check wire of gabion cages for rusting and wear. Repair or replace any damaged areas immediately to restore designed effectiveness and to prevent damage or erosion of the slope or stream bank.

References

City of Knoxville, Stormwater Engineering, Knoxville BMP Manual - Best Management Practices. July 2003. <http://www.ci.knoxville.tn.us/engineering>

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

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New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

Figure RW-1

Construction of Rock Retaining Structures

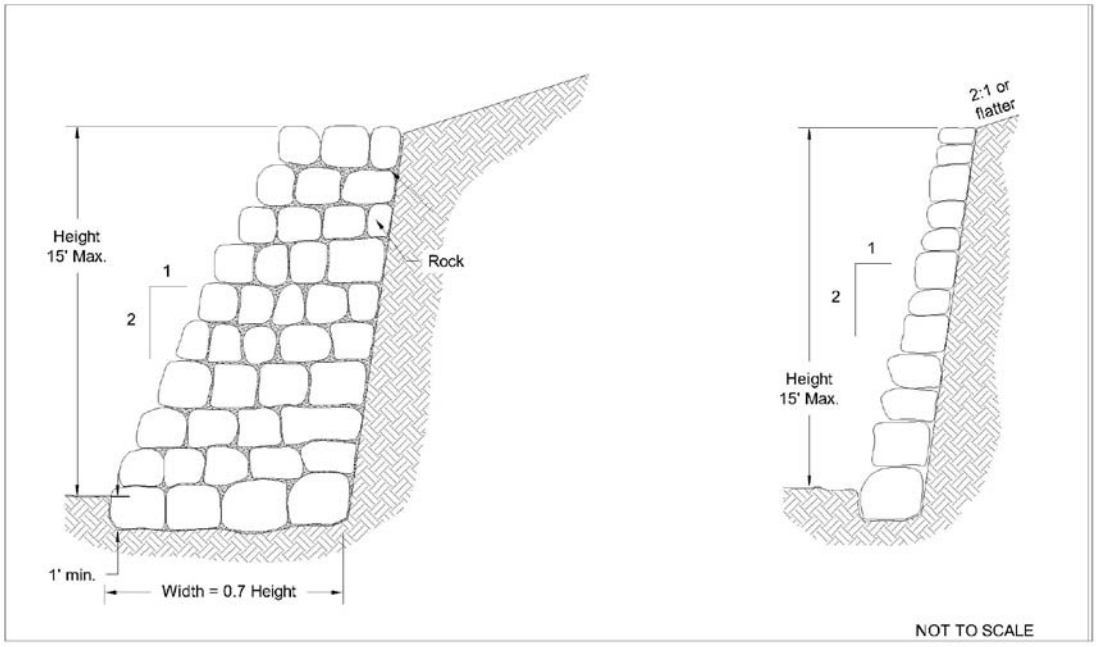
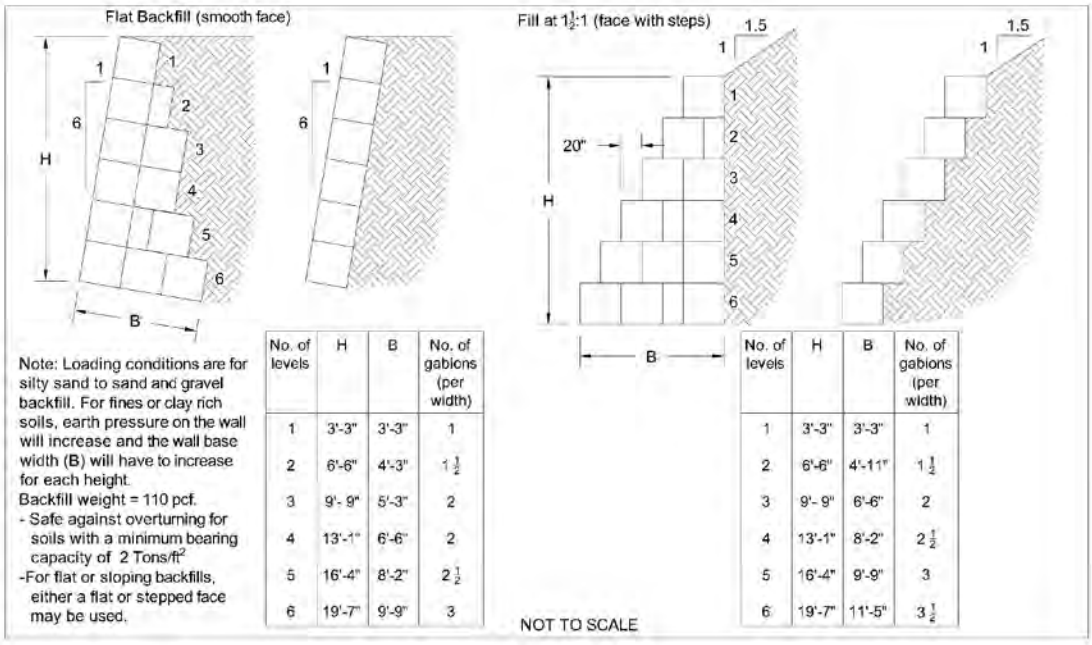


Figure RW-2
Gabion Design



Note: Loading conditions are for silty sand to sand and gravel backfill. For fines or clay rich soils, earth pressure on the wall will increase and the wall base width (B) will have to increase for each height.
Backfill weight = 110 pcf.
- Safe against overturning for soils with a minimum bearing capacity of 2 Tons/ft^2
-For flat or sloping backfills, either a flat or stepped face may be used.

No. of levels	H	B	No. of gabions (per width)
1	3'-3"	3'-3"	1
2	6'-6"	4'-3"	1 ½
3	9'- 9"	5'-3"	2
4	13'-1"	6'-6"	2
5	16'-4"	8'-2"	2 ½
6	19'-7"	9'-9"	3

No. of levels	H	B	No. of gabions (per width)
1	3'-3"	3'-3"	1
2	6'-6"	4'-11"	1 ½
3	9'- 9"	6'-6"	2
4	13'-1"	8'-2"	2 ½
5	16'-4"	9'-9"	3
6	19'-7"	11'-5"	3 ½

Revegetation (RV)

Specification Section 02900

Description

Revegetation involves planting seed to establish a vegetative cover on disturbed areas. Revegetation reduces erosion and sedimentation by stabilizing disturbed areas in a manner that is economical, adaptable to site conditions, and allows selection of the most appropriate plant materials. Revegetation also:

- Absorbs the impact of raindrops
- Reduces the velocity of runoff
- Reduces runoff volumes by increasing water percolation into the soil
- Binds soil with roots
- Protects soil from wind
- Improves wildlife habitat
- Enhances natural beauty

Applicability

Revegetation is most effective on slopes no steeper than 2:1 and may be used in areas where exposed soil surfaces are not to be regraded for periods longer than 30 days. Such areas include denuded areas, soil stockpiles, berms, temporary road banks, etc.

Limitations

The effectiveness of revegetation can be limited due to the following:

- High erosion potential during establishment.
- The need for stable soil temperature and soil moisture content during germination and early growth.
- The need to reseed areas that fail to establish.

Proper seedbed preparation and the use of quality seed are important in this practice. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Seeding does not immediately stabilize soils. Prior to seeding, install necessary erosion and sediment control practices such as diversions, straw bales, and basins until vegetation is established.

Design criteria

Successful plant establishment can be maximized with proper planning; consideration of soil characteristics; selection of plant materials that are suitable for the site; adequate seedbed preparation, liming, and fertilization; timely planting; and regular maintenance. A Revegetation Manual, which indicates the methods and materials needed to accomplish revegetation on differing site conditions, is provided as Appendix B to the Stormwater Management Plan (SWMP).

Coordination and scheduling

1. Coordinate installation of seeding materials during normal planting seasons for each type of seed material required.
2. Seeding in areas that are non-irrigated or not provided with sprinkling or watering systems shall be restricted according to the following schedule:
    a. Below 6000' elevation: Spring seeding shall occur between spring thaw and July 1st. Fall seeding shall occur from September 1st until consistent ground freeze.
    b. 6000' to 7000' elevation: Spring seeding shall occur between spring thaw and July 1st. Fall seeding shall occur from August 15th until consistent ground freeze.
    c. 7000' to 8000' elevation: Spring seeding shall occur between spring thaw and July 15th. Fall seeding shall occur from August 1st until consistent ground freeze.
    d. Above 8000' elevation: Seeding shall occur from spring thaw until consistent ground freeze.
    e. Spring thaw shall be defined as the earliest date in a calendar year in which seed can be buried ½ inch into the topsoil thru normal drill seeding methods.
    f. Consistent ground freeze shall be defined as that time during fall months in which the topsoil, due to freeze conditions, prevents burying seed ½ inch thru normal drill seeding operations.

Seed, soil amendments, and fertilizer

1. Seed mixes will vary depending on landowner requirements and the site elevation.
2. Soil amendments:
    a. AV Superphosphate 18-46-0: Commercial, phosphate mixture, soluble; minimum of 20 percent available phosphoric acid.

        Arkansas Valley Seed, 400 Moffat CR 220, Craig, CO 81625
        Willard McLaughlin - District Sales Manager
        Mobile: 970-629-0263. Fax: 970-234-8023
        Email: wmmclaughlin@seedsolutions.com

    b. Other soil amendments may also be used.
3. Fertilizers:
    a. Sustane 8-2-4: Slow release granular fertilizer.

        Sustane – Natural Fertilizer of America, Inc.
        310 Holiday Avenue P.O. Box 19 Cannon Falls, MN 55009
        Phone: 1-800-352-9245 Fax: 507-263-3029 www.sustane.com

    b. Other fertilizers may also be used.

Mulches

See Mulching (M) and Hydraulic Mulching (HM) for mulch materials to be used for flat and steep slopes, respectively.

Erosion control materials

1. Flexible Growth Medium: Flexterra FGM. Strictly comply with manufacturer's installation instructions and recommendations. Use approved hydro-spraying machines with fan-type nozzle (50-degree tip). Apply FGM from opposing directions to soil surface.

   Nilex, 15171 E. Fremont Drive, Centennial, CO 80112
   Phone: 1-800-537-4241 Fax: 303-766-1110 www.nilex.com

2. Non-asphaltic Tackifier: Organic derivative vegetative gum tackifier recommended by fiber-mulch manufacturer for slurry application, nontoxic and free of plant growth- or germination-inhibitors.

3. Other erosion control materials may also be used.

Construction specifications

See Table RV-1 for typical seeding guidelines. See Table RV-2 for typical seeding guidelines when using an Erosion Control Blanket (ECB) or a Turf Reinforcement Mat (TRM).

Seeding

1. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
2. Seed shall be uniformly sown by drill, by hydro-seeding (without mulch admixture), or by broadcasting. Drill and Hydro-seeding rates shall be the amount specified. Broadcast seeding rates shall be one and a half times the amount specified. Broadcast seeding shall be raked or chain dragged into the soil to a depth of approximately one-quarter inch (1/4") to one-half inch (1/2").
3. The seeding shall be done in one application crossing the area at right angles to one another to guarantee even coverage.
4. Protect seeded areas against erosion by uniformly spreading mulch after completion of seeding operations in accordance with Mulching (M) and Hydraulic Mulching (HM).

Cleanup and protection

1. During stormwater management & reclamation activities, keep pavements clean and work areas in an orderly condition.
2. Protect well pad, access road, private property, and federal lands from damage due to stormwater management & reclamation operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged well pad, access road, private property, and federal lands work as directed.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP. Vegetation is considered established when a density of at least 70 percent of pre-disturbance levels has been reached. Seeded areas should be inspected for failure and any necessary repairs and re-seedings should be made within the same season, if possible.

References

Encana Oil & Gas (USA), Inc, Revegetation Manual. Chenoweth & Associates Environmental Consultants. 2007.

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United States Army Corps of Engineers (USACE), Engineering and Design - Handbook for the Preparation of Storm Water Pollution Prevention Plans for Construction Activities. February 1997.

Table RV-1

Typical Seeding Guidelines

All slopes accessible to drill seeder and straw crimper

Material	Description	Quantity
Seed Mix	Drill Seeding (twice in perpendicular directions)	20 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1000 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre
Certified Weed Free Straw	Weed Free Crimped Straw	2000 lbs./acre

All slopes accessible to drill seeder

Material	Description	Quantity
Seed Mix	Drill Seeding (installed in perpendicular directions)	20 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1000 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre

Four wheeler broadcast seeding & tine harrowing

Material	Description	Quantity
Seed Mix	Broadcast Seeded & Tine Harrowed	40 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1000 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre

Chest broadcast seeding & hand raking

Material	Description	Quantity
Seed Mix	Broadcast Seeded & Hand Raked	40 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1000 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre

Table RV-2

Typical Seeding Guidelines if using

Erosion Control Blankets (ECB) or Turf Reinforcement Mats (TRM)

SLOPES 1:1 and/or Greater and Medium to High Concentrated Flows

Material	Description	Quantity
Seed Mix	Seed Hydraulically Applied	50 lbs./acre
Guar Tackifier	Guar Tackifier (Nylex dlamanna@nilex.com)	75 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1100 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre
ECB or TRM	Per Table ECB-1 or TRM-1	per spec.

SLOPES 2:1 to 1:1 and Medium Concentrated Flows

Material	Description	Quantity
Seed Mix	Seed Hydraulically Applied	45 lbs./acre
Guar Tackifier	Guar Tackifier (Nylex dlamanna@nilex.com)	75 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1100 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100lbs./acre
ECB or TRM	Per Table ECB-1 or TRM-1	per spec.

SLOPES 2:1 to 3:1 and Medium Concentrated Flows

Material	Description	Quantity
Seed Mix	Broadcast Seeding	45 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1100 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre
ECB or TRM	Per Table ECB-1 or TRM-1	per spec.

SLOPES 3:1 or less and Low Concentrated Flows

Material	Description	Quantity
Seed Mix	Seed Hydraulically Applied	40 lbs./acre
Guar Tackifier	Guar Tackifier (Nylex dlamanna@nilex.com)	40 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1100 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre
ECB or TRM	Per Table ECB-1 or TRM-1	per spec.

SLOPES 3:1 or less and Low Concentrated Flows

Material	Description	Quantity
Seed Mix	Broadcast Seeding	40 lbs./acre
SUSTANE 8-2-4	Sustane 8-2-4 (Nylex dlamanna@nilex.com)	1100 lbs./acre
Soluble Humates	Soluble Humates (Nylex dlamanna@nilex.com)	1100 lbs./acre
ECB or TRM	Per Table ECB-1 or TRM-1	per spec.

Riprap (R)

Specification Section 02730

Description

Riprap is a permanent, erosion-resistant layer made of native rocks/stones/boulders or crushed concrete. It is intended to stabilize areas subject to erosion and protect against scour of the soil caused by concentrated, high velocity flows.

Applicability

Riprap can be used for areas subject to erosion or weathering, particularly where conditions prohibit the establishment of revegetation or where flow velocities exceed 5 ft/sec. Riprap may be used in the following applications:

- Cut-and-fill slopes
- Channel side slopes and/or bottoms
- Inlets and outlets to sediment traps
- Check dams
- Roadside ditches

Limitations

Riprap is limited by steepness of slope, because slopes greater than 1.5:1 have potential riprap loss due to erosion and sliding. When working within flowing streams, measures should be taken to prevent excessive turbidity and erosion during construction. Bypassing base flows or temporarily blocking base flows are two possible methods.

Design criteria

Gradation

A well-graded mixture of rock sizes should be used instead of one uniform size (with the exception of dry stacking boulders). 50% by weight should be larger than the specified design size. The diameter of the largest stone size in such a mixture should be 1.5 times the d50 size with smaller sizes graded down to 1 inch. When dry stacking up a slope, boulders may be uniform in size or may get gradually smaller as the boulders are placed up the slope.

Quality

Riprap must be durable so that freeze/thaw cycles do not decompose it in a short time. They should be angular and not subject to breaking down when exposed to water or weathering. The specific gravity should be at least 2.5.

Size

The sizes of stones used for riprap protection are determined by purpose and specific site conditions:

1. Slope Stabilization. Riprap stone for slope stabilization not subject to flowing water should be sized for the proposed grade. The gradient of the slope to be stabilized should be less than the natural angle of repose of the stone selected. Angles of repose of riprap stones may be estimated from Figure R-1. Riprap used for surface stabilization of slopes does not add significant resistance to sliding or slope failure and should not be considered a retaining wall. Slopes approaching 1.5:1 may require special stability analysis. The inherent stability of the soil must be satisfactory before riprap is used for surface stabilization. Some slopes constructed in extremely rocky soils may not require additional riprap or other controls because the native soil itself is so rocky that it may already be considered riprap and is not likely to erode.
2. Stream bank Protection. If the shear stress is estimated, riprap stone for stream bank protection can be selected from the gradations in Table R-1, below. The shear stress can be estimated from the depth of flow and the channel slope (see note for Table R-1). The riprap should extend 2 feet below the channel bottom and be keyed into the bank both at the upstream end and downstream end of the proposed work or reach.

Filter material

Filter material is sometimes used between riprap and the underlying soil surface to prevent soil from moving through the riprap. Filter cloth material or a layer of sand and/or gravel is usually used for the filter.

Construction specifications

Minor deviations from the following construction specifications are acceptable as long as performance oriented specifications are maintained. The performance oriented specification for riprap is that erosion is not observed on the area with riprap application and that sediment is not observed to leave the ripraped area. If erosion or sediment is observed, the riprap should be re-designed and/or re-installed.

See Figure R-2 for riprap slope stabilization and stream bank protection. See Figure R-3 for dry stacking boulders. See Sediment Trap (ST) for a detail of a riprap lined channel leading into a sediment trap.

1. Subgrade Preparation. Prepare the subgrade for riprap to the required lines and grades shown on the plans. Compact any fill required in the subgrade to a density approximating that of the undisturbed material or overfill depressions with riprap. Remove brush, trees, stumps, and other objectionable material. Cut the subgrade sufficiently deep so that the finished grade of the riprap will be at the elevation of the surrounding area. Channels should be excavated sufficiently to allow placement of the riprap in a manner such that the finished inside dimensions and grade of the riprap meet design specifications.
2. Sand/gravel filter blanket. If using a granular filter, spread filter stone in a uniform layer to the specified depth. Where more than one layer of filter material is used, spread the layers with minimal mixing.
3. Synthetic filter fabric. If using a filter fabric, place the cloth directly on the prepared foundation. Where large stones are to be placed, a 4-inch layer of fine sand or gravel is recommended to protect the filter cloth. Filter fabric is not recommended as a filter on slopes steeper than 2 horizontal to 1 vertical.

4. Stone placement. Place riprap so that it forms dense, well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement. Place riprap to its full thickness in one operation. Do not place riprap by dumping through chutes or other methods that cause segregation of stone sizes. If a filter is used, be careful not to dislodge the underlying base filter or damage the filter cloth when placing the stones. If damage occurs, remove the riprap and repair filter.
5. The toe of the riprap should be keyed into a stable foundation at its base as shown in Figure R-2 if required for slope stabilization and stream bank protection. The finished slope should be free of pockets of small stone or clusters of large stones. Hand placing may be necessary to achieve proper distribution of stone sizes to produce a relatively smooth, uniform surface. The finished grade of the riprap should blend with the surrounding area.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. If riprap has been damaged or dislodged, repairs should be made to prevent a progressive failure. If repairs are needed repeatedly at one location, the site should be evaluated to determine if the original design conditions have changed. Channel obstructions such as trees and sediment bars can change flow patterns and cause erosive forces that may damage riprap. Control of weed and brush growth may be needed in some locations.

Removal/Abandonment

Riprap is generally not removed.

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

Table R-1

Riprap Gradations

Unit shear stress (lb/ft^2)	D_{50}	d_{max}	Minimum blanket thickness (inches)
0.67	2	4	6
2	6	9	14
3	9	14	20
4	12	18	27
5	15	22	32
6	18	27	32
7.8	21	32	38
8	24	36	43

Unit shear stress calculated as T=y*d*s where:

T = shear stress in lb/ft^2

y = unit weight of water, 62.4 lb/ft^2

d = flow depth in ft

s = channel gradient in ft/ft

Figure R-1
Angles of Repose of Riprap Stones

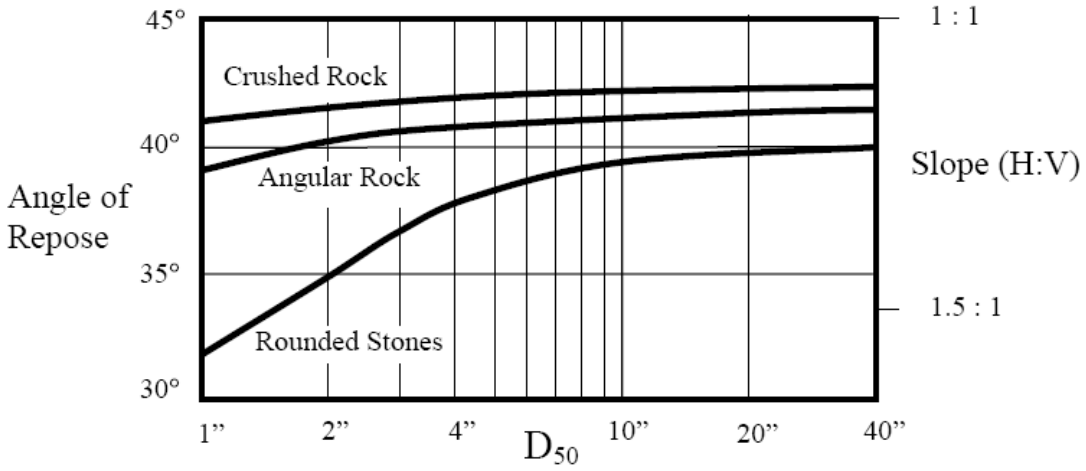


Figure R-2
Typical Riprap Slope Protection Detail

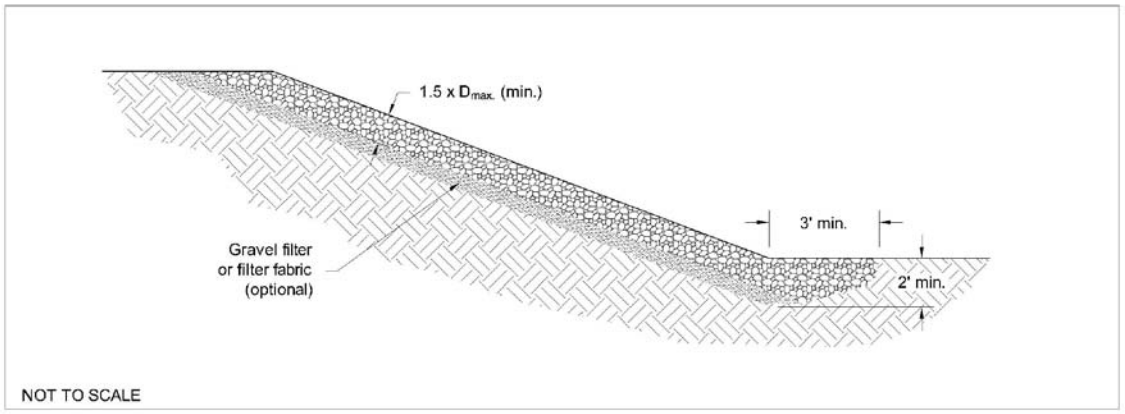
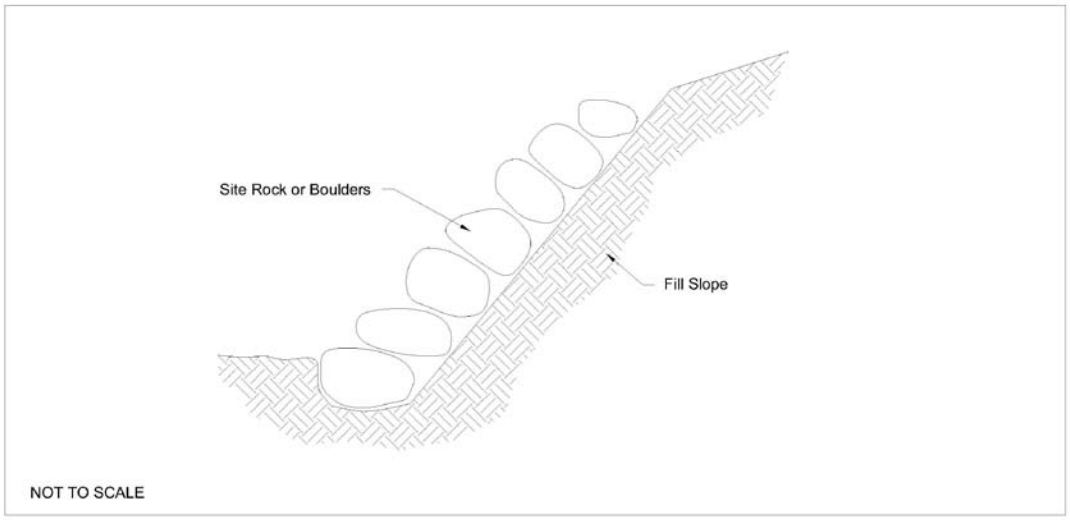


Figure R-3
Typical Boulder Drystack Detail



Soil Stabilizers (SS)

Specification Section 02340

Description

Soil stabilizers (also known as soil binders) consist of stabilizing emulsions that are applied directly to the surface of disturbed soil to temporarily reduce soil erosion. Soil binders are categorized as:

- Short-lived plant-based materials
- Long-lived plant-based materials
- Polymeric emulsion blends (acrylic polymers)
- Cementitious-based binders

Applicability

Soil binders are used on bare soil areas where vegetation may not be desired (such as near compressor stations and helicopter pads) in order to reduce soil loss. Soil binders are also suitable for use on stockpiles.

Limitations

- Soil binders are a temporary measure.
- Product must be reapplied 6-12 months after initial application.
- Soil binders may not be compatible with certain soils.
- Runoff can penetrate a treated area at the top of a slope, undercut the treated soil, and cause spot failures by discharging at a point further down the slope.
- Performance depends on temperature, humidity, and traffic across treated areas.

Design criteria

No formal design is required.

Construction specifications

1. Soil binder must be non-toxic to plant and animal life. Some examples include Guar, Starch, Pitch & Rosin Emulsion, Liquid Polymers of Methacrylates & Acrylates, and Gypsum. However, many others are available and may be used. Select a soil binder that is appropriate for the region, use and soil type.
2. Soil binder is typically mixed in a water truck or hydroseeder and applied in a liquid state. Use emulsion formulas for applications with water trucks.

3. Apply soil binder over a roughened soil surface on slopes not greater than 1H:1V. Do not apply immediately before or during a rain event or where standing water is present.
4. Soil binder can be applied in combination with organic fertilizers and humates, if desired.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect for rill erosion and reapply soil binder if necessary, usually every 6 to 12 months or when the surface has been disturbed.

References

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp

California Stormwater Quality Association, Stormwater Best Management Practice (BMP) Handbook – Construction. January, 2003. <http://www.cabmphandbooks.com/Construction.asp>

Subsoil Segregation (SubS)

Specification Section 02230

Description

Subsoil segregation during construction of well pads, pipelines, or roads involves the removal and stockpiling of all excess subsoil cut material separate from the removal and stockpiling of surface (topsoil) material. Topsoil handling shall be in accordance with the Topsoil Conservation and Segregation BMP.

Applicability

Subsoil segregation applies to the construction of all well pads, roads, pipelines, and any other construction activity where subsoil is temporarily stockpiled.

Limitations

- Stockpiling increases the overall area of disturbance at a site.
- Stockpiles often require revegetation and also require other erosion and sediment controls during the establishment of vegetation such as silt fences or diversions.

Design criteria

No formal design is required.

Construction specifications

Stockpile Location

1. Locate the stockpile so that it meets specifications and does not interfere with work on the site.
2. Stockpiles should be located and protected so that wind and water erosion are minimized and reclamation potential is maximized.
3. During the installation of pipelines, trench spoil will be stockpiled according to Figure SubS-1.

Subsoil excavation

1. Prior to subsoil excavation, all available topsoil shall be striped and stockpiled in accordance with the Topsoil Conservation and Segregation BMP.
2. All perimeter stormwater controls shall be in place prior to topsoil stripping and subsoil excavation.
3. Excavation shall be confined to the immediate construction areas.

Stockpiling

1. Soil shall be stockpiled in such a manner that natural drainage is not obstructed and no off-site sediment damage shall result.
2. Keep topsoil segregated and stored separately from subsoil materials to avoid mixing during construction, storage, and interim reclamation. Never place subsoil materials on top of topsoil material.
3. Side slopes of the stockpile shall not exceed 2:1.
4. Stockpiles should be tracked according to Surface Roughening (SR) and stabilized to prevent erosion and off-site sedimentation. Perimeter controls shall be placed around the stockpile immediately. This may involve a diversion to route sediment laden runoff to a stabilized outlet, a silt fence to capture sediments, or any other applicable stormwater perimeter control. Revegetation of the stockpile, according to Revegetation (RV), can help reduce erosion as well as maintain its biological viability.

Topsoiling during reclamation

Part of the reclamation process involves salvaging and reusing all available topsoil to spread over disturbed areas prior to revegetation. Reclamation measures should begin as soon as possible after the disturbance and continue until successful reclamation is achieved.

1. **Well pads – interim reclamation –** Minimize the footprint of disturbance by reclaiming all portions of the well site not needed for production operations. Re-spread topsoil over areas not needed for operations prior to revegetation.
2. **Well pads – final reclamation –** Where the topography is flat and it is, therefore, unnecessary to re-contour the well location at the time of final reclamation, the operator should set aside sufficient topsoil for final reclamation of the small, unreclaimed area around the wellhead. On sloped ground, during final reclamation, the topsoil and interim vegetation must be re-stripped from portions of the site that are not at the original contour, the well pad re-contoured, and the topsoil re-spread over the entire disturbed site to ensure successful revegetation.
3. **Roads – interim reclamation –** Reclaim portions of the road not needed for vehicle travel wherever possible by covering cut slopes, fill slopes, and borrow ditches with topsoil salvaged during road construction prior to revegetation.
4. **Pipelines – final reclamation –** Reclaim disturbed area on completion of pipeline installation. The stripped topsoil shall be re-spread over the entire ROW to ensure successful revegetation.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect for rills and other evidence of stockpile erosion. Also inspect perimeter stormwater controls in accordance with the appropriate BMP.

Removal/Abandonment

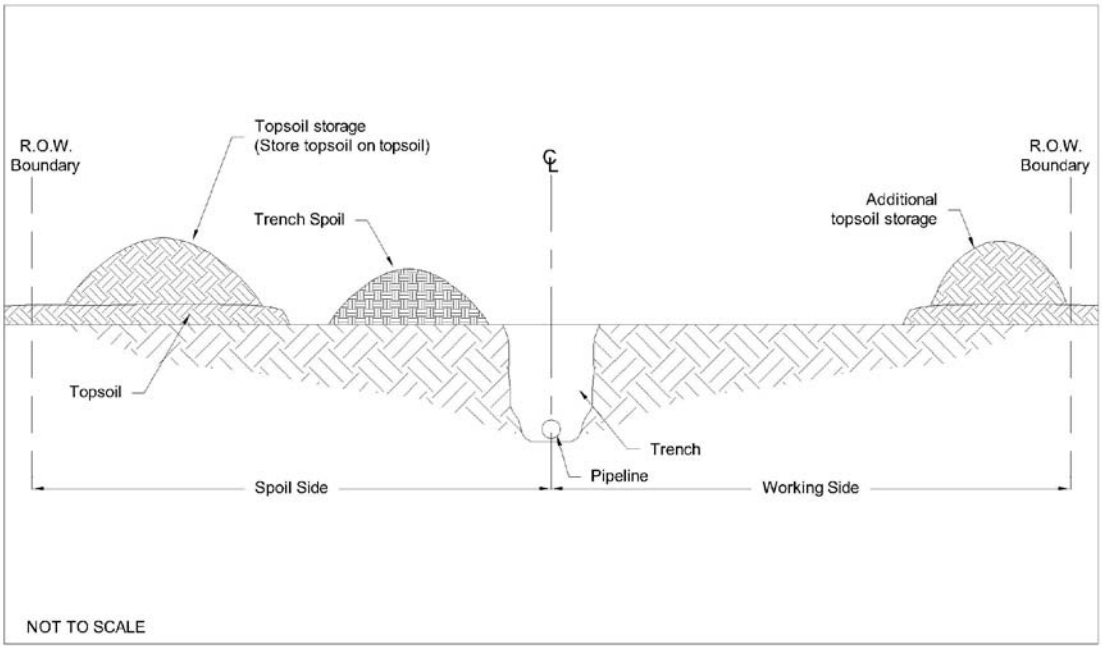
Stockpiles may be removed when the site is ready for interim or final reclamation.

References

United States Army Corps of Engineers (USACE), Engineering and Design - Handbook for the Preparation of Storm Water Pollution Prevention Plans for Construction Activities. February 1997.

United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book." BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Figure SubS-1
Stockpiling for Pipeline Installation



Surface Roughening (SR)

Corrugating/Furrowing

Tracking

Minibenching

Pocking

Description

Surface (soil) roughening is a temporary erosion control practice often used in conjunction with grading. Soil roughening involves increasing the relief of a bare soil surface using construction equipment. Slopes that are not fine graded and that are left in a roughened condition can reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares the soil for seeding and planting by giving seed an opportunity to take hold and grow. The following types of soil roughening are discussed in this BMP:

- Corrugating/Furrowing
- Tracking
- Minibenching
- Pocking

Applicability

Soil roughening is most effective for areas of 1 acre or less, and works well for the following applications:

- Any slope, but particularly fill slopes greater than 3:1
- Areas with highly erodible soils
- Soils that are frequently disturbed
- Prior to application of permanent or temporary seeding
- Adjacent to roadways as “irrigating” furrows to divert runoff away from roads

Limitations

- Soil roughening is not appropriate for rocky slopes.
- Soil compaction might occur when roughening with tracked machinery.
- Soil roughening is of limited effectiveness in anything more than a gentle or shallow depth rain.
- If roughening is washed away in a heavy storm, the surface will have to be re-roughened and new seed laid.

Design criteria

No formal design required. However, the selection of the appropriate method (corrugating or tracking) depends on the type of slope. Steepness, mowing requirements, and/or a cut or fill slope operation are all factors considered in choosing a roughening method.

Construction specifications

To slow erosion, roughening should be done as soon as possible after grading activities have ceased (temporarily or permanently) in an area. All cut and fill slopes should be roughened wherever possible. Do not blade or scrape the final fill slope face. Excessive compacting of the soil surface should be avoided during roughening, and areas should be seeded as quickly as possible after roughening is complete.

Corrugating/Furrowing

Corrugating/furrowing (Figure SR-1) uses machinery to create a series of ridges and depressions that run across the slope on the contour. Groove using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth of a front-end loader bucket. Do not make the grooves less than 3 inches deep or more than 15 inches apart. Corrugations/furrows may be used adjacent to roadways to divert runoff away from roads.

Tracking

Tracking is the most common method of soil roughening and is sometimes used as a method to hold down mulch. However, tracking is generally not as effective as corrugating. Tracking should be used primarily in sandy soils to avoid undue compaction of the soil surface. Operate tracked machinery up and down the slope to leave horizontal depressions in the soil (Figure SR-2). Tracking may also be performed with a sheep's foot compactor. Do not back-blade during the final grading operation.

Minibenching

Benches shall be constructed on an even contour line. Benches shall be constructed approximately 2 feet deep and according to Figure SR-3.

Pocking

Pocking is performed with a backhoe as shown in the photo at the beginning of this section.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Roughening might need to be repeated after storm events. Inspections of roughened slopes will indicate where additional erosion and sediment control measures are needed. If rills appear, they should be filled, graded again, and reseeded as soon as possible. Proper dust control methods should be used.

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

Figure SR-1
Corrugating

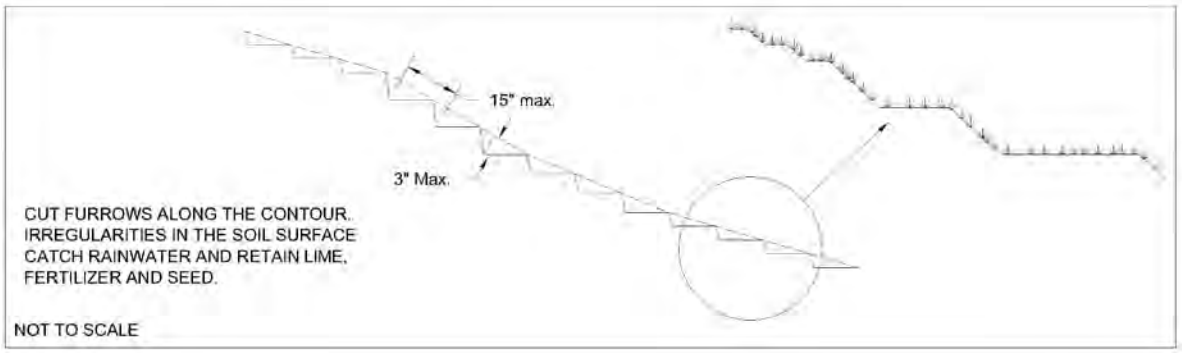


Figure SR-2
Tracking

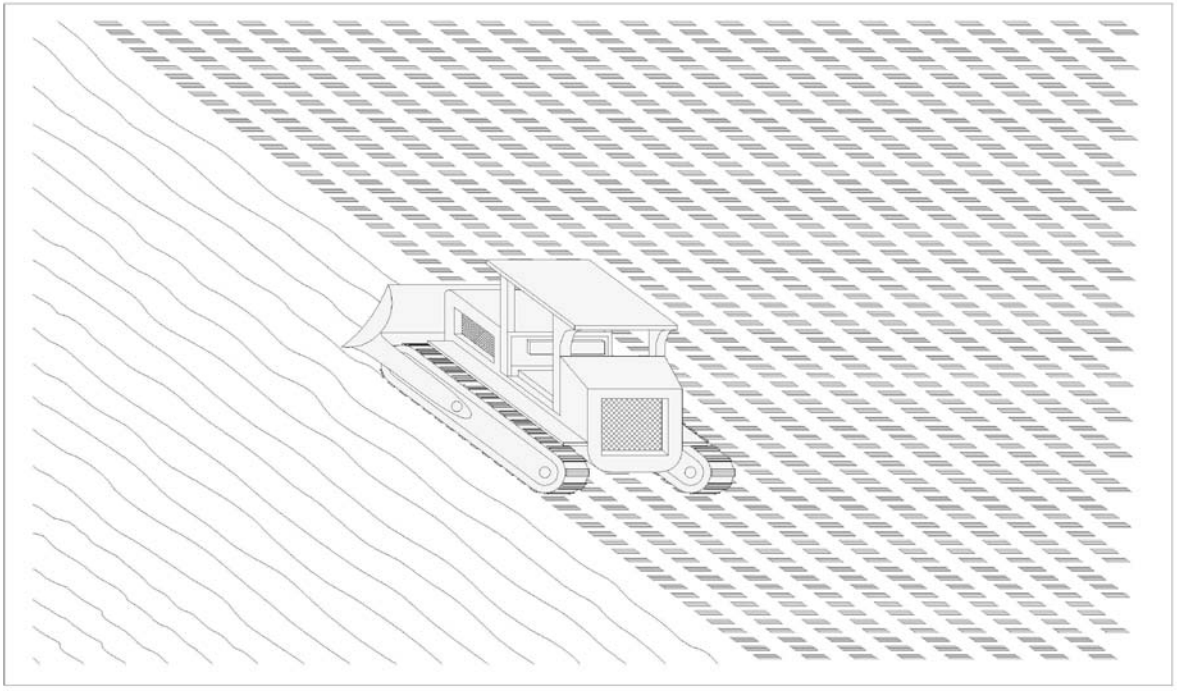
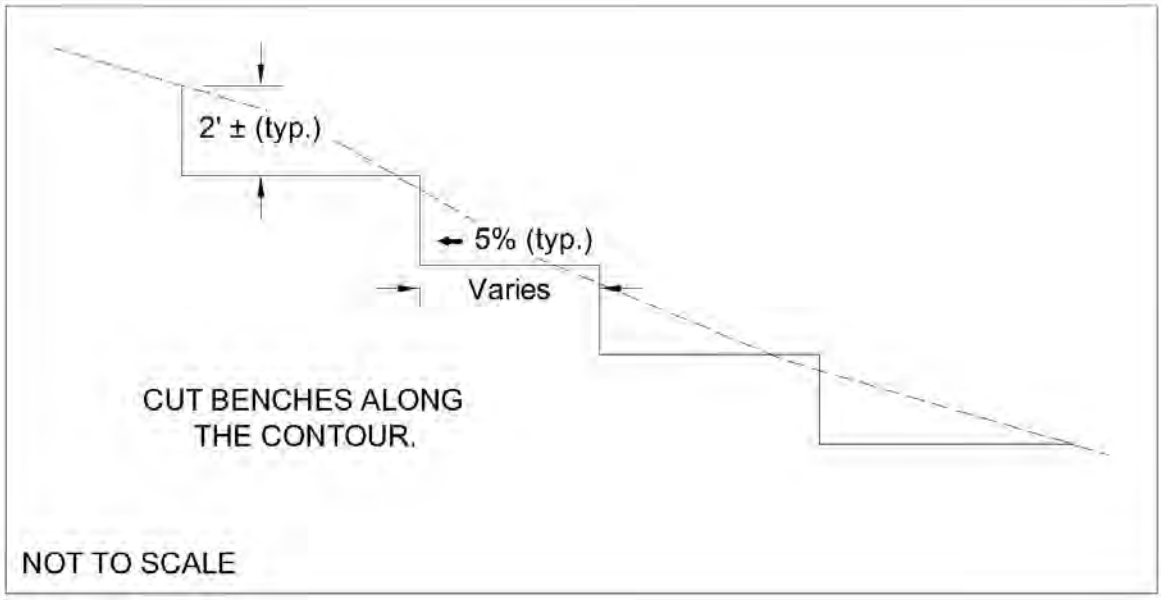


Figure SR-3
Minibenching



Terracing (T)

Specification Section 02310

Description

Terraces (also called benches or contour trenches) are properly spaced along a cut or fill slope and made of either earthen embankments, ridge and channel systems, or are cut directly into a rock face of a cut slope. Terraces are often constructed with an adequate grade to promote drainage to a stabilized outlet. Terraces reduce damage from erosion by collecting and redistributing surface runoff to stable outlets at slower speeds and by decreasing the distance of overland runoff flow. They also surpass smooth slopes in holding moisture and help to minimize sediment loading of surface runoff. When terraces are constructed into steep bedrock faces they help to stabilize the slope by catching loose rocks and other material which may fall from above.

Applicability

Terraces are most effective for areas less than 10 acres in size and, are suitable for the following applications:

- Areas with an existing or expected water erosion problem and no vegetation.
- Cut or fill slopes greater than 5 feet in height, which are not part of a trench or excavation.
- Graded areas with smooth hard surfaces or any cleared area prior to seeding.
- Where the length of slopes need to be shortened by terracing.
- On steep rock walls, particularly those greater than 60 feet in height.

Limitations

- Terraces are not appropriate for use on sandy or shallow soils.
- If too much water permeates the soil in a terrace system, sloughing could occur, and cut and fill costs could increase substantially.

Design criteria

The design of terraces should be determined by a civil engineer based upon actual site conditions.

Construction specifications

In the absence of a specific design, terraces may be constructed according to Figure T-1 for cut slopes and Figure T-2 for fill slopes.

1. Construct diversion ditches at the top of the slope (if necessary for large upslope drainage areas) to prevent or reduce surface water from running down the slope face.
2. The upper terrace should begin immediately below the top of the fill slope. Continue constructing terraces down to the toe of the slope. Terraces shall be a minimum of 6 feet wide. However, a minimum width of 8 feet is ideal so that a crimper has access for mulching.
3. Space terraces according to the following:

Slope	Vertical distance between terraces
2:1	15-25 feet
3:1	25-35 feet
4:1	35-45 feet

4. Terraces must drain to a stabilized outlet, such as a stabilized waterway, vegetated area, or other suitable outlet. Slope drains may be needed to convey surface runoff from the terraces or benches to the toe of the slope without causing erosion. Analysis of the local site conditions should determine the needed outlets.
5. Remove the loose material that collects at the end of terraces or benches and blend the ends of each terrace or bench into the natural ground surface.
6. Stabilize or revegetate the slope with methods applicable to the particular site.

For terraces constructed into high rock walls of cut slopes, the vertical spacing may be anywhere from 10 to 100 feet and the width anywhere from 6 to 100 feet, as determined by a civil engineer.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Maintain terrace ridge height and outlet elevations. Remove sediment that has accumulated in the terrace to maintain capacity and a positive channel grade. If excessive seepage or surface runoff is a problem, control the seepage/runoff with appropriate drainage facilities. Take prompt action as needed to ensure proper drainage and slope stability. Repair rills and reseed damaged areas as they develop. Substantial maintenance of the newly planted or seeded vegetation may be required.

References

City of Knoxville, Stormwater Engineering, Knoxville BMP Manual - Best Management Practices. July 2003. http://www.ci.knoxville.tn.us/engineering

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Field Office Technical Guide. 2002. <www.nrcs.usda.gov/technical/efotg>

Figure T-1
Terracing – Cut Slopes

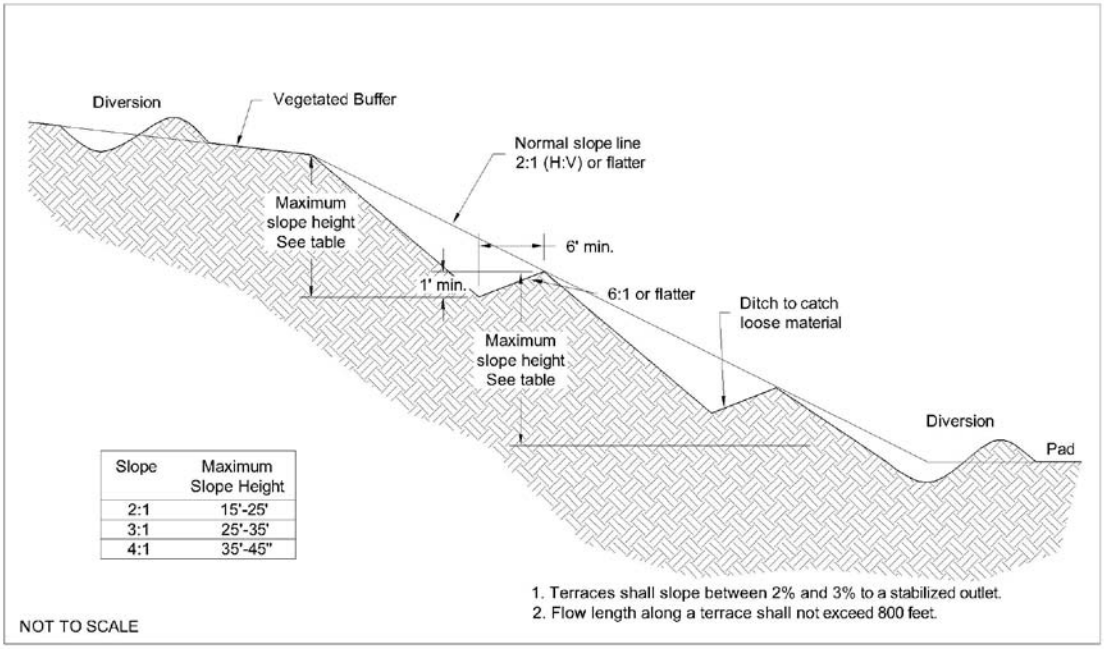
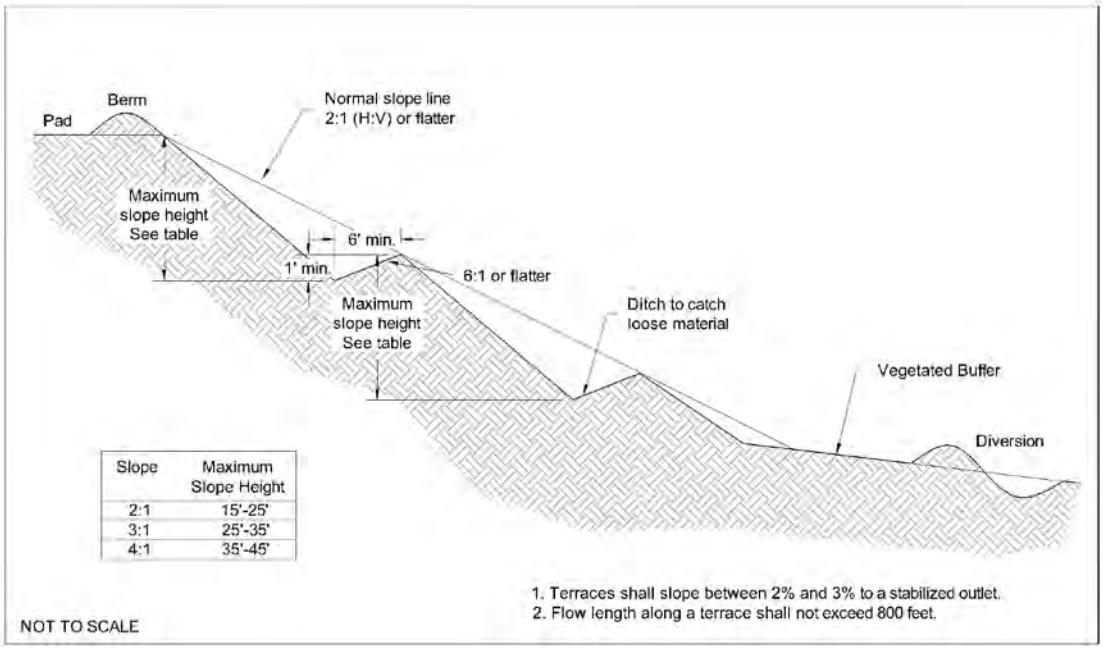


Figure T-2
Terracing – Fill Slopes



Topsoil Conservation and Segregation (TopS) Specification Section 02230

Description

Topsoil conservation and segregation during construction of well pads, pipelines, or roads involves the removal and stockpiling of all surface soil materials from the entire cut and fill area for later reuse during interim and final reclamation. Topsoil provides a planting and growth medium that is more desirable than deeper subsoils for use during reclamation and revegetation activities.

If there is an excess of cut material, subsoil may also be stockpiled in accordance with the Subsoil Segregation BMP.

Applicability

Topsoil conservation and segregation applies to the construction of all well pads, roads, pipelines, and any other construction activity where soil is disturbed and later revegetated.

Limitations

- Stockpiling increases the overall area of disturbance at a site.
- Stockpiles often require revegetation and also require other erosion and sediment controls during the establishment of vegetation such as silt fences or diversions.
- Topsoil conservation and segregation required planning and coordination.

Design criteria

No formal design is required.

Construction specifications

Stockpile Location

1. Locate the stockpile so that it meets specifications and does not interfere with work on the site.
2. Stockpiles should be located and protected so that wind and water erosion are minimized and reclamation potential is maximized.
3. Stockpiles located down slope of a well pad will serve as a diversion and/or a detention pond (tertiary spill containment) during storm events. See Figure TopS-1.
4. Stockpiles located upslope of a well pad will serve as a berm to divert surface runoff around the site and to a stabilized outlet. See Figure TopS-2.

5. Stockpiles should ideally be located in all directions around the perimeter of a well pad as shown in the attached Figure TopS-3. Stockpile should be tracked/compacted into a stable landform with a convex ridge and a concave toe. Stockpile should then be seeded and/or mulched.
6. During the installation of pipelines, soil will be stockpiled according to Figure TopS-4. Topsoil should be compacted, if possible, and scheduling should limit the time of exposure.

Topsoil stripping

1. All perimeter stormwater controls shall be in place prior to stripping topsoil.
2. Stripping shall be confined to the immediate construction areas.
3. The depth of topsoil to be stripped and stockpiled should be determined during an on-site inspection prior to the start of any excavation activity, but is commonly at least 4 to 6-inches.

Topsoil segregation and stockpiling

1. Soil shall be stockpiled in such a manner that natural drainage is not obstructed and no off-site sediment damage shall result.
2. Keep topsoil segregated and stored separately from subsoil materials to avoid mixing during construction, storage, and interim reclamation. Never place subsoil materials on top of topsoil material.
3. Side slopes of the stockpile shall not exceed 2:1.
4. Stockpiles should be tracked according to Surface Roughening (SR) and stabilized to prevent erosion and off-site sedimentation. Perimeter controls shall be placed around the stockpile. This may involve a diversion to route sediment laden runoff to a stabilized outlet, a silt fence or wattle to capture sediments, or any other applicable stormwater perimeter control. Revegetation of the stockpile, according to Revegetation (RV), can help reduce erosion as well as maintain its biological viability.

Topsoiling during reclamation

Part of the reclamation process involves salvaging and reusing all available topsoil to spread over disturbed areas prior to revegetation. Reclamation measures should begin as soon as possible after the disturbance and continue until successful reclamation is achieved.

1. **Well pads – interim reclamation –** Minimize the footprint of disturbance by reclaiming all portions of the well site not needed for production operations. Re-spread topsoil over areas not needed for operations prior to revegetation.
2. **Well pads – final reclamation –** Where the topography is flat and it is, therefore, unnecessary to re-contour the well location at the time of final reclamation, the operator should set aside sufficient topsoil for final reclamation of the small, unreclaimed area around the wellhead. On sloped ground, during final reclamation, the topsoil and interim vegetation must be re-stripped from portions of the site that are not at the original contour, the well pad re-contoured, and the topsoil re-spread over the entire disturbed site to ensure successful revegetation.
3. **Roads – interim reclamation –** Reclaim portions of the road not needed for vehicle travel wherever possible by covering cut slopes, fill slopes, and borrow ditches with topsoil salvaged during road construction prior to revegetation.
4. **Pipelines – final reclamation –** Reclaim disturbed area on completion of pipeline installation. The stripped topsoil shall be re-spread over the entire ROW to ensure successful revegetation.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect for rills and other evidence of stockpile erosion. Also inspect perimeter stormwater controls in accordance with the appropriate BMP.

Removal/Abandonment

Stockpiles may be removed when the site is ready for interim or final reclamation.

References

United States Army Corps of Engineers (USACE), Engineering and Design - Handbook for the Preparation of Storm Water Pollution Prevention Plans for Construction Activities. February 1997.

United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book." BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Figure TopS-1

Topsoil Stockpile – Located Below Well Pad

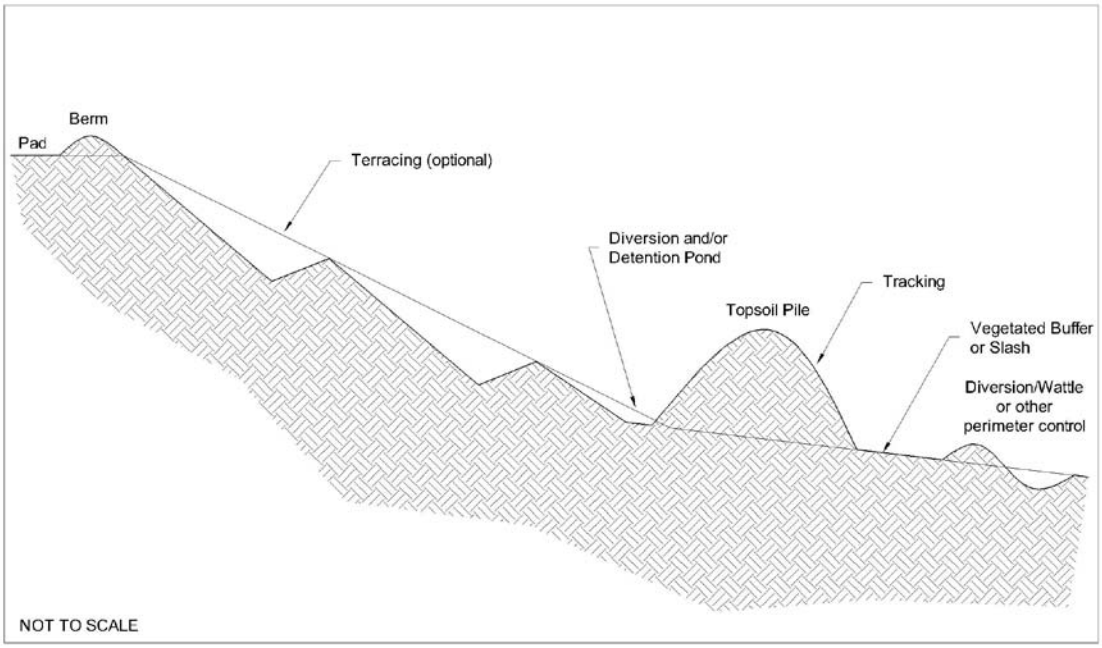


Figure TopS-2
Topsoil Stockpile – Located above Well Pad

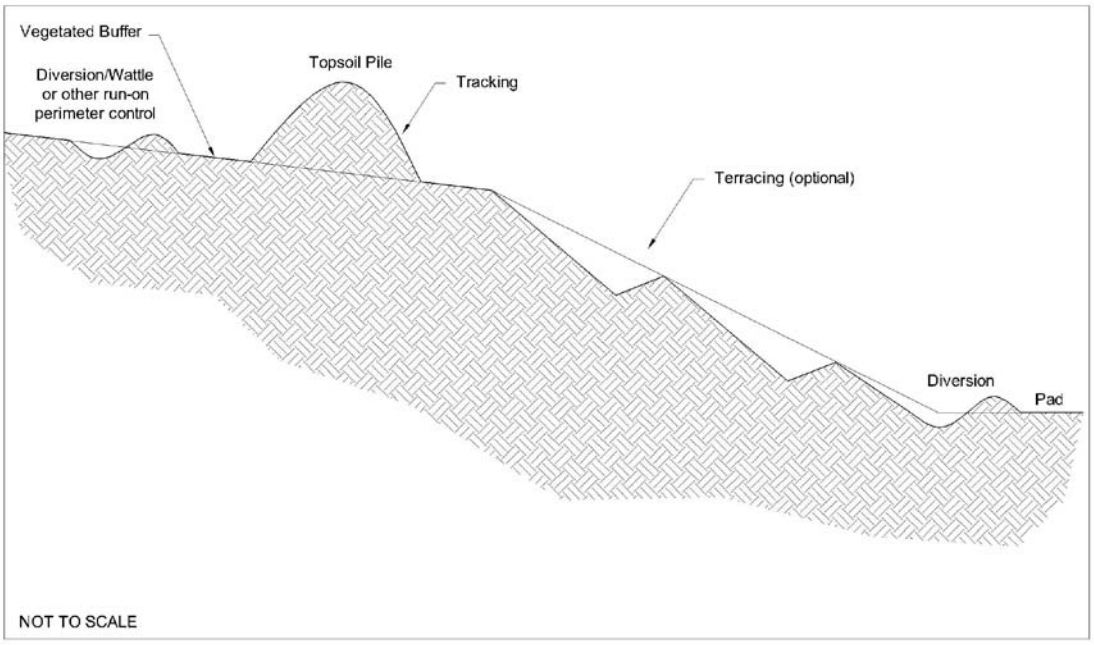


Figure TopS-3
Topsoil Stockpile – Plan View

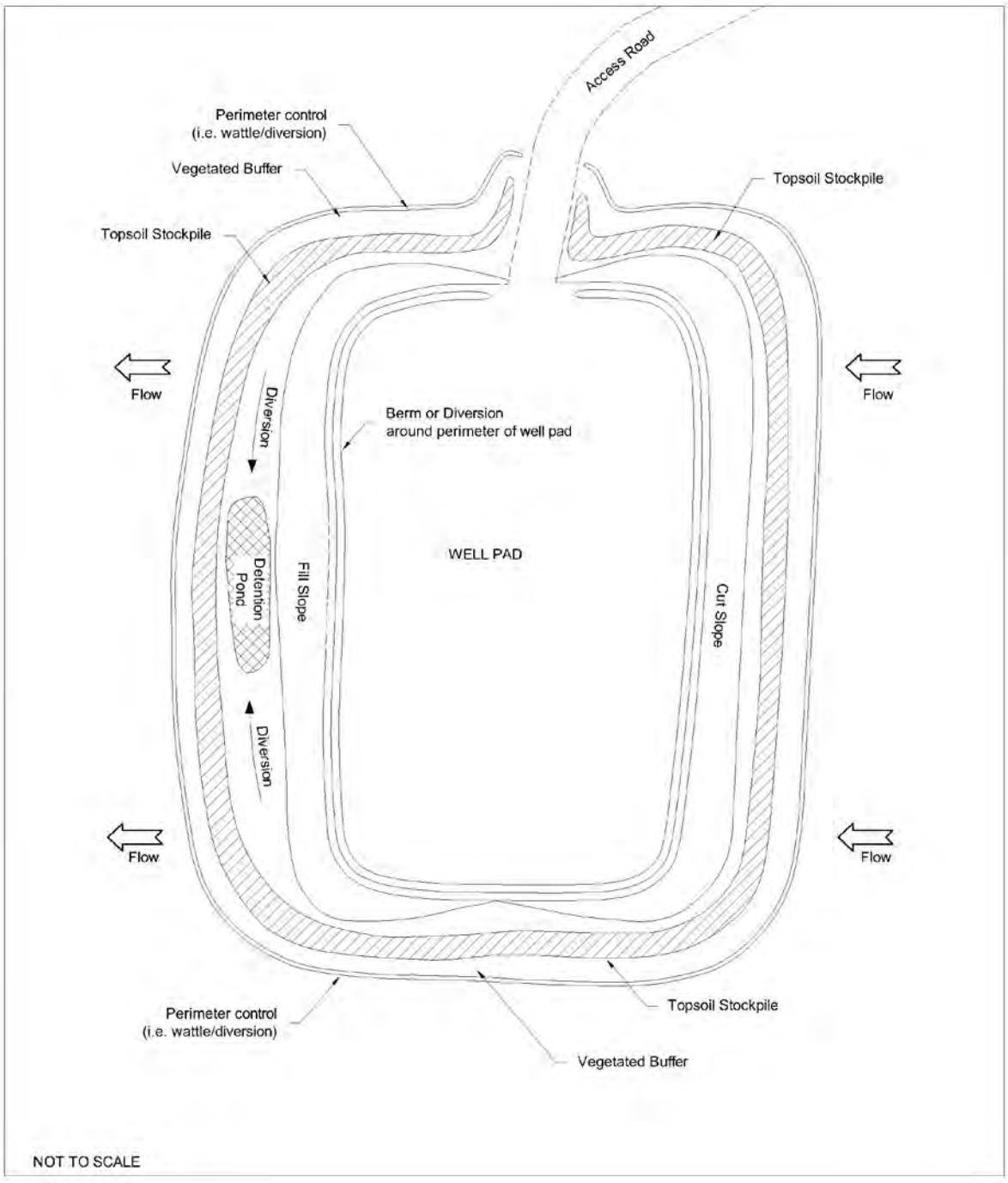
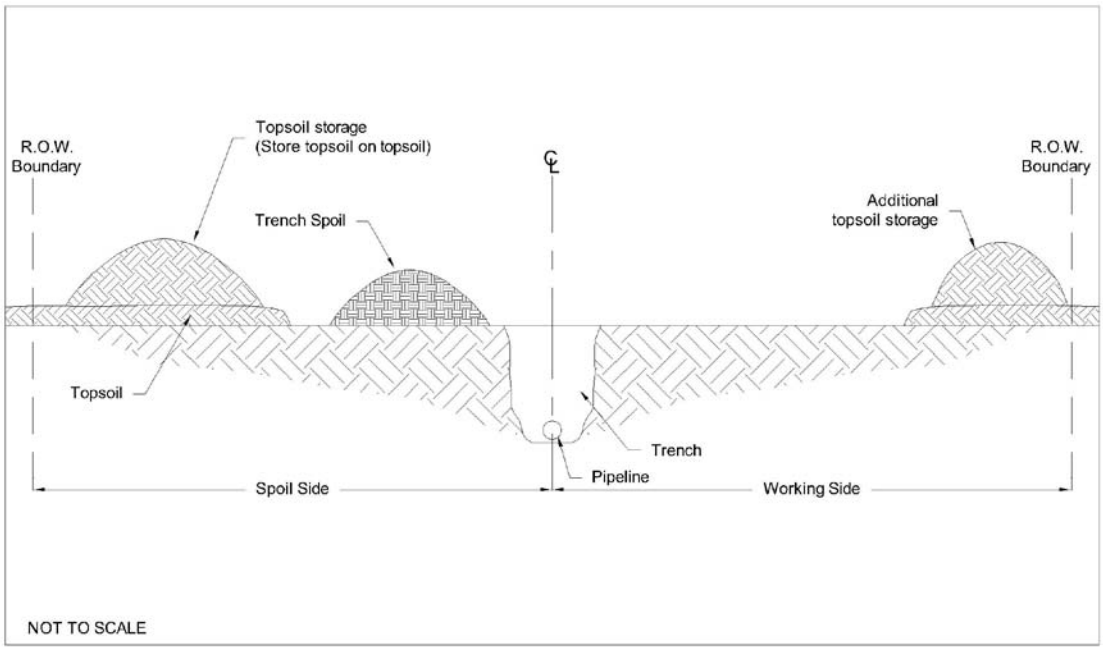


Figure TopS-4
Topsoil Stockpile for Pipeline Installation



Turf Reinforcement Mat (TRM)

Description

A turf reinforcement mat (TRM) is a rolled permanent erosion control product composed of UV-stabilized, non-degradable, synthetic materials (which may include an organic, biodegradable fiber component) processed into a three-dimensional matrix. TRMs are typically installed in ditches, swales, channels, and slopes where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation to prevent erosion.

Applicability

TRMs may be used in the following applications:

- To control erosion on steep slopes and to promote the establishment of vegetation.
- To stabilize channels against erosion from concentrated flows.
- Used in transition areas before and after hard armor (i.e., riprap, concrete, asphalt etc.) to provide for stable and non-erosive transition.
- May be used on slopes steeper than 1:1.

Limitations

- In an unvegetated state, velocities should not exceed 14 ft/sec maximum or the limitations provided by the manufacturer.
- In a vegetated state, velocities should not exceed 25 ft/sec maximum or the limitations provided by the manufacturer.
- Maximum slope is dictated by the soil stability and above referenced limited velocity and shear stress limitations.
- Soils must be conducive to the establishment of vegetation.

Design criteria

No formal design is required.

Construction specifications

1. All vegetation, roots, rocks, and other objectionable material shall be removed and disposed of so as not to create loss of soil contact by the TRM when installed.
2. Select the appropriate TRM. North American Green Products are listed in Table TRM-1. However, other products, such as Green Armor (www.greenarmorsystem.com) may also be used. Site specifics shall dictate TRM use.
3. Select the appropriate seed mix according to the Revegetation (RV) BMP. Apply seed prior to fabric installation for stabilization of construction sites.
4. Installation of the blankets shall be in accordance with the manufacturer's recommendations or according to Figure TRM-1. For blankets being placed in channels, the fabric should be rolled out parallel to the channel if the width is sufficient to cover the entire width of the channel. The fabric needs to be in continuous contact with exposed soil.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspections should determine if cracks, tears, or breaches have formed in the fabric. If the effectiveness of the BMP has been reduced, the fabric should be repaired or replaced immediately. Re-anchor loosened matting and replace missing matting and staples as required. It is necessary to maintain contact between the ground and the blanket at all times.

References

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

North American Green, 2004. http://www.nagreen.com

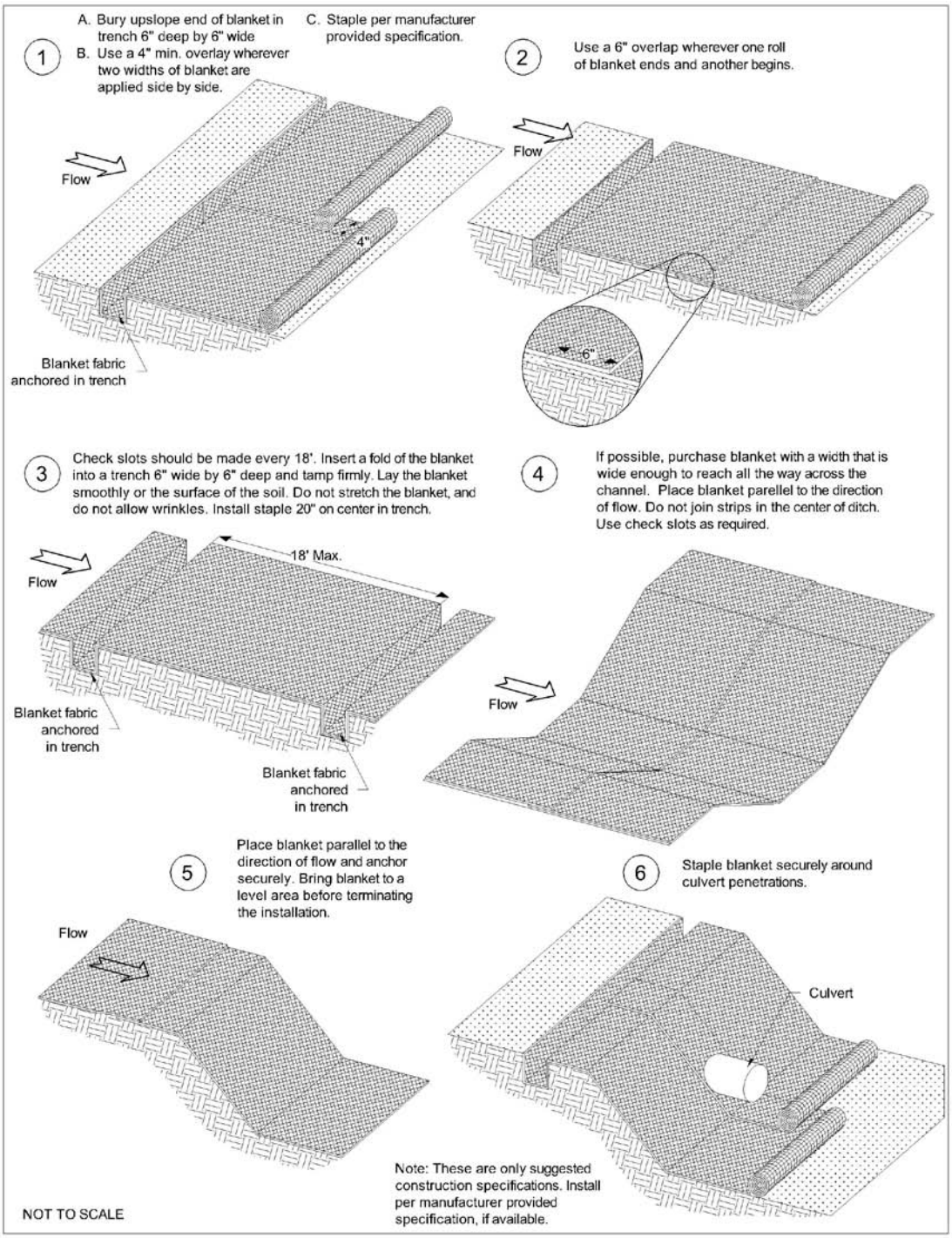
Table TRM-1

Suggested Blanket Types

Description (North American Green Product #)	**Longevity**	**Applications**	**Max. Flow Velocity (feet/sec.)**
Three UV Stable Nets Top Net 5 Ib. Black Corrugated Center Net 24 Ib. Black Bottom Net 5 Ib. Black 70% Straw / 30% Coconut Matrix Material (SC250)	24 month grow-in period	1:1 & Greater Slopes Medium to High Flow Channels	9.5 (unveg.) 15 (veg.)
Three UV Stable Nets Top Net 8 Ib. Black Corrugated Center Net 24 Ib. Black Bottom Net 8 Ib. Black 100% Coconut Fiber Matrix Material (C350)	36 month grow-in period	1:1 & Greater Slopes High Flow Channels	10.5 (unveg.) 20 (veg.)
Three UV Stable Nets Top Net 24 Ib. Black Corrugated Center Net 24 Ib. Black Bottom Net 24 Ib. Black 100% Polypropylene Fiber Matrix Material (P550)	36 month grow-in period or when sparse vegetation stand is expected	1:1 & Greater Slopes Extreme High Flow Channels	12.5 (unveg.) 25 (veg.)

Figure TRM-1

Turf Reinforcement Mat Installation



Vegetated Buffer (VB)

Specification Section 02900

Description

Vegetated buffers (also known as vegetated filter strips) are areas of either natural or established vegetation that are maintained to protect the water quality of neighboring areas. Buffers reduce the velocity of stormwater runoff, provide an area for the runoff to permeate the soil, contribute to groundwater recharge, and act as filters to catch sediment. The reduction in velocity also helps to prevent soil erosion.

The use of existing natural vegetation is preferred over newly established vegetation for the following reasons:

- Can process higher quantities of stormwater runoff than newly seeded areas.
- Does not require time to establish.
- Has a higher filtering capacity than newly planted vegetation because aboveground and root structures are typically denser.
- Reduces stormwater runoff by intercepting rainfall, promoting infiltration, and lowering the water table through transpiration.
- Provides a fully developed habitat for wildlife.

Applicability

Vegetated buffers can be used in any area that is able to support vegetation but they are most effective and beneficial on floodplains, near wetlands, along streambanks, and as stabilized outlets to runoff controls such as diversions, water bars, or culverts. Buffers are also effective in separating land use areas that are not compatible and in protecting wetlands or water bodies by displacing activities that might be potential sources of non-point source pollution.

Limitations

- Vegetated buffers should be within the permitted area on Encana owned land.

- Vegetated buffers require plant growth before they can be effective, and land on which to plant the vegetation must be available.
- Although vegetated buffers help to protect water quality, they usually do not effectively counteract concentrated stormwater flows to neighboring or downstream wetlands.

Design criteria

No formal design is required.

Construction specifications

1. Vegetated buffers should be within the permitted area on Encana owned land.
2. Buffer widths should be determined after careful consideration of slope, vegetation, soils, depth to impermeable layers, runoff sediment characteristics, type and quantity of stormwater pollutants, and annual rainfall. Buffer widths should increase as slope increases.
3. Zones of vegetation (native vegetation in particular), including grasses, deciduous and evergreen shrubs, and understory and overstory trees, should be intermixed.
4. Fertilizing seeded or planted ground may enhance growth (and improve its effectiveness as a buffer).
5. When using naturally vegetated areas, vegetation should be marked for preservation before clearing activities begin. Barriers may be used to prevent the approach of equipment within protected areas.
6. Direct sediment-laden water onto the naturally vegetated or stabilized planted ground.
7. Do not place any equipment, construction debris, or extra soil in the buffer area.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Keeping vegetation healthy in a recently established buffer requires routine maintenance, which (depending on species, soil types, and climatic conditions) may include weed control, fertilizing, liming, and irrigating. Once established or if using a naturally vegetated area, buffers do not require much maintenance beyond repairing or replacing damaged vegetation. Inspections should focus on encroachment, gully erosion, density of vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If there is more than 6 inches of sediment in one place, it should be removed.

Removal/Abandonment

During final site cleanup, any barriers placed around preserved natural areas should be removed.

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Drainage Control BMPs

Berm (B)
Culvert (C)
Diversion (D)
Drainage Dip (DD)
Pipeline Water Crossing (PWC)
Roadside Ditches (RSD)
Slope Drain (SD)
Swale (S)
Trench Breakers (TB)
Water Bar (WB)
Wing Ditch (WD)

Berm (B)

Specification Section 01570/02310/02370

Description

A berm is a ridge of compacted soil located at the top or base of a sloping disturbed area to contain or divert surface runoff. Berms may be constructed from either excavated topsoil or subsoil.

The purpose of a berm is to control runoff velocity, divert on-site surface runoff to a sediment trapping device, and/or divert clean water away from disturbed areas.

Applicability

Berms are usually appropriate for drainage basins smaller than 5 acres, but with modifications they can be capable of servicing areas as large as 10 acres. With regular maintenance, earthen berms have a useful life span of approximately 18 months. Berms are applicable for the following applications:

- At the perimeter of a well pad (particularly the outer edge) to ensure that runoff remains on the pad and is diverted to a well pad detention pond, if available. See Detention Pond (DP).
- Along the outside shoulder of an insloped road to ensure that runoff from the roadway drains inward and to protect the fill slope from continual disturbances during road blading and maintaining. See Land Grading (LG) – Roads.
- Upslope of cut or fill slopes to divert flows away from disturbed areas.
- As a toe berm down-slope of cut or fill slopes to divert on-site runoff to a stabilized outlet or sediment trapping device, although diversions are more commonly used for this application. See Diversion (D).
- As temporary slope breakers to reduce runoff velocity and divert water off the construction right-of-way.
- On well-pads for secondary containment.
- As a windrow lip along pipelines and roadways.
- At the Pad Access Road Interface (PARI) to prevent stormwater from leaving or coming onto sites where the access road connect with the well pad or other facility.

Limitations

- Berms may erode if not properly compacted and stabilized with vegetation or an erosion control blanket. Berms which are adjacent to concentrated flows will require erosion blanketing according to Erosion Control Blanket (ECB).
- If a berm crosses a vehicle roadway or entrance, its effectiveness can be reduced. Wherever possible, berms should be designed to avoid crossing vehicle pathways.

Design criteria

No formal design is required.

Construction specifications

1. Prior to berm construction, remove all trees, brush, stumps, and other objects in the path of the berm and till the base of the berm before laying the fill. Fill may consist of topsoil or subsoil excavated during the construction of nearby roads or well pads. If fill material is excavated adjacent to berm, follow the specification for Diversion (D).
2. Construct the berm according to Figure B-1 for the appropriate application. For points where vehicles will cross the berm, the side slope should be no steeper than 3:1 and the mound may be surfaced with gravel. This will prolong the life of the berm and increase effectiveness at the point of vehicle crossing. For well pad perimeter installation the pad side of the berm should be sloped at 1.5:1 to help prevent vehicles from backing over the edge of the pad.
3. To remain effective, berms may be compacted with tracked equipment, if possible.
4. Most (but not all) berms will have positive drainage to a stabilized outlet so that runoff does not collect in ponds on the upslope side of the berm, but instead flows along the berm until it reaches a stabilized outlet. Field location should be adjusted as needed. Stabilized outlet may be a well-vegetated area, a well pad detention pond, or a sediment control such as a silt fence or a sediment trap where sediment can settle out of the runoff before being discharged to surface waters.
5. If the expected life span of the berm is greater than 15 days, it is recommended that the berm be stabilized with vegetation or an erosion control blanket immediately after construction. Stabilization is required where concentrated flows are expected.
6. Berms should be constructed and fully stabilized prior to commencement of major upslope land disturbance. This will maximize the effectiveness of the structure as a stormwater control device.
7. If using berms as temporary slope breakers to reduce runoff velocity, space the berms according to the following table:

Slope (%)	Spacing (feet)
5 – 15	250-350
>15 – 30	150-250
>30	50-150

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Berms should be inspected for evidence of erosion or deterioration to ensure continued effectiveness. Berms should also be maintained at the original height. Any decrease in height due to settling or erosion, which impacts the effectiveness of the BMP, should be repaired immediately.

Removal/Abandonment

Berms should remain in place and in good condition until all upslope disturbed areas are permanently stabilized. There is no need to formally remove the berm on completion of stabilization until interim or final reclamation.

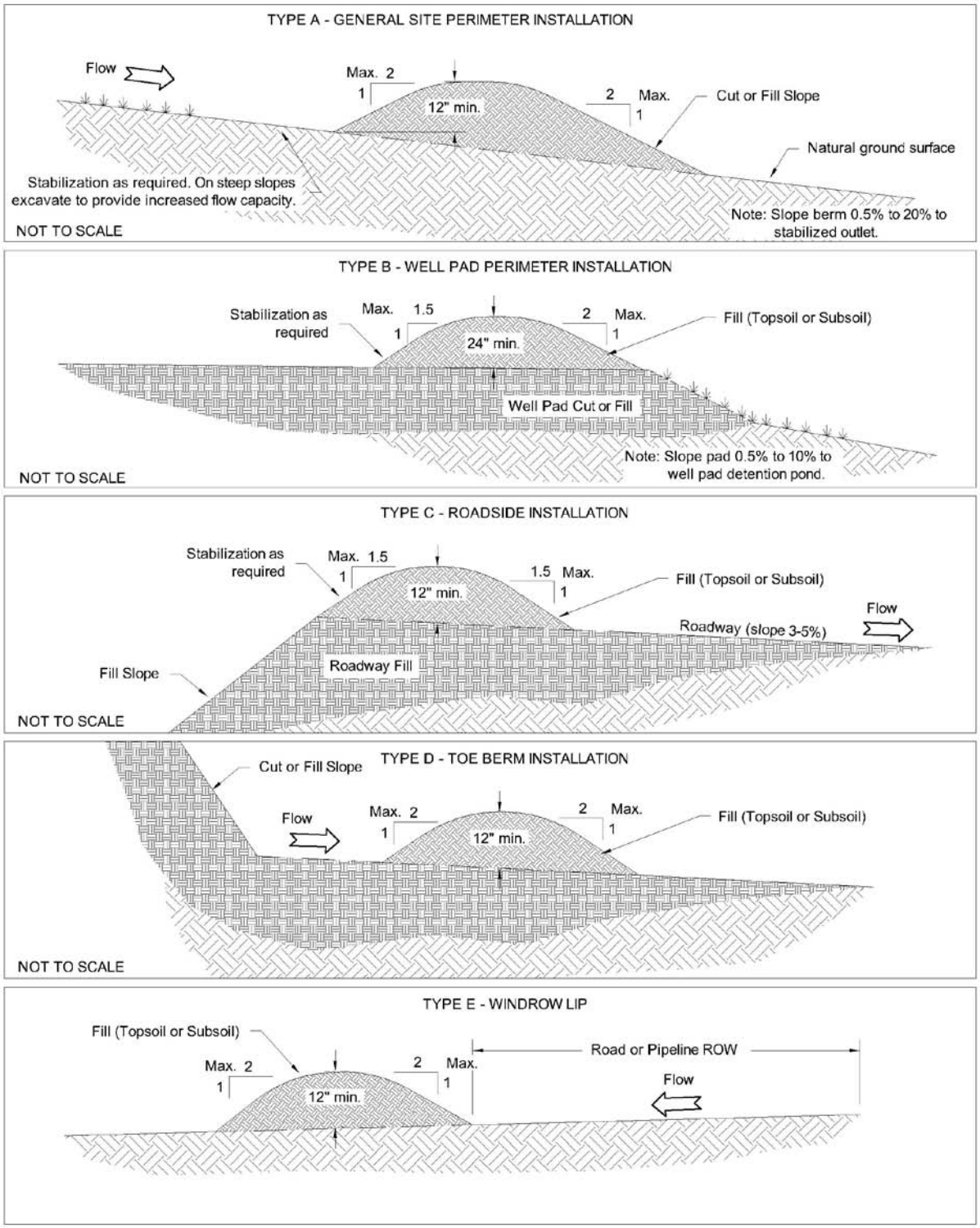
References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

Figure B-1

Berm Installation



Culvert (C)

Specification Section 02610




Description

Culverts are typically concrete, steel, aluminum, or plastic pipe used to move ditch water under the road or to direct stream flow under the road or construction area.

Culvert protection is required at both the inlet to the culvert (upstream side) and the outlet to the culvert (downstream side).

Culvert inlet protection may involve placing boulders, riprap, gabions, rock retaining walls, slash, and/or any other protection at the inlets of pipes. Riprap, or other energy-dissipating devices, will reduce the velocity of stormwater flows and thereby prevent erosion and help protect the inlet structure.

Culvert outlet protection involves placing structurally lined aprons or other appropriate energy-dissipating devices, such as large boulders or plunge pools, at the outlets of pipes to reduce the velocity of stormwater flows and thereby prevent scouring at stormwater outlets, protect the outlet structure, and minimize potential for erosion downstream.

Applicability

Culverts are ideal on road grades less than 15%. For grades over 15%, it is difficult to slow down the water or remove it from the road surface rapidly. On such steep grades, it is best to use frequently spaced relief culverts and drainage crossing culverts with armored ditches. Culverts may be used in the following applications:

- As drainage crossing culverts in streams and gullies to allow normal drainage to flow under the traveled way.
- As ditch relief culverts to periodically relieve the inside ditch line flow by piping water to the opposite side of the road where the flow can be dispersed away from the roadway. Culverts placed in natural drainages may be utilized for ditch relief.
- In other areas, as needed, to direct runoff under roadways.

Riprap inlet protection should be used where velocities and energies at the inlets of culverts are sufficient to erode around the inlet structure. Riprap may also be used to help channel the stormwater to the inlet of the culvert.

Culvert outlet protection should be used where discharge velocities and energies at the outlets of culverts or channels are sufficient to erode the next downstream reach.

Limitations

- If undersized, culverts are susceptible to plugging and require cleaning.
- Culverts will not filter sediment.
- Culverts are easily crushed if not properly designed.
- Rock aprons at culvert outlets should not be placed on slopes steeper than 10 percent. Runoff from pipe outlets at the top of cuts/fills or on slopes steeper than 10 percent should be routed via slope drains or riprap chutes to a rock apron at the toe of the slope. Otherwise flows will re-concentrate and gain velocities as the flow leaves the apron.

Design criteria

Capacity

All culverts should be designed for a minimum 25-year-frequency storm with an allowable head that does not overlap the roadway. However, the minimum acceptable size culvert diameter to prevent failure from debris blockage is 24 inches (36 inches for perennial stream crossings). Pipe size can be determined using general design criteria, such as in Table C-1, but is ideally based upon site-specific hydrologic analysis. Factors to be considered include the geographic area being drained, soils and slopes in the drainage area, annual precipitation, and likely storm events.

Depth

The depth of culvert burial must be sufficient to ensure protection of the culvert barrel for the design life of the culvert. This requires anticipating the amount of material that may be lost due to road use and erosion.

Slope

The barrel slope of the culvert should not have long sections of subcritical flow. This minimizes the settling of silt in the barrel. The slopes should be designed so the minimum velocity through the barrel will be no less than 3 feet per second for a 2-year storm frequency.

Inlet/outlet protection design

Sediment traps, gabions, or rock retaining walls at culvert inlets and outlets shall be designed according to their appropriate BMPs. Riprap aprons at culvert outlets shall be designed as follows:

Tailwater depth. The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tailwater depth is less than half the diameter of the outlet pipe, and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a Minimum Tailwater

Condition. If the tailwater depth is greater than half the pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition.

Riprap apron size & D50. The apron length (L_A) and the D50 of the riprap shall be determined from Table C-2 according to the design flow and whether there is a minimum or maximum tailwater condition. The apron width (W) shall then be determined as:

$$W = d + 0.4\ L_A$$

where d is the diameter of the culvert.

If the pipe discharges directly into a well defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation 1 foot above the maximum tailwater depth or to the top of the bank, whichever is less. The upstream end of the apron, adjacent to the pipe, shall have a width two (2) times the diameter of the outlet pipe, or conform to pipe end section if used.

Riprap materials. The outlet protection may be done using rock riprap or grouted riprap. Riprap shall be composed of a well-graded mixture of stone size so that 50 percent of the pieces, by weight, shall be larger than the D50 size determined from Table C-2. A well-graded mixture, as used herein, is defined as a mixture composed primarily of larger stone sizes, but with a sufficient mixture of other sizes to fill the smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1.5 times the D50 size. All grout for grouted riprap must be one part Portland cement for every 3 parts sand, mixed thoroughly with water.

Filter. If a filter cloth or gravel is used, it should be designed according to Riprap (R).

Apron thickness. The minimum thickness of the riprap layer shall be 1.5 times the maximum stone diameter for D50 of 15 inches or less; and 1.2 times the maximum stone size for D50 greater than 15 inches.

Riprap stone quality. Stone for riprap shall consist of field stone or rough unhewn quarry stone. The stone shall be hard and angular and of a quality that will not disintegrate on exposure to water or weathering. The specific gravity of the individual stones shall be at least 2.5. Site rock or site boulders may be used provided it has a density of at least 150 pounds per cubic foot, and does not have any exposed steel or reinforcing bars.

Construction specifications

Culvert inlet protection

Figure C-1 shows typical culvert inlet protection. However, site specifics shall dictate actual design.

1. After installation of a culvert, examine the stream channel for the amount of debris, logs, and brushy vegetation present. In channels with large amounts of debris, consider using oversized pipes.
2. Typically, the culvert inlet will have a sediment trap and a slide (head) gate that will normally be kept closed. In this case, sediment will settle out of runoff prior to washing through the culvert. If used, the slide gate will be opened only after collected water within the sediment trap is visually checked for any oil sheens.
3. Boulders may be drystacked around the culvert inlet and up the slope to the edge of the road.

Drainage crossing culverts

1. See Figure C-2 for installation details.
2. Make road crossings of natural drainages perpendicular to the drainage to minimize pipe length and area of disturbance.

3. Use single large pipes versus multiple smaller diameter pipes to minimize plugging potential in most channels (unless roadway elevation is critical). In very broad channels, multiple pipes are desirable to maintain the natural flow spread across the channel. All culverts should be concrete, corrugated metal pipe (CMP) made of steel or aluminum, or properly bedded and backfilled corrugated plastic pipe.
4. Align culverts in the bottom and middle of the natural channel flowline so that installation causes no change in the stream channel alignment or stream bottom elevation. Culverts should not cause damming or pooling or increase stream velocities significantly.
5. Extend the outlet of the culvert at least 1 foot beyond the toe of the slope to prevent erosion of the fill material. Alternatively, use retaining walls (headwalls) to hold back the fill slope.
6. It may be necessary to install riprap, erosion control blanketing, a combination of the riprap and blanketing, or other energy dissipater device at the outlet end of the culvert to reduce soil erosion or to trap sediment.
7. It may be desirable to construct pulloffs/turnouts for vehicles on one or both sides of narrow culvert crossings. This will help avoid culvert crushing as well as disturbance to roadside ditches and berms.

Ditch relief culverts

1. See Figure C-3 for installation details.
2. Ditch relief culverts can provide better flow when skewed 0 to 30 degrees perpendicular to the road.
3. The culvert gradient should be at least 2% greater than the approach ditch gradient. This improves the flow hydraulics and reduces siltation and debris from plugging the culvert inlet.
4. Discharge culvert at natural ground level where possible (see Figure C-4 Type A), on firm, non-erosive soil or in rocky or brushy areas. If discharged on the fill slopes, armor outlets with riprap or slash (see Figure C-4 – Type B), or use down-drain structures (see Figure C-4 – Type C and Slope Drain (SD)).
5. Extend the inlet of the culvert at least 1 foot beyond the flowline of the roadside ditch. Extend the outlet of the culvert at least 1 foot beyond the toe of slopes to prevent erosion of the fill material.
6. It may be necessary to install riprap or other energy dissipater devices at the outlet end of the culvert to prevent soil erosion or to trap sediment.
7. Spacing of culverts is dependent on the road gradient, soil types, and runoff characteristics. The following table gives suggested culvert spacing. However, spacing will be dependent on site specific conditions and topography.

Soil type	Road grade		
	2–4%	5–8%	9–12%
Highly corrosive granitic or sandy	220'-260'	160'-200'	120'-160'
Intermediate erosive clay or load	290'-330'	240'-280'	180'-220'
Low erosive shale or gravel	380'-420'	305'-345'	230'-270'

8. It may be desirable to construct pulloffs/turnouts for vehicles on one or both sides of narrow culvert crossings. This will help avoid culvert crushing as well as disturbance to roadside ditches and berms.

Backfill and compaction

1. See Figure C-5.
2. Firmly compact well-graded fill material (soil or road base) around culverts, particularly around the bottom half, using placement in layers to achieve a uniform density. Use slightly plastic sandy gravel with fines. Avoid the use of fine sand and silt rich soils for bedding material because of their

susceptibility to piping. Pay particular attention to culvert bedding and compaction around the haunches of the pipe. Do not allow the compaction to move or raise the pipe. In large fills, allow for settlement.

3. Cover the top of metal and plastic culvert pipes with fill to a depth of at least 1 foot to prevent pipe crushing by heavy trucks. Use a minimum cover of 2 feet of fill over concrete pipe. For maximum allowable fill height, follow the manufacturer's recommendations.
4. Mound fill over the top of culvert pipes so that the road is slightly raised at culvert locations to help prevent erosion and water from ponding over culvert crossings. This practice, as well as placing large boulders around the culvert outlets, will also help to prevent culverts from crushing.

Culvert outlet protection

1. Prepare the sub-grade for the riprap to the required lines and grades. Any fill required in the sub-grade shall be compacted to a density of approximately that of the surrounding undisturbed material.
2. If a pipe discharges into a well-defined channel, the channel's side slopes may not be steeper than 2:1.
3. Construct apron to the design length and width with no slope (Figure C-6). The invert elevations must be equal at the receiving channel and the apron's downstream end. No overfall at the end of the apron is allowed. The elevation of the downstream end of the apron shall be equal to the elevation of the receiving channel or adjacent ground. The outlet protection apron shall be located so that there are no bends in the horizontal alignment.
4. Line the apron with riprap, grouted riprap, or concrete. Riprap should be the appropriate size and thickness as designed. See Riprap (R) for the placement of riprap. Alternately, flared culvert ends may be used.
5. If a culvert outlets at the top of cuts/fills or on slopes steeper than 10 percent one of the following two options is suggested:
    a. Transition culvert to a slope drain according to Slope Drain (SD). The slope drain shall convey stormwater to the bottom of the slope where a riprap apron, as designed above, shall prevent erosion at the slope drain outlet.
    b. Line slope below culvert outlet with a riprap channel to convey stormwater to the bottom of the slope where a riprap apron, as designed above, shall prevent erosion at the bottom of the slope. The riprap channel shall be designed according to the table in the Riprap (R) BMP that is based on depth of flow and slope. The riprap channel shall dip into the slope so that all water is contained within the channel, flows to the riprap outlet apron at the base of the slope, and does not spill over the sides onto unprotected soil.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP and PCSWMP. Any debris that may be blocking the culvert inlet or outlet should be removed. Inspect riprap at culvert inlets and outlets for damaged or dislodged stones. If any damage to culvert or inlet/outlet protection is noted or if there is any evidence of scour, repairs should be made immediately.

References

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book". BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Table C-1

Culvert Sizing

Drainage Area (acres)	Size of Drainage Structure (diameter and area)			
	Steep Slopes (Light Vegetation) C=0.7		Gentle Slopes (Heavy Vegetation) C=0.2	
	Round Pipe (in)	Area (sq. ft)	Round Pipe (in)	Area (sq. ft)
0 – 10	30"	4.9	18"	1.8
10 - 20	42"	9.6	24"	3.1
20 - 35	48"	12.6	30"	4.9
35 - 75	72"	28.3	42"	9.6
75 - 125	84"	38.5	48"	12.6
125 - 200	96"	50.3	60"	19.6

Notes: If pipe size is not available, use the next larger pipe size for the given drainage area. For intermediate terrain, interpolate between pipe sizes. Pipe size is based upon the Rational Formula and Culvert Capacity curves. Assumes a rainfall intensity of 3 to 4 in/hr. Values of "C" are the Runoff Coefficients for the terrain.

Table C-2

Outlet Protection Design

Riprap Aprons for Low Tailwater
(downstream flow depth < 0.5 x pipe diameter)

Culvert Diameter	Lowest value			Intermediate values to interpolate from									Highest value		
	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}
	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In
12"	4	7	2.5	6	10	3.5	9	131	6	12	16	7	14	17	8.5
15"	6.5	8	3	10	12	5	15	16	7	20	18	10	25	20	12
18"	10	9	3.5	15	14	5.5	20	17	7	30	22	11	40	25	14
21"	15	11	4	25	18	7	35	22	10	45	26	13	60	29	18
24"	21	13	5	35	20	8.5	50	26	12	65	30	16	80	33	19
27"	27	14	5.5	50	24	9.5	70	29	14	90	34	18	110	37	22
30"	36	16	6	60	25	9.5	90	33	15.5	120	38	20	140	41	24
36"	56	20	7	100	32	13	140	40	18	180	45	23	220	50	28
42"	82	22	8.5	120	32	12	160	39	17	200	45	20	260	52	26
48"	120	26	10	170	37	14	220	46	19	270	54	23	320	64	37

Riprap Aprons for High Tailwater
(downstream flow depth > 0.5 x pipe diameter)

Culvert Diameter	Lowest value			Intermediate values to interpolate from									Highest value		
	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}
	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In
12"	4	8	2	6	18	2.5	9	28	4.5	12	36	7	14	40	8
15"	7	8	2	10	20	2.5	15	34	5	20	42	7.5	25	50	10
18"	10	8	2	15	22	3	20	34	5	30	50	9	40	60	11
21"	15	8	2	25	32	4.5	35	48	7	45	58	11	60	72	14
24"	20	8	2	35	36	5	50	55	8.5	65	68	12	80	80	15
27"	27	10	2	50	41	6	70	58	10	90	70	14	110	82	17
30"	36	11	2	60	42	6	90	64	11	120	80	15	140	90	18
36"	56	13	2.5	100	60	7	140	85	13	180	104	18	220	120	23
42"	82	15	2.5	120	50	6	160	75	10	200	96	14	260	120	19
48"	120	20	2.5	170	58	7	220	85	12	270	105	16	320	120	20

Figure C-1
Typical Inlet Protection

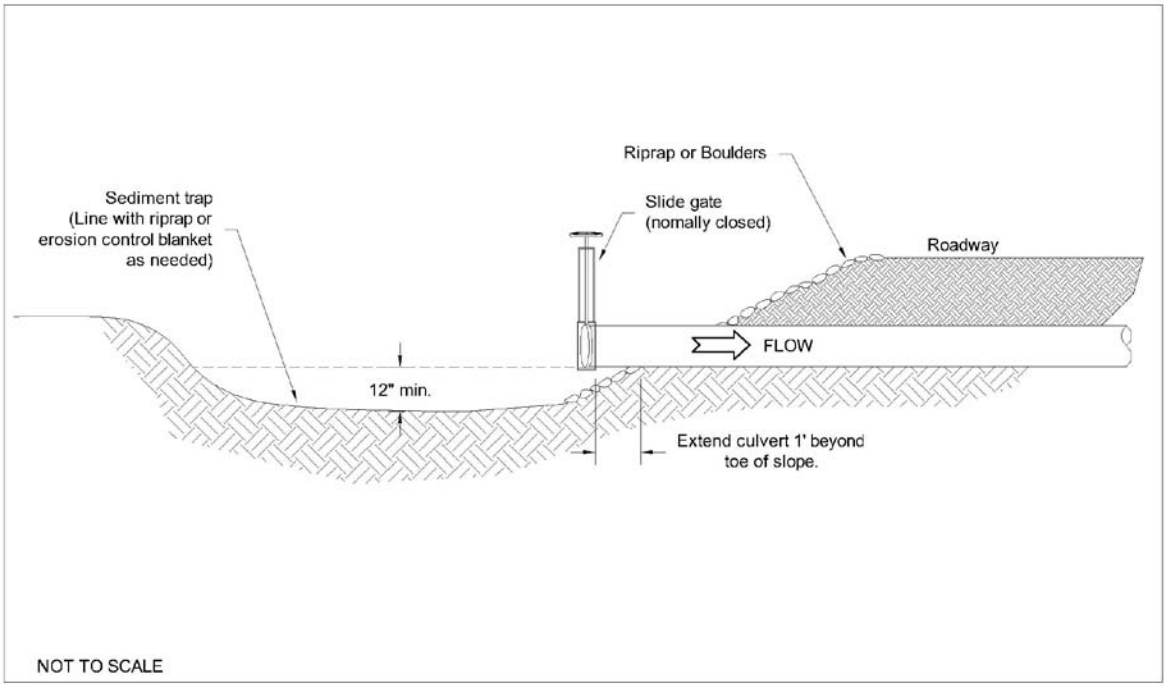


Figure C-2
Drainage Crossing Culvert Alignment & Overflow Dip

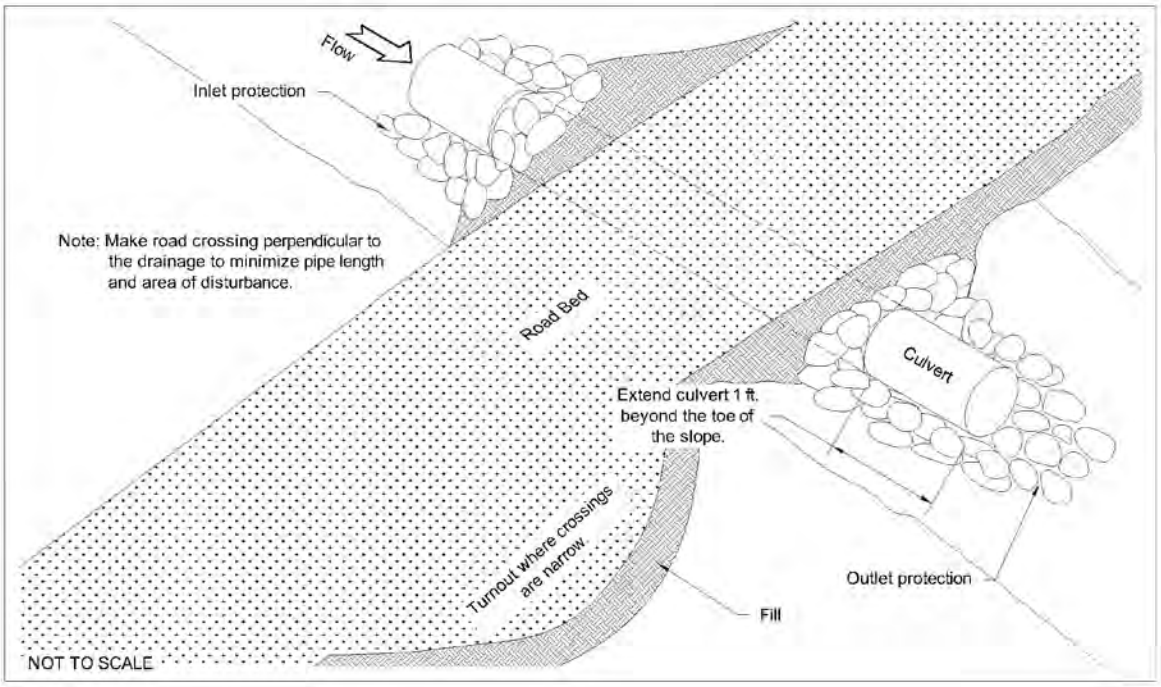


Figure C-3
Ditch Relief Culvert Installation

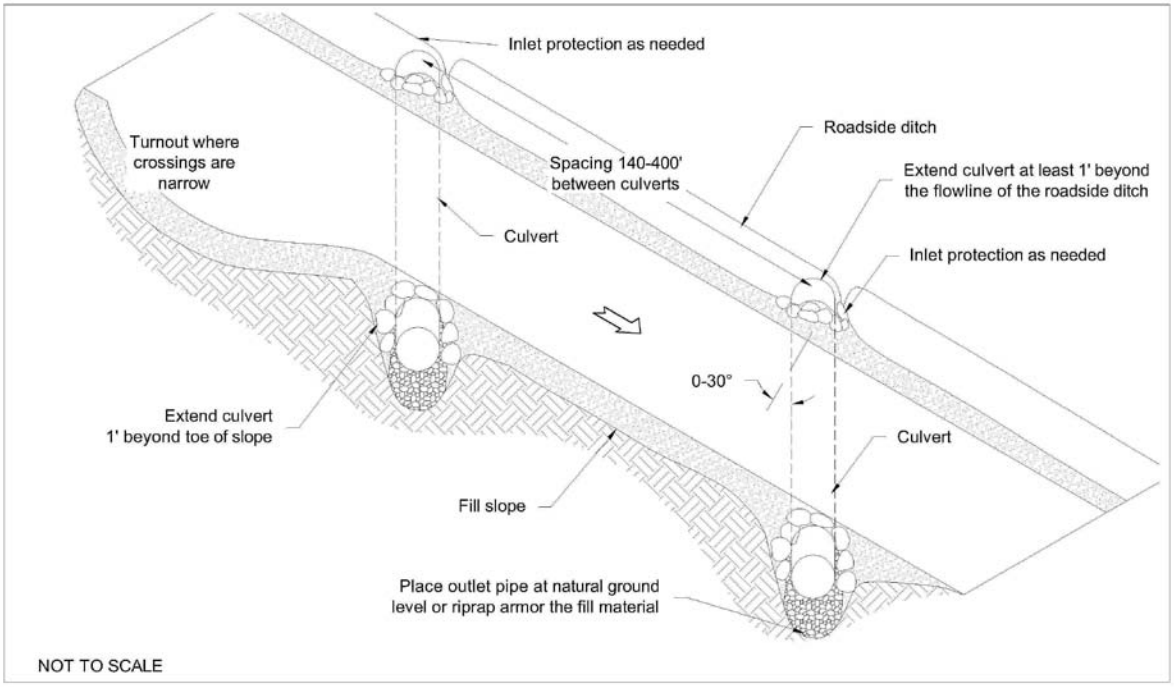


Figure C-4
Culvert Installation Options

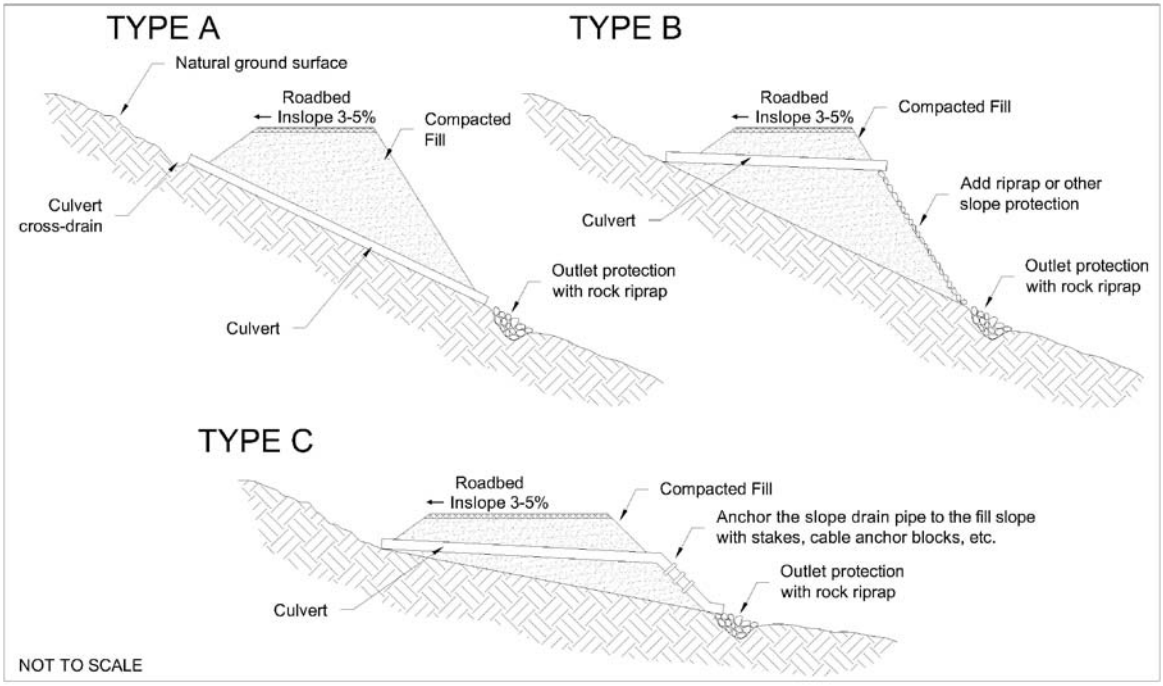


Figure C-5
Culvert Backfill and Compaction

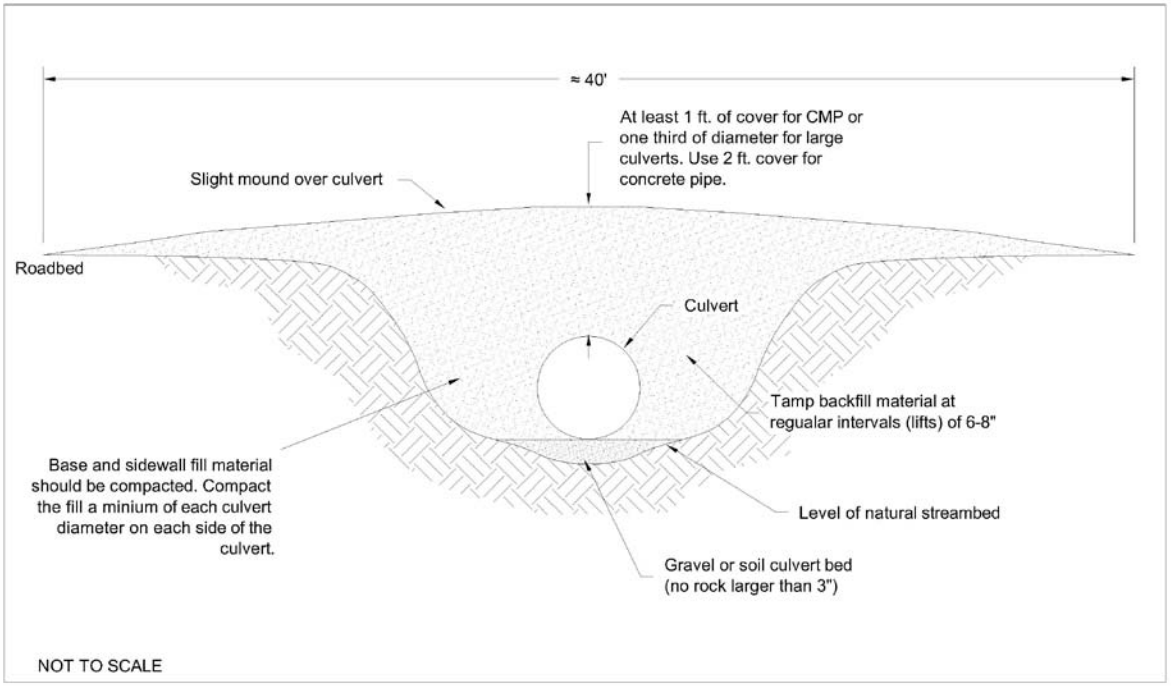
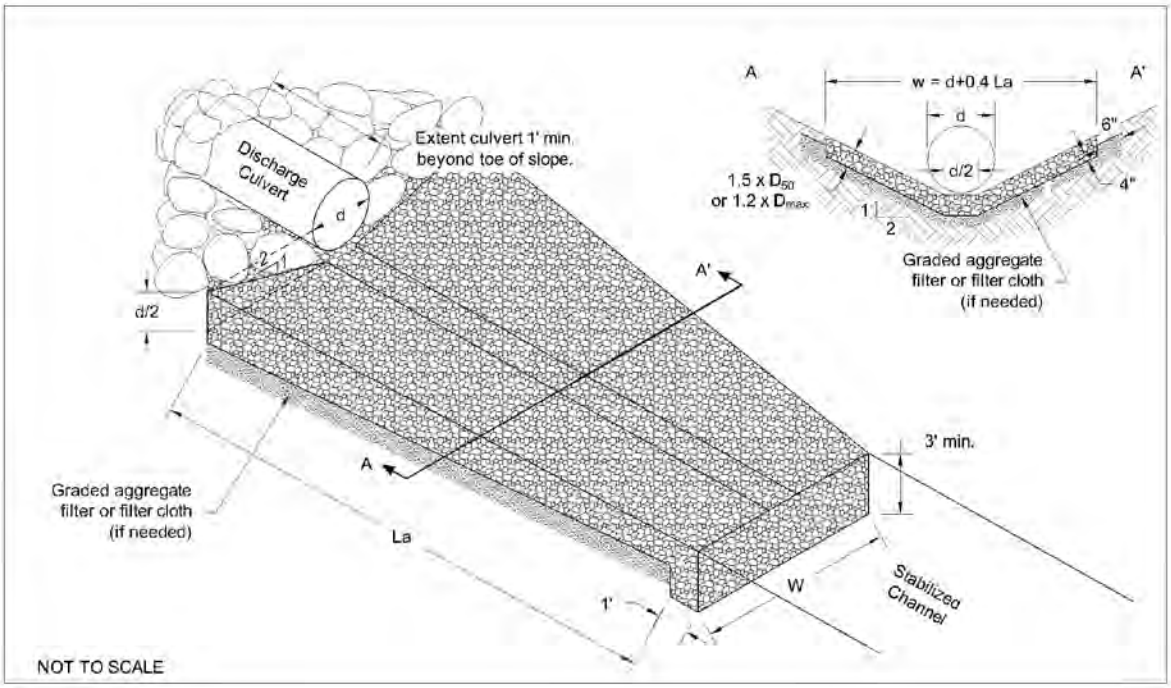


Figure C-6
Typical Outlet Protection



Diversion (D)

Specification Section 01570/02310/02370

Definition

A diversion is a drainage way with a swale adjacent to a supporting ridge on the lower side that is constructed across the slope. The supporting ridge may be constructed with the excavated material from the swale or may be constructed with other fill material, such as topsoil (i.e. a topsoil stockpile may be used to create a diversion and direct runoff). The purpose of a diversion is to prevent run-on from entering a disturbed area, to prevent sediment laden storm runoff from leaving the construction site or disturbed area, to prevent flows from eroding slopes, and to direct sediment laden flows to a trapping device.

Applicability

Diversions may be designed for temporary or permanent use. The maximum drainage area for temporary, un-compacted diversions is 2 acres. For drainage areas larger than 2 acres but less than 10 acres, the diversion should be compacted. For undisturbed drainage areas larger than 10 acres, a permanent diversion may be designed to handle larger flows. Diversions may be used for the following applications:

- Up-slope of cut or fill slopes to convey or divert flows away from disturbed areas. Diversions up-slope of well pads may be constructed with topsoil.
- Down-slope of cut or fill slopes to divert on-site runoff to a stabilized outlet or sediment trapping device. Diversions down-slope of well pads may be constructed with topsoil.

- At the outer edge of a well pad to ensure that runoff remains on the pad and is diverted to a well pad detention pond, if available. See Detention Pond (DP).
- Where runoff from higher areas has potential for causing erosion, or interfering with, or preventing the establishment of, vegetation on lower areas.
- Where the length of slopes needs to be reduced so that soil loss will be kept to a minimum.
- At the perimeter of a site or disturbed area.

Limitations

- The area around the diversion channel that is disturbed by its construction must be stabilized (with vegetation or other erosion control) so that it is not subject to similar erosion as the steep slope the channel is built to protect.
- To alleviate erosion capability, diversions must be directed into a stabilized outlet or well-vegetated area or to sediment trapping devices, where erosion sediment can settle out of the runoff before being discharged to surface waters.
- Temporary diversions should be designed to avoid crossing vehicle pathways.
- Diversions should be used with caution on soils subject to slippage.

Design criteria

For a temporary diversion (drainage area less than 10 acres), no formal design is necessary. For other permanent diversions (drainage area larger than 10 acres) the following guidelines apply:

Location

Diversion location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope, and the development layout. Where possible (shallow slopes), a vegetated buffer strip should be left between the edge of the cut or fill slope and the diversion.

Capacity

Peak rates of runoff values used in determining the capacity requirements shall be as outlined by TR-55, Urban Hydrology for Small Watersheds. The constructed diversion shall have capacity to carry, as a minimum, the peak discharge from a 10-year frequency rainfall event with freeboard of not less than 0.3 feet.

Cross section

See Figure D-2 for details. The diversion channel may be parabolic or trapezoidal in shape, or if space allows the diversion may be a stable landform with rounded features. The diversion shall be designed to have stable side slopes. The side slopes shall not be steeper than 2:1 and shall be flat enough to ensure ease of maintenance of the diversion and its protective vegetative cover. The ridge shall have a minimum width of 4 feet at the design water elevation; a minimum of 0.3 feet freeboard and a reasonable settlement factor (10%) shall be provided.

Velocity and grade

The permissible velocity for the specific soil type will determine the maximum grade. The maximum permissible velocity for sand and silt vegetated channels is 3 ft/sec, and 5 ft/sec for clay vegetated channels. Diversions are not usually applicable below high sediment producing areas unless structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with, or before, the diversions.

Construction specifications

General

1. All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the diversion.
2. All diversions shall have uninterrupted positive grade to an outlet.
3. Each diversion must have an adequate outlet where outflow will not cause damage. Diverted runoff from a disturbed area shall be conveyed to a sediment trapping device. Diverted runoff from an undisturbed area shall outlet to a sediment trapping device or into an undisturbed stabilized area at non-erosive velocities. Vegetated outlets shall be installed before diversion construction, if needed, to ensure establishment of vegetative cover in the outlet channel.

Temporary diversion (drainage area <10 acres)

See Figure D-1.

1. The diversion shall be excavated or shaped to line, grade, and cross section as required to meet the specified criteria. The diversion does not need to be compacted if the contributing drainage area is less than 2 acres.
2. Stabilization with vegetation is not required as long as sediment traps or other sediment control devices are provided.

Permanent diversion (drainage area >10 acres)

See Figure D-2.

1. The diversion shall be excavated or shaped to line, grade, and cross section as required to meet the criteria specified herein, and be free of bank projections or other irregularities which will impede normal flow.
2. Parabolic and triangular-shaped, grass-lined channels should not have a top width of more than 30 feet. Trapezoidal, grass-lined channels may not have a bottom width of more than 15 feet unless there are multiple or divided waterways, they have a riprap center, or other methods of controlling the meandering of low flows are provided.
3. If grass-lined channels have a base flow, a stone center or subsurface drain or another method for managing the base flow must be provided.
4. Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the complete diversion.
5. All earth removed and not needed in construction shall be spread or disposed of on the construction side of the diversion so that it will not interfere with the functioning of the diversion.
6. Immediately after the ridge and channel are constructed, they must be seeded or hydro-seeded and mulched according to Revegetation (RV) and Mulching (M) or Erosion Control Blanket (ECB) along with any disturbed areas that drain into the diversion.
    a. For design velocities less than 3.5 ft/sec, seeding and mulching may be used for establishment of the vegetation. It is recommended that, when conditions permit, temporary diversions or other means should be used to prevent water from entering the diversion during the establishment of the vegetation.
    b. For design velocities of more than 3.5 ft/sec, the diversion shall be stabilized with seeding protected by Jute or Excelsior matting, or with seeding and mulching until the vegetation is established.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Channels should be cleared of sediment, repairs made when necessary, and seeded areas reseeded if a vegetative cover is not established. Maintain diversion capacity, ridge height, and outlet elevations especially if high sediment yielding areas are in the drainage area above the diversion. Establish necessary cleanout requirements. Redistribute sediment as necessary to maintain the capacity of the diversion.

Removal/Abandonment

Temporary and un-compacted diversions shall remain in place only until the disturbed areas are permanently stabilized. Permanent diversions shall remain in place until final reclamation.

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Field Office Technical Guide. 2002. <www.nrcs.usda.gov/technical/efotg>

Figure D-1

Temporary Diversion Installation

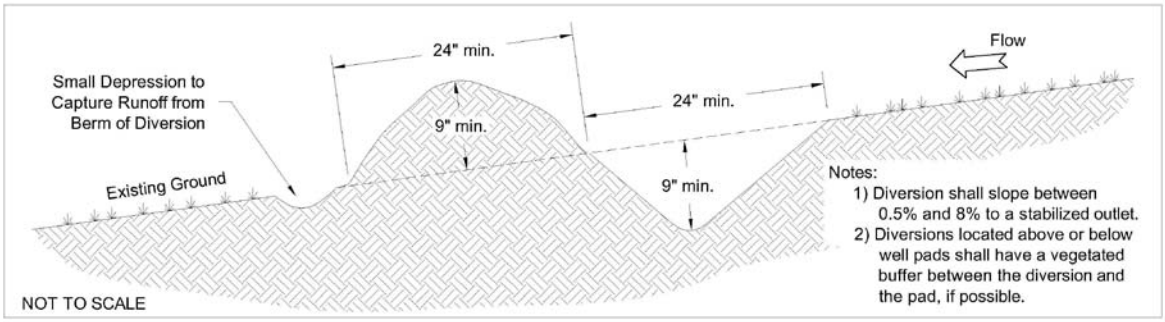
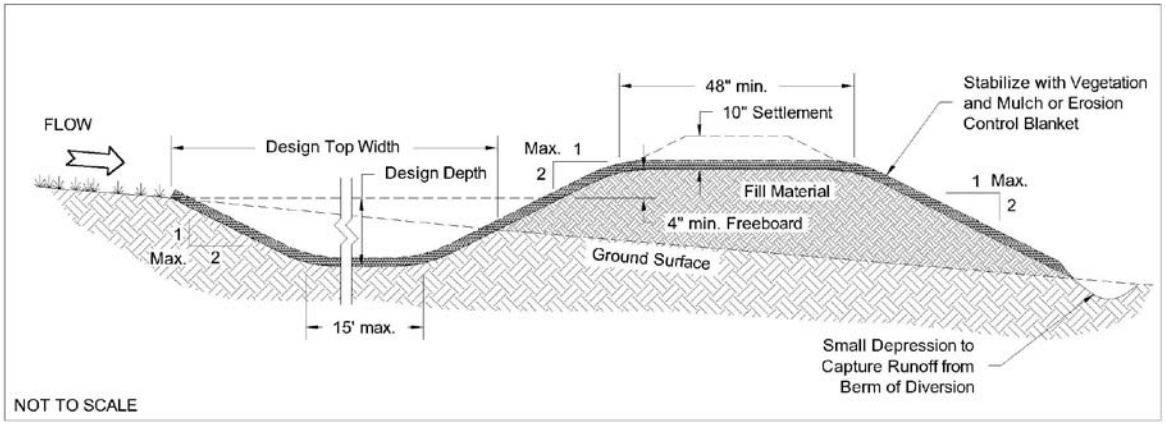


Figure D-2
Permanent Diversion Installation



Drainage Dip (DD)

Specification Section 02310

Description

Drainage dips intercept and remove surface water from the road and shoulders before the combination of water volume and velocity begins to erode the surface materials. Drainage dips are constructed diagonally across and as part of the road surface, and will pass slow traffic while dispersing surface water. A drainage dip is a very gentle roll in the road that is implemented when the road is originally constructed and graded. Drainage dips should not be confused with water bars, which are normally used for drainage and erosion protection of pipeline right-of-ways or closed/blocked roads.

Applicability

Drainage dips may be used in the following applications:

- To move water off the road surface efficiently and economically
- In place of a culvert, which is costly and susceptible to plugging or failure
- On low volume, low to moderate speed roads (10-35 mph) with grades less than 12%

Limitations

- Size limited by the safe passage of trucks and equipment
- May cause concentrated flows from sheet flows
- Requires vegetative cover or other sediment filter/trap at discharge point

Design criteria

No formal design required.

Construction specifications

See Figure DD-1.

1. Construct rolling dips deep enough to provide adequate drainage, angled 0-25 degrees from perpendicular to the road, with a 3-5% outslope, and long enough (50 to 200 feet) to pass vehicles and equipment.

2. Spacing of drainage dips depends upon local conditions such as soil material, grade, and topography. See Table DD-1 for recommended maximum distances between drainage dips.
3. In soft soils, armor the mound and dip with gravel or rock, as well as the outlet of the dip.
4. Outlet protection may consist of riprap to slow velocity, sediment traps or other sediment controls, or simply a well vegetated area.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspections should pay close attention to discharge points.

References

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

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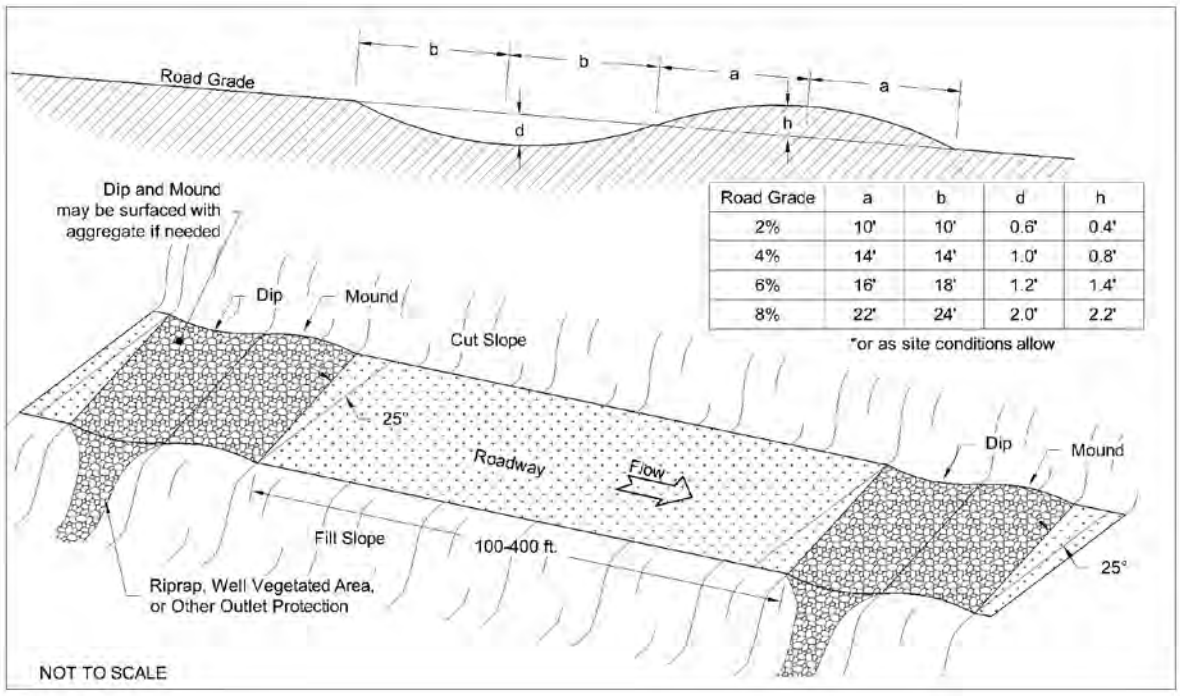
United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book". BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Table DD-1
Maximum Distance between Drainage Dips

Road Grade, %	Low to Non-Erosive Soils (1)	Erosive Soils (2)
0 - 3	400'	200'
4 - 6	300'	160'
7 - 9	250'	130'
10 - 12	200'	110'
12+	160'	100'

(1) Low Erosion Soils = Coarse Rocky Soils, Gravel, and Some Clay
(2) High Erosion Soils = Fine, Friable Soils, Silt, Fine Sands

Figure DD-1
Typical Drainage Dip



Road Grade	a	b	d	h
2%	10'	10'	0.6'	0.4'
4%	14'	14'	1.0'	0.8'
6%	16'	18'	1.2'	1.4'
8%	22'	24'	2.0'	2.2'

*or as site conditions allow

Pipeline Water Crossing (PWC)

Specification Section 02400

Description

There are several methods for pipeline water crossings. This BMP discusses open cut, flume, dam and pump, and bore or directional drill.

Applicability

Pipeline water crossings are applicable anytime a pipeline is constructed across a live flowing water crossing.

Limitations

Pipeline water crossings should not block, dam, or change the natural course of any drainage. Crossings should also be scheduled during low flow periods and the amount of time spent working in-stream should be minimized. Avoid seasonal high risk periods within lifecycles of resident aquatic organisms.

Open Cut:

- Grading of banks may be required.
- Potential high sediment release.
- Problematic in boulders and bedrock.
- Trench is prone to sloughing.

Flume:

- May be minor sediment release.
- Flow limited by flume size.
- Difficult to install. Requires relatively long, straight channel.
- Flume pipe can be crushed or blocked during construction.

Dam and Pump:

- May be minor sediment release.
- Limited by pump capacity.
- Hose may impede construction traffic.

Bore or Directional Drill:

- Requires additional workspace.
- Potential for borehole cave-in.
- Requires disposal of drilling mud.

Design criteria

The figures and measures contained in this BMP are typical and not site-specific. Detailed design drawings might be required with input from an engineer and other specialists.

Construction specifications

In general, pipeline water crossings shall follow these guidelines:

- Schedule crossing during low flow period, if possible.
- No refueling of mobile equipment within 200 feet of waterbody.
- Installation of a temporary equipment crossing is required at all flowing waterbodies. If a temporary equipment crossing is installed, it must be built in accordance with site specific drawings.
- Pipelines buried across stream crossings should be buried below the scouring depth.
- Maintain clean water flow and eliminate, where possible, the release of sediment or suspended solids. Maintain downstream flow.
- Minimize disturbance and erosion of the watercourse bed and banks.
- At completion of pipeline water crossing, restore waterbody channel to approximate pre-construction profile and substrate.
- At completion of pipeline water crossing, restore stream banks to approximate original condition and stabilize, as necessary.

Open Cut

See Figure PWC-1.

1. Contractor shall trench up to both sides of crossing.
2. Complete all in-stream activities within 24 hours, if feasible.
3. In agricultural land, strip topsoil from spoil storage area.
4. Construct sediment barriers along the sides of stockpiles and across the entire construction R.O.W. to prevent silt laden water and spoil from flowing back into waterbody. Barriers may be temporarily removed to allow construction activities but must be replaced by the end of each work day.
5. In-stream spoil to be stored out of the stream channel a minimum of 10 feet from the water's edge and within the construction R.O.W.
6. Trench through watercourse using mainline excavation equipment where practical.
7. Install soft plugs at the edge of stream banks until just prior to pipe installation to control water flow & trench sloughing.
8. Maintain stream flow throughout crossing construction.
9. Backfill with native material.

Flume

See Figure PWC-2.

1. Size flume to handle anticipated flows.
2. Stockpile all required materials prior to beginning in-stream work. Complete construction of the in-stream pipe section. Weight and pretest pipe, if warranted, prior to commencing in-stream activity.
3. Install a pre-assembled flume, or construct a flume and install both an upstream and downstream dam.
4. Install additional erosion control, if required, downstream of the flume outlet.
5. Ensure a tight seal about the dam and flume prior to undertaking trench excavation. Beginning in the early morning, excavate the trench as quickly as practical placing spoil out of the stream channel. Create spoil containment sumps or berms, if warranted, to keep spoil from flowing back into the stream channel.

6. Pump excavation as required to prevent downstream flow of silted water. Direct the pumped water onto vegetated areas well back from the watercourse. Construct water containment sumps, if warranted.
7. Install pipe.
8. Backfill the stream channel.
9. Remove downstream seal materials.
10. Remove upstream seal materials.
11. Remove the flume.

Dam and Pump

See Figure PWC-3.

1. Stockpile all required materials prior to beginning in-stream work. Complete construction of the in-stream pipe section. Weight and pretest pipe, if warranted, prior to commencing in-stream activity.
2. Install pumps in natural pool upstream of the excavation.
3. Excavate temporary sump within right-of-way if no natural pool exists. Check pump operation to equalize flow.
4. Ensure pumps can handle anticipated flow. Have standby pumps and generators capable of handling 100% of anticipated flow onsite and ready to be used if operating pumps fail.
5. Construct the upstream dam on the edge of the temporary workspace to allow for a wide excavation. Ensure dam is impermeable. Construct dam using sand bags, aquadam, sheet piling or other approved material that ensures a tight seal of the bed and banks.
6. Plug the vehicle crossing culvert or construct the downstream dam. Where a bridge is used, the bridge and dam should be installed as close to the edge of the temporary workspace as practical to allow for a wide excavation.
7. Assess the need to dewater isolated section of the watercourse and ensure tight seal about dams prior to trenching.
8. Excavate trench as rapidly as possible. Create spoil containment sumps, if warranted, to keep spoil from flowing back into the stream channel.
9. Install pipe.
10. Backfill the stream channel.
11. Remove the downstream dam or vehicle crossing plug.
12. Remove the upstream dam or vehicle crossing plug.

Bore or Directional Drill

1. Acquire and mark additional temporary workspace.
2. Set up equipment back from the edge of the watercourse; do not clear or grade within buffer zone except along the work side, if temporary vehicle crossing is installed.
3. Excavate bellhole. Store spoil on opposite side of right-of-way.
4. Complete boring and tie-in to mainline.
5. Pump bellhole dry if seepage becomes a problem. Dewater bellholes onto stable, vegetated land, not directly back into watercourse.

6. If using a directional drill, install suitable drilling mud tanks or sumps to prevent contamination of watercourse. Install sumps down-slope from the drill entry and anticipated exit points to contain any release of drilling mud. Dispose of drilling mud in accordance with the appropriate regulatory authority requirements.
7. Backfill and compact. Leave a crown to allow for subsidence.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. All erosion, drainage, and sediment controls installed as part of a pipeline water crossing shall be maintained in accordance with its individual BMP.

References

Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association. October 2005. Pipeline Associated Watercourse Crossings 3rd Edition. Prepared by TERA Environmental Consultants and Salmo Consulting Inc. Calgary, AB.

United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "*Gold Book.*" BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Figure PWC-1

Typical Open Cut Pipeline Water Crossing

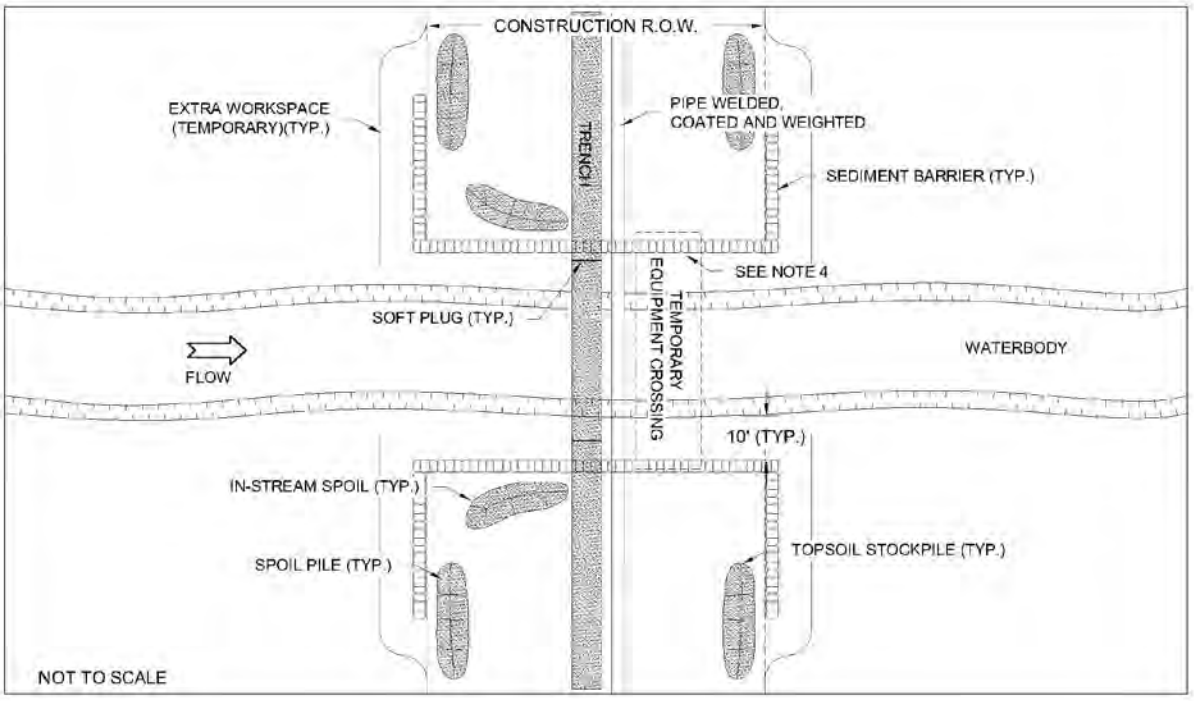


Figure PWC-2
Typical Flume Pipeline Water Crossing

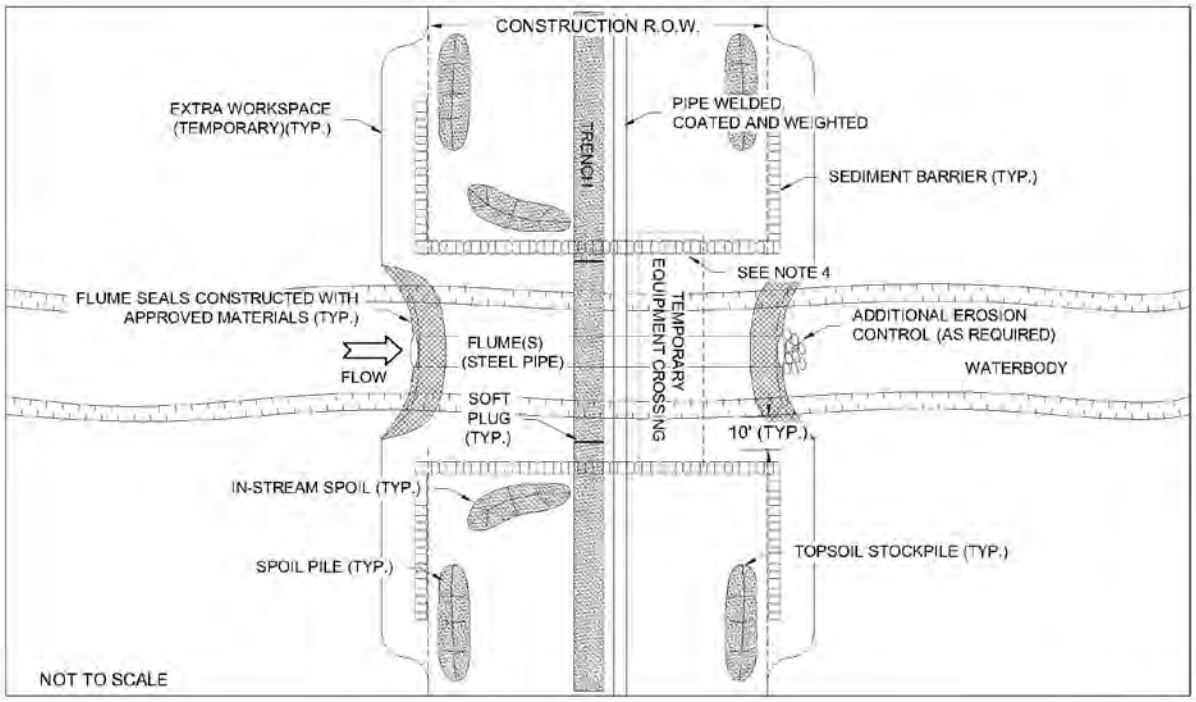
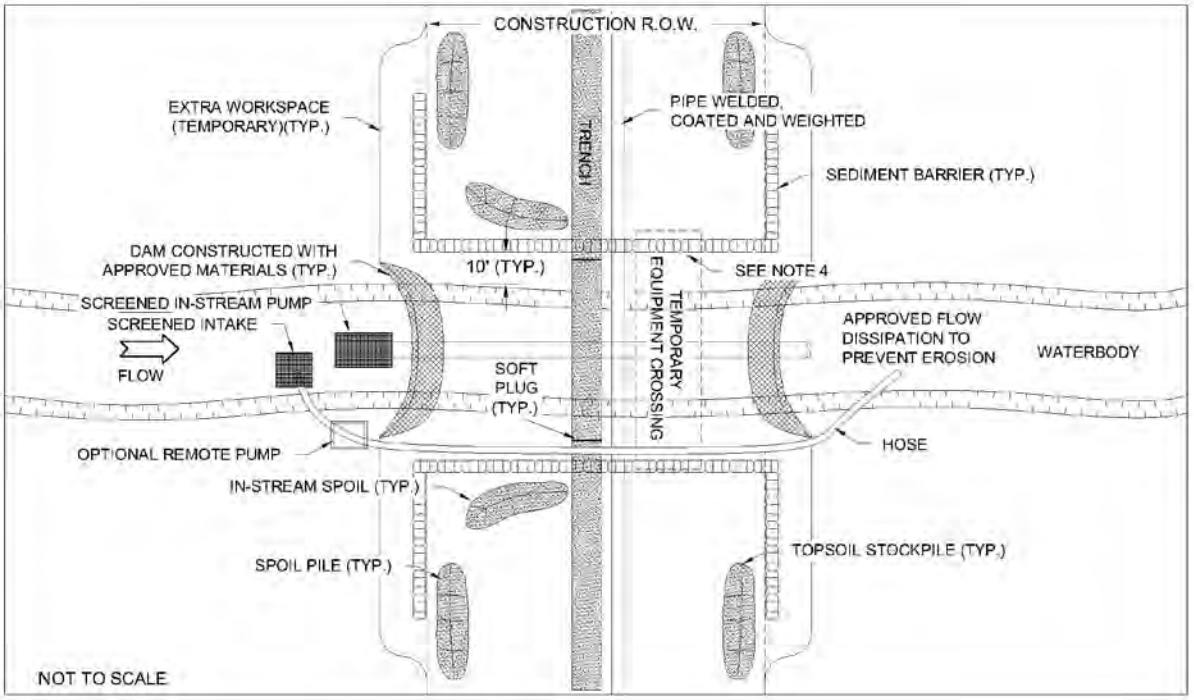


Figure PWC-3
Typical Dam and Pump Pipeline Water Crossing



Roadside Ditches (RSD)

Specification Section 02310

Description

Roadside ditches are channels constructed parallel to roads. The ditches convey concentrated runoff of surface water from roads and surrounding areas to a stabilized outlet.

Applicability

- Roadside ditches should be used for all roads built on sloping topography and with either an insloped or a crowned design.

Limitations

- If roadside ditches are not installed correctly they may become a source of erosion.
- Roadside ditches do not necessarily filter sediment from runoff.

Design criteria

No formal design is required.

Construction specifications

1. Roadside ditches should be constructed with no projections of roots, stumps, rocks, or similar debris.
2. Excavate ditches along roadside to a width and depth that can handle expected flows according to Figure RSD-1.
3. All ditches shall have uninterrupted positive grade to an outlet. Slope ditch so that water velocities do not cause excessive erosion, but no less than 0.5%. If steep slopes and high velocities exist, use check dams to slow runoff and catch sediment.
4. To control erosion and collect sediment, line ditch with aggregate and construct aggregate check dams according to Figure CD-1 of Check Dam (CD). The aggregate used to line the roadside ditch and construct aggregate check dams should be the same material as used to surface the roadway. If aggregate is not available, erosion control blankets may be used to help stabilize roadside ditches.
5. All ditches shall convey runoff to a sediment trapping device such as a Sediment Trap (ST) or an undisturbed, well vegetated, and stabilized area at non-erosive velocity. Ditches may also be periodically relieved by culverts or continuously relieved by furrows constructed for that purpose (as described in the Surface Roughening BMP).

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Road ditches should be inspected for any signs of channelization, and repaired as necessary. Also inspect for sediment buildup at outlets and at aggregate check dams and remove if necessary.

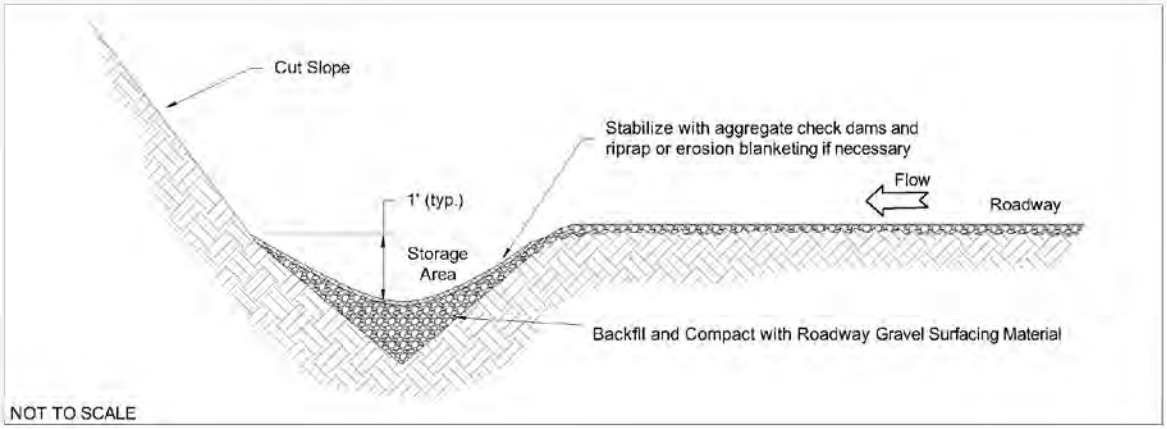
References

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book". BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Figure RSD-1
Roadside Ditch Installation



Slope Drain (SD)

Specification Section 02370

Description

A slope drain is a conduit extending the length of a disturbed slope and serving as a temporary outlet for a diversion, a sediment trap, or a detention pond located at the top of a slope. Slope drains convey runoff without causing erosion on or at the bottom of the slope. This practice is a temporary measure used during grading operations until permanent drainage structures are installed and until slopes are permanently stabilized. They are typically used for less than 2 years.

Applicability

Slope drains can be used on most disturbed slopes to eliminate gully erosion problems resulting from concentrated flows discharged at a diversion outlet. Recently graded slopes that do not have permanent drainage measures installed should have a slope drain and a temporary diversion installed. A slope drain used in conjunction with a diversion conveys stormwater flows and reduces erosion until permanent drainage structures are installed.

Limitations

The area drained by a temporary slope drain should not exceed 5 acres. Physical obstructions substantially reduce the effectiveness of the drain. Other concerns are failures from overtopping because of inadequate pipe inlet capacity, and reduced diversion channel capacity and ridge height.

Design criteria

No formal design is required.

Construction specifications

See Figure SD-1 for installation details.

1. The slope drain inlet may be a diversion, a well pad detention pond, or a sediment trap.
2. The slope drain may or may not have a slide gate installed at the inlet end of the pipe in order to control when water is released through the slope drain.
3. The top of the berm over the slope drain inlet shall be at least 6 inches higher at all points than the top of the inlet pipe.
4. The slope drain may consist of metal or plastic pipe or half pipe. The pipe is typically corrugated, although for flatter, shorter slopes, a plastic or concrete lined channel is sometimes used. If flexible tubing is used, it shall be constructed of a durable material.
5. The slope drain shall have a slope of 3 percent or steeper.

6. The slope drain shall outlet into a sediment trapping device when the drainage area is disturbed. A riprap apron shall be installed below the pipe outlet where water is being discharged into a stabilized area.
7. A riprap apron shall be used below the pipe outlet where clean water is being discharged into a stabilized area.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspections should determine if capacity of slope drain was exceeded or if blockages occurred. Repairs should be made promptly. Construction equipment and vehicular traffic must be rerouted around slope drains.

Removal/Abandonment

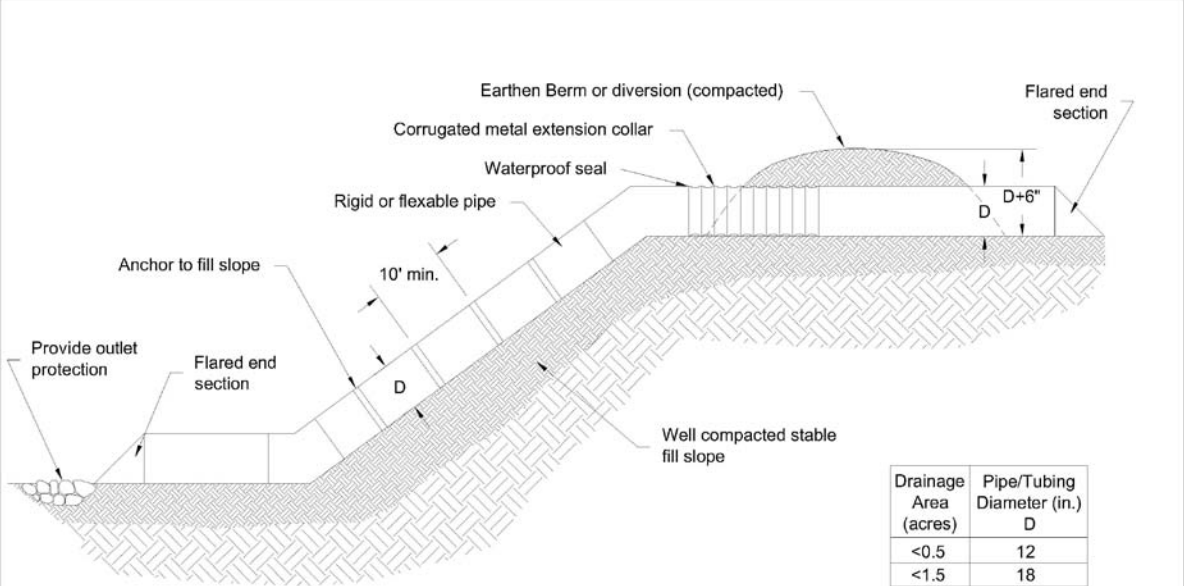
Remove slope drain on completion of construction and stabilization activities.

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

Figure SD-1
Slope Drain Installation



Drainage Area (acres)	Pipe/Tubing Diameter (in.) D
<0.5	12
<1.5	18
<2.5	21
<3.5	24
<5	30

Swale (S)

Specification Section 01570/02310/02370

Description

A swale is an excavated drainageway used to prevent runoff from entering disturbed areas by intercepting and diverting it to a stabilized outlet or to intercept sediment laden water and divert it to a sediment trapping device.

Applicability

Swales are usually appropriate for drainage basins smaller than five acres, but with modifications they can be capable of servicing areas as large as ten acres. Swales may be used in the following applications:

- To divert flows from entering a disturbed area.
- Intermittently across disturbed areas to shorten overland flow distances.
- To direct sediment laden water along the base of slopes to a trapping device.

Design criteria

No formal design is required.

Construction specifications

See Figure S-1 for details.

1. All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the swale.
2. The appropriate size and design of temporary swales depends on the size of the contributing drainage area according to Figure S-1.
3. The swale shall be free of bank projections or other irregularities which will impede normal flow.
4. All swales shall have uninterrupted positive grade to an outlet.
5. Diverted runoff from a disturbed area shall be conveyed to a sediment trapping device.

6. Diverted runoff from an undisturbed area shall outlet directly into an undisturbed, well vegetated and stabilized area at non-erosive velocity.
7. Fills shall be compacted by earth moving equipment.
8. All earth removed and not needed for construction shall be placed so that it will not interfere with the functioning of the swale.

Stabilization shall be as per Table S-1.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Ensure swale is operating as intended and clear out any accumulated sediment, if necessary.

Removal/Abandonment

Swales may or may not be removed. Swales collecting runoff from disturbed areas shall remain in place until the disturbed areas are permanently stabilized.

References

New York State Department of Environmental Conservation, *New York Guidelines for Urban Erosion and Sediment Control.* New York. Fourth Edition, 1997.

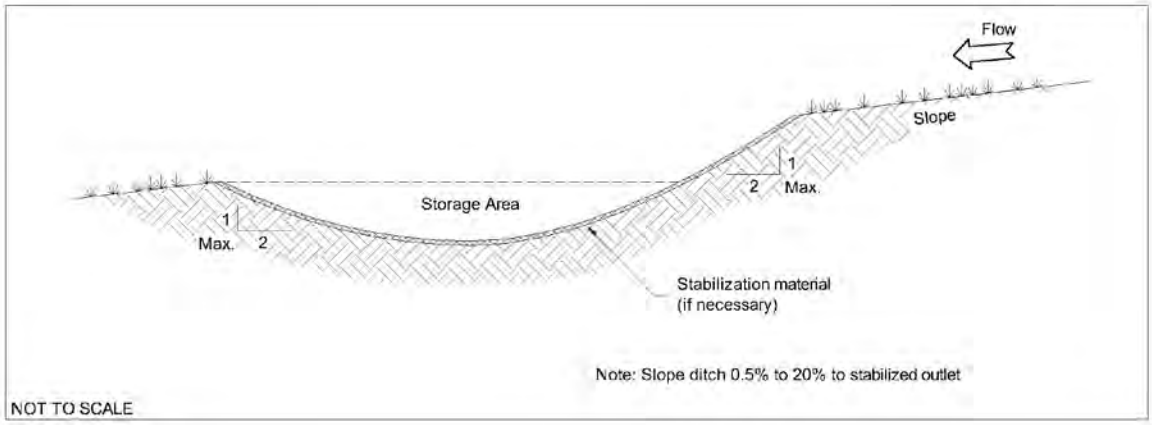
Table S-1
Swale Stabilization

		Stabilization Material	
Type of Treatment	**Channel Grade[1]**	**A (<5 Ac.)**	**B (5-10 Ac)**
1	0.5-3.0%	Seed & Straw Mulch	Seed & Straw Mulch
2	3.1-5.0%	Seed & Straw Mulch	Seed and cover with Jute or Excelsior, Sod, or lined with 2 in. stone
3	5.1-8.0%	Seed and cover with Jute, Excelsior, Sod, or line with 2 in. stone	Line with 4-8 in. or stone or Recycled Concrete Equivalent[2]
4	8.1-20%	Line with 4-8 in. or stone or Recycled Concrete Equivalent[2]	Engineering Design

[1]In highly erodible soils, as defined by the local approving agency, refer to the next higher slope grade for type of stabilization.

[2]Recycled Concrete Equivalent shall be concrete broken into the required size, and shall contain no steel reinforcement.

Figure S-1
Swale Installation



Trench Breakers (TB)

Description

Trench breakers, also known as trench plugs, are used to slow the flow of subsurface water along a pipeline trench. Trench breakers may be constructed of materials such as sand bags, earth filled sacks, bentonite, polyurethane foam, or equivalent materials.

Applicability

Trench breakers may be used in the following applications:

- On steep slopes.
- Above wetlands.
- At waterbody crossings.
- At road crossings.

Design criteria

No formal design is required.

Construction specifications

1. Trench breakers should be installed both before and after the lowering-in of pipeline.
2. An engineer or similarly qualified professional shall determine the need for and spacing of trench breakers. Otherwise, spacing shall be according to the following table:

Slope (%)	Spacing (feet)
5 – 15	250’-350’
15 – 30	150’-250’
>30	50’-150’

3. At a minimum, install a trench breaker at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from a waterbody or wetland and where needed to avoid draining a waterbody or wetland.
4. Dig keys into trench bottom and sides to the extent feasible for added stability.
5. Trench breakers should be installed to the top of the excavated trench line.
6. Backfill around trench breaker and mark location, if necessary.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Repair any damaged areas.

References

Federal Energy Regulatory Commission (FERC), Upland Erosion Control, Revegetation, and Maintenance Plan. January 2003.

Water Bar (WB)

Specification Section 02310/02370

Description

A water bar is an earthen ridge, or ridge and channel, constructed diagonally across pipeline right-of-ways (ROWs) or other disturbed area that is subject to erosion. Water bars are the primary BMP for controlling water velocity on steep ROWs by diverting surface runoff at pre-designed intervals.

Applicability

Water bars are applicable where runoff protection is needed to prevent erosion on sloping access ROWs or long, narrow sloping areas generally less than 100 feet in width. This is a practice that is often used on buried pipelines, limited-use roads, trails, and firebreaks. It is an excellent method of retiring roads and trails as well as abandoned roads where surface water runoff may cause erosion of exposed mineral soil.

Limitations

- Not for use on concentrated flows
- May cause concentrated flows from sheet flow
- Requires vegetative cover or other filter at discharge point

Design criteria

No formal design is required.

Construction specifications

See Figure WB-1.

1. Clear the base for the ridge before placing fill.
2. Install the water bar across the ROW according to Figure WB-1 as soon as the base is cleared and graded. The off-slope drainage should be 2 to 5 percent.
3. Use a trackhoe or bulldozer to compact the ridge to the design cross section.
4. Vehicle crossings shall be stabilized with gravel. Exposed areas shall be immediately seeded and mulched.
5. Extend the water bar inlet and outlet 1 foot or more beyond the edge of the ROW or disturbed area to keep the diverted water from re-entering the area.
6. Space the water bars according to Table WB-1.
7. Locate the outlet on an undisturbed area. Field spacing shall be adjusted to use the most stable outlet areas. Outlet protection will be provided when natural areas are not adequate (see Figure WB-2).

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect water bars for erosion damage and sediment. Check outlet areas and make repairs as needed to restore operation.

Removal/Abandonment

If water bars are used on a closed or blocked road, they should be removed prior to re-opening of the road. Water bars on pipeline ROWs, infrequently used roads, or other disturbed areas may remain in place as long as necessary.

References

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

Maine Department of Conservation, Best Management Practices for Forestry: Protecting Maine's Water Quality. Maine Forest Service, Forest Policy and Management Division. Augusta, Maine. 2004. <http://www.state.me.us/doc/mfs/pubs/pdf/bmp_manual/bmp_manual.pdf>

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

Table WB-1

Water Bar Spacing

Road/Trail Grade (%)	Low to Non-Erosive Soils (1)	Erosive Soils (2)
0 - 5	220'-270'	115'-145'
6 – 10	175'-225'	85'-115'
11 - 15	125'-175'	50'-80'
16 - 20	90'-140'	35'-65'
21 - 30	75'-125'	25'-55'
31+	25'-75'	15'-45'

[1]Low Erosion Soils = Coarse Rocky Soils, Gravel, and Some Clay

[2]High Erosion Soils = Fine, Friable Soils, Silt, Fine Sands

[3]Site-specific terrain may also dictate spacing of water bars

Figure WB-1
Water Bar Installation

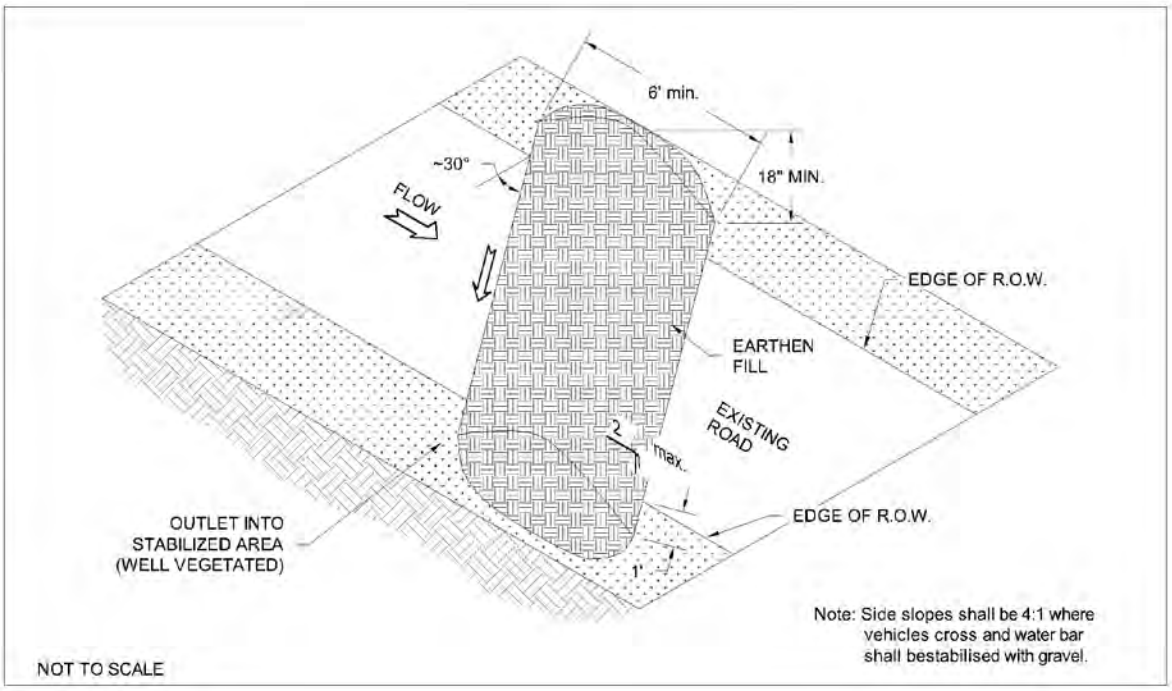
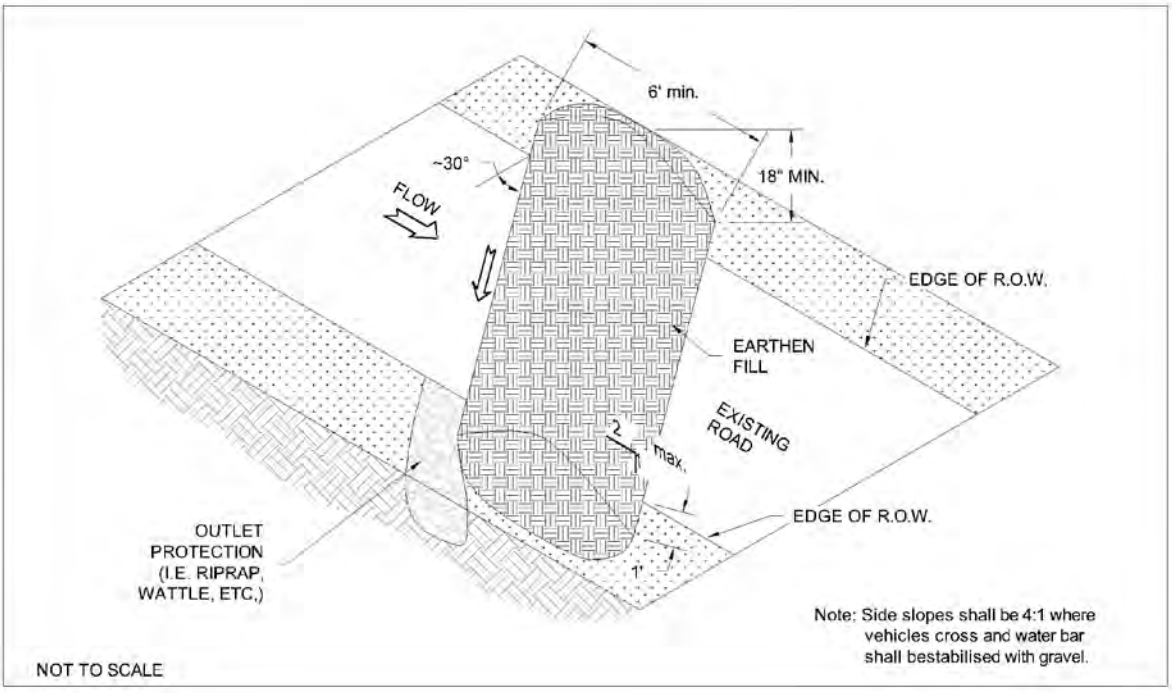


Figure WB-2
Water Bar Installation (with outlet protection)



Wing Ditch (WD)

Specification Section 01570/02310/02370

Description

Wing ditches (turnouts) are extensions of roadside ditches. Wing ditches effectively remove runoff water from the roadside ditch into well-stabilized areas before it reaches a waterway.

Applicability

- Wing ditches should be used as much as possible but their best use may be on slopes longer than 150 ft or greater than 5%, as conditions allow.
- Wing ditches are applicable where fairly flat naturally vegetated areas exist at intervals by the roadside.

Limitations

- Wing ditches should be on gradual slopes only.
- Wing ditches require vegetative cover or other filter at the discharge point.
- Wing ditches only work well if small volumes of runoff drain into the turnout. Wing ditches should only receive runoff from the road and ditch surface, not from large, uphill watersheds.

Design criteria

No formal design is required.

Construction specifications

1. Use wing ditches wherever possible and on undisturbed soil.
2. Slope wing ditch gradually down from bottom of roadside ditch.
3. Angle wing ditch at approximately 30 degrees to the roadside ditch.
4. Discharge wing ditch into well-vegetated area or install a secondary control such as a wattle, sediment trap, or silt fence. As a good Rule of Thumb, the vegetated outlet area should be a minimum of one-half the size of the total drainage area draining into it. If well-vegetated outlet areas are not available, use culverts or other controls to direct runoff to a stabilized area.
5. Space wing ditches according to slope as indicated on Figure WD-1.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Wing ditches should be inspected for any signs of channelization, and repaired as necessary. Structures will fail if water exits in channelized flow. Also inspect for sediment buildup at the outlet and remove if necessary.

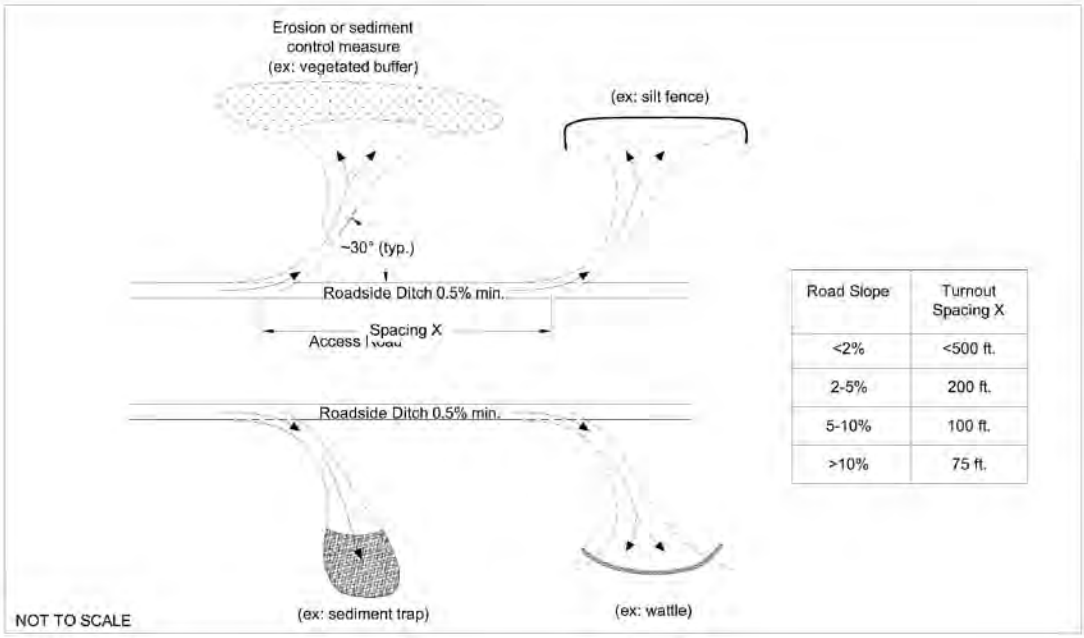
References

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

United States Department of the Interior and United States Department of Agriculture. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book". BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Figure WD-1
Wing Ditch Layout



Sediment Control BMPs

Check Dam (CD)
Detention Pond (DP)
Filter Berm (FB)
Rumble Strip (RS)
Sediment Trap (ST)
Silt Fence (SF)
Slash (SL)
Straw Bale Barrier (SBB)
Wattles (W)

Check Dam (CD)

Specification Section 01570/02370

Description

Check dams are small, temporary dams constructed across a diversion or roadside ditch. Check dams can be constructed using aggregate, rock, sandbags, gravel bags, earth with erosion control blanketing, straw bales, or wattles and are used to slow the velocity of concentrated flow in a channel and thus reduce erosion. As a secondary function, check dams can also be used to catch sediment from the channel itself or from the contributing drainage area as stormwater runoff flows through or over the structure.

Applicability

Check dams are most often used in small, open channels with a contributing drainage area of less than 10 acres, and side slopes of 2:1 or less. Check dams may be used in the following applications:

- In diversions or roadside ditches where it is not practical to line the channel or implement other flow control and sediment control practices.
- In diversions or roadside ditches where temporary seeding has been recently implemented but has not had time to take root and fully develop.
- As a series of check dams, spaced at appropriate intervals, used in one of the above two applications.

Limitations

- Check dams should not be used in live, continuously flowing streams unless approved by an appropriate regulatory agency.
- Check dams may require frequent removal of accumulated sediments. Dams should therefore be located in areas accessible to maintenance vehicles.
- Leaves have been shown to be a significant problem by clogging check dams in the fall. Therefore, they might necessitate increased inspection and maintenance.
- Straw bale check dams decompose over time, and may be consumed by livestock.

Design criteria

No formal design is required.

Construction specifications

Minor deviations from the following construction specifications are acceptable as long as performance oriented specifications are maintained. The performance oriented specification for check dams is that sediment is not observed on the down gradient side of the dam. If sediment is observed on the down gradient side of the dam, the check dam should be maintained or re-installed.

1. Install aggregate check dams according to Figure CD-1, wattle check dams according to Figure CD-2, earth check dams according to Figure CD-3, and straw bale check dams according to Figure CD-4.
2. Check dams should be located in areas accessible to maintenance vehicles for the periodic removal of accumulated sediments.
3. Dams should be installed with careful placement of the construction material. Mere dumping of the dam material into a channel is not appropriate and will reduce overall effectiveness.
4. Check dams can be constructed from a number of different materials. When using rock, the material diameter should be 1 to 15 inches depending on the expected velocity and quantity of runoff within the channel. Aggregate check dams constructed within roadside ditches should use the same material used to surface the roadway. Earth collected during excavation of diversions or roadside ditches may also be placed as check dams if covered with erosion control blanketing. Straw bales, wattles, or sand/gravel bags may also be used, but only if rock or aggregate is unavailable or not feasible for the location.
5. All check dams should have sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage. The center of the dam should be at least 6 inches lower than the edges. This design creates a weir effect that helps to channel flows away from the banks and prevent further erosion.
6. Additional stability may be achieved by implanting the dam material approximately 6 inches into the sides and bottom of the channel, if necessary.
7. If possible, dams used in a series should be spaced such that the base of the upstream dam is at the same elevation as the top of the next downstream dam. However, spacing shall be determined based on site-specific conditions and needs.
8. When installing more than one check dam in a channel, outlet erosion stabilization measures should be installed below the final dam in the series. Because this area is likely to be vulnerable to further erosion, riprap, erosion control blanket lining, or some other stabilization measure is highly recommended.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. During inspection, large debris, trash, and leaves should be removed. The center of a check dam should always be lower than its edges. If erosion or heavy flows cause the edges of a dam to fall to a height equal to or below the height of the center, and the effectiveness of the BMP is compromised, repairs should be made immediately. Accumulated sediment should be removed from the upstream side of a check dam when the sediment has reached a height of approximately one-half the original height of the dam (measured at the center). Close attention should be paid to the repair of damaged or rotting straw bales or wattles, and undercutting beneath dams. Replacement of check dam material should be accomplished promptly.

Removal/Abandonment

Removal of check dams is optional. Check dams within roadside ditches are usually used as temporary controls, where other check dams may be left in place to silt out. If removing a check dam, all accumulated sediment should be removed. Removal of a check dam should be completed only after the contributing drainage area has been completely stabilized. Permanent vegetation should replace areas from which gravel, stone, logs, or other material has been removed.

References

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. <http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp>

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Figure CD-1
Aggregate Check Dam Installation

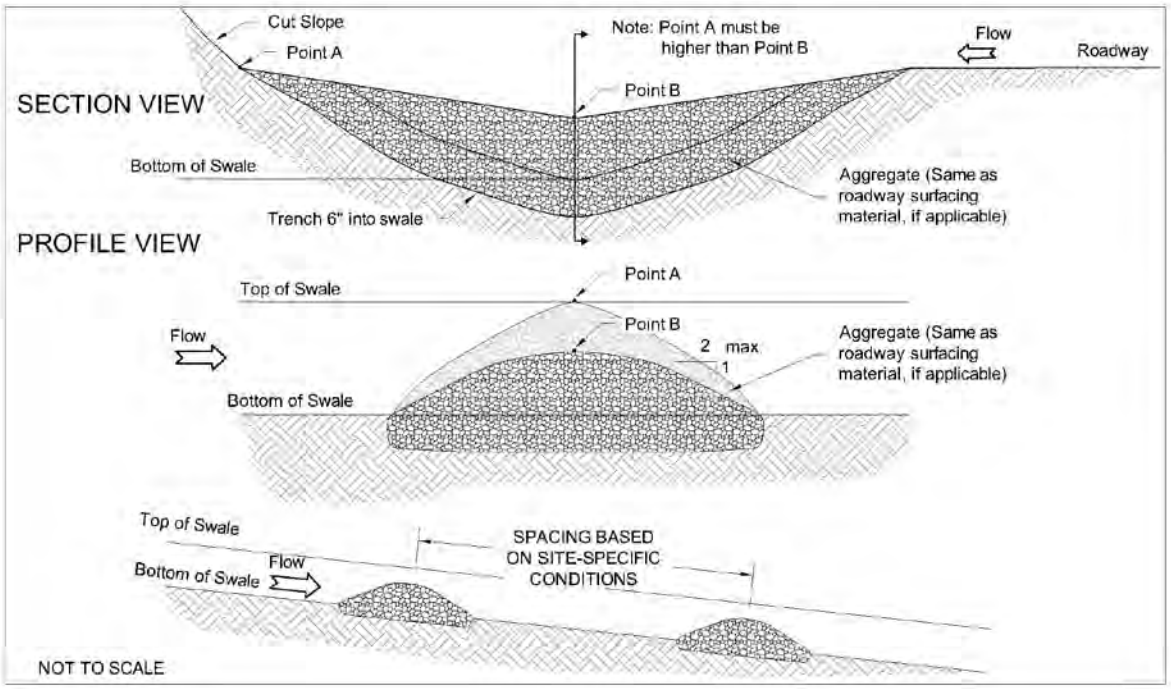


Figure CD-2
Wattle Check Dam Installation

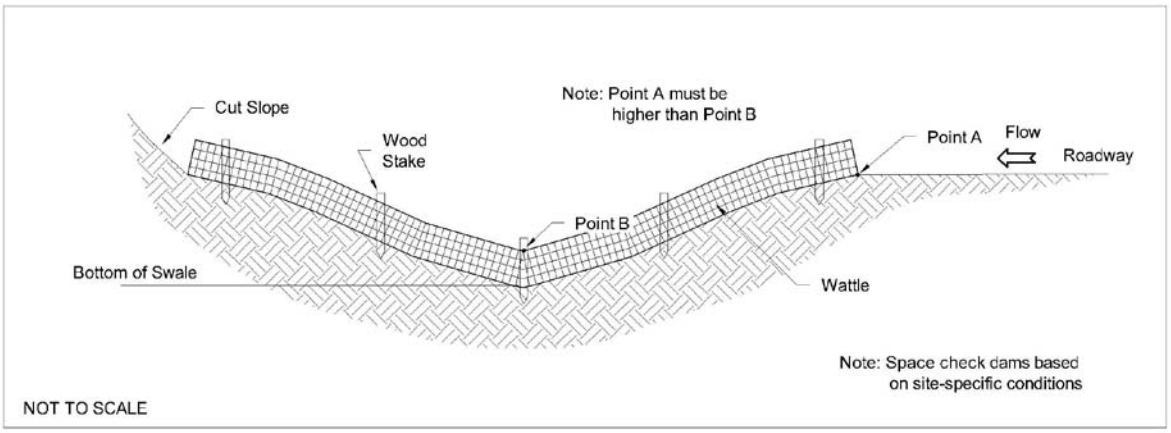


Figure CD-3
Earthen Check Dam Installation

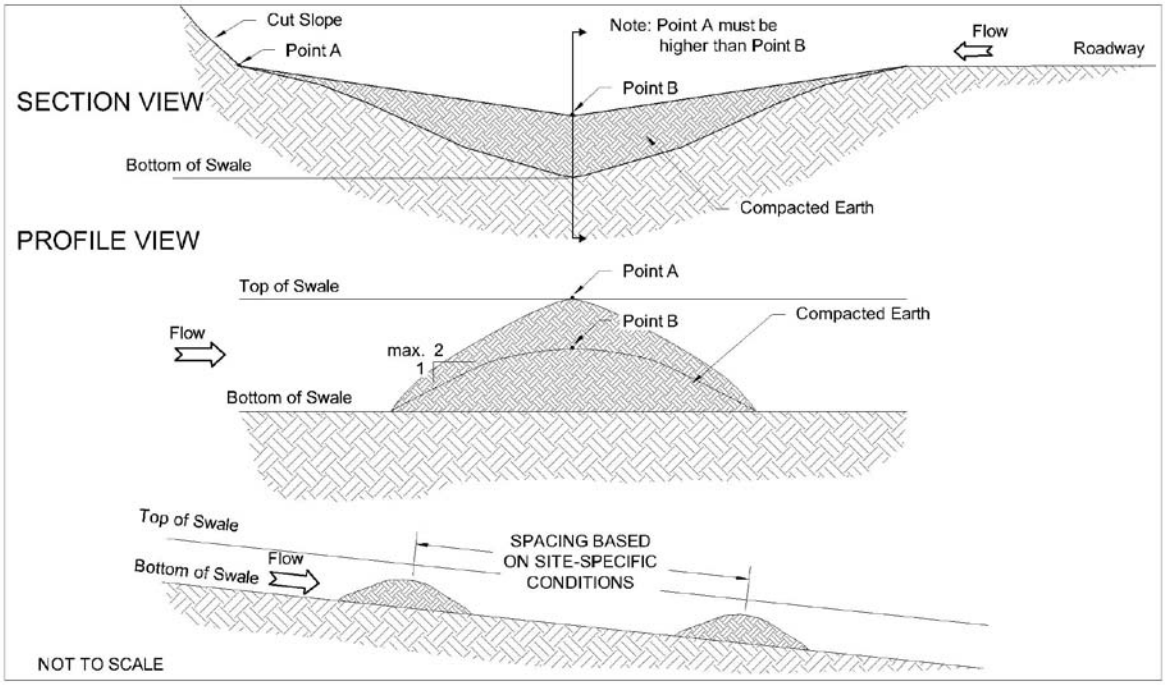
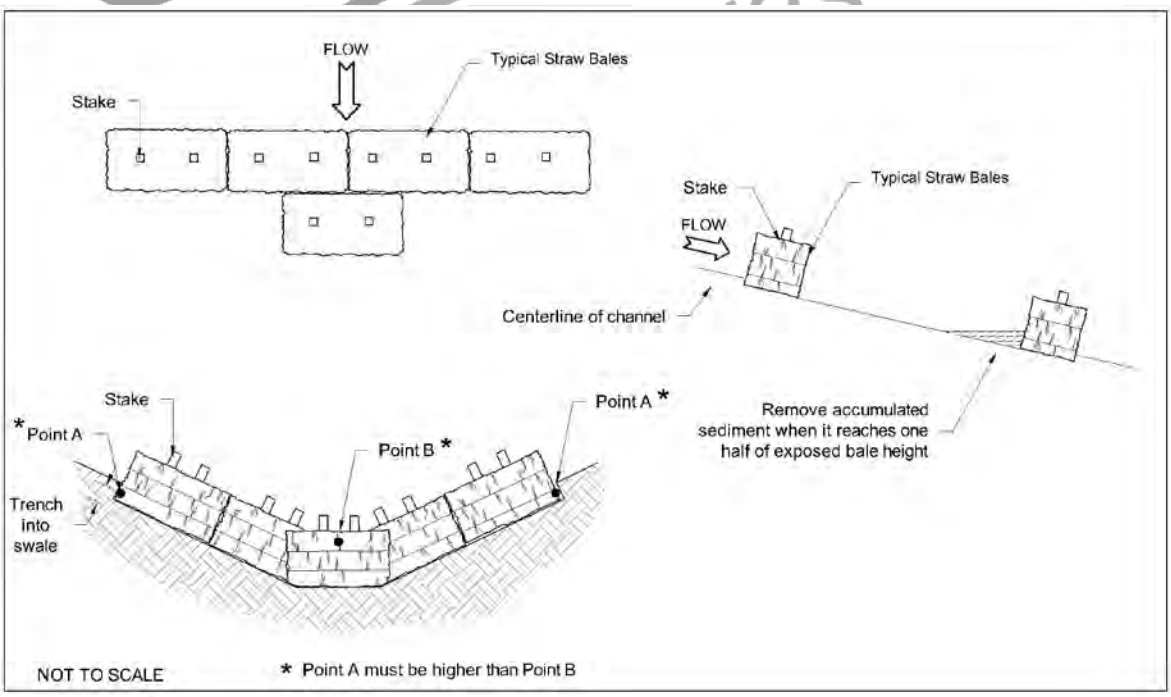


Figure CD-4
Straw Bale Check Dam Installation



Detention Pond (DP)

Specification Section 02660

Description

A detention pond is a large ponding area that stores water for a limited amount of time while allowing sediment to settle out of runoff water. These ponds are formed by excavating below grade and/or by constructing an earthen embankment with an outlet to slow the release of runoff. The outlet may consist of a culvert (with or without a slide gate), a spillway, a level spreader, or any combination of these.

Applicability

Detention ponds may be used in the following applications:

- At the base of well pads or down-slope of other large disturbed areas.
- On each well pad to collect and store all runoff from the surface of the pad.
- Any location where it is desired to capture runoff from a large drainage area (up to 10 acres).
- As tertiary spill containment to prevent any accidental discharges from leaving the site.

Limitations

- Regular maintenance is needed to remove sediment. Ponds should be located near roads or where accessible to remove sediment.
- Water may remain in the pond for extended periods causing an ideal spot for mosquitoes and other insects to gather. Locate the pond in a sunny spot if possible.
- Never construct a detention pond on a live flowing stream or in wetlands.
- Detention ponds constructed on well pads that have not been properly designed may collect runoff from areas other than the surface of the pad, which may be more volume than the detention pond is designed to handle.

Design criteria

Location

Detention ponds should be located at points of discharge from disturbed areas. The location will be determined by the natural terrain, drainage pattern of the runoff, and the accessibility for maintenance. Ponds should not be located in areas where their failure due to stormwater runoff excess can lead to further erosive damage of the landscape. Alternative diversion pathways should be designed to accommodate these

potential overflows. Detention pond locations should also allow for easy maintenance access for the periodic removal of accumulated sediment.

Well pad detention ponds shall be located at an outside edge of the pad and as far as possible from the pad access road, utilities, and all infrastructures.

Storage capacity

A detention pond should be designed to maximize surface area for infiltration and sediment settling. This will increase the effectiveness of the pond and decrease the likelihood of backup during and after periods of high runoff intensity. The approximate storage capacity of each pond should be 3,600 ft^3 per acre of contributing drainage area. The volume of a detention pond can be approximated by the following equation:

$$\text{Volume } (ft^3) = 0.4 \times \text{surface area } (ft^2) \times \text{maximum pool depth (ft)}$$

If the volume is more than 100 acre-feet the detention pond should be constructed as designed by a Professional Engineer.

Embankment

If the embankment is more than 10 feet high (measured vertically from the ground surface to the crest of the spillway) the detention pond should be constructed as designed by a Professional Engineer.

Construction specifications

Construct detention pond according to Figure DP-1.

1. If possible, detention ponds, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.
2. Ponds should be located above the floodplain, where possible.
3. Area under embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. The pool area shall be cleared.
4. The fill material for the embankment shall be free of roots and other woody vegetation as well as over-sized stones, rocks, organic material or other objectionable material. The embankment shall be compacted by traversing with equipment while it is being constructed. Seeding of the embankment should be performed as soon as possible after construction of the sediment reservoir. Erosion control blanketing may also be used to cover the embankment in combination with seeding or during time periods when seeding is ineffective.
5. There are three options for dewatering of the detention pond:
    a. **Culvert or slope drain** - Dewatering may be achieved through a 6- to 12-inch corrugated metal or plastic culvert. The culvert invert shall be located approximately 1 foot above the bottom of the pond to allow space for sedimentation. The culvert or slope drain shall be sloped and routed through the detention pond berm to discharge into a sediment trapping device or into a well-stabilized area. An optional steel slide gate as manufactured by Waterman Industries, or similar, may be installed at the culvert or slope drain inlet. The gate, if used, will normally stay closed, and may use a positive one-quarter turn cam lock which will hold the gate in any position to enable easy regulation of flow. The detention pond must be designed with safe access to the slide gate when the pond if full of water.
    b. **Spillway -** Dewatering may be achieved through a defined spillway located at least 6-inches lower than the berm of the detention pond. The spillway shall be stabilized with riprap or erosion control blanket. The spillway shall be discharge into a sediment trapping device or into a well-stabilized area.

c. **Level spreader –** Dewatering may be achieved through a level spreader, which may extend around as much as half of the reservoir berm. A level spreader is a device used to prevent erosion and to improve infiltration by spreading concentrated storm water runoff evenly over the ground at a level contour as shallow flow instead of through channels. This reduces flow speed and increases infiltration. The level spreader may consist of compacted earth, which will be vegetated on completion of construction. However, if erosion is noted during inspections it may be necessary to install aggregate, erosion control blanketing, straw bales, or wattles along the length of the level spreader.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. The primary maintenance consideration for detention ponds is the removal of accumulated sediment from to ensure the continued effectiveness of the pond. Sediments should be removed when the pond reaches approximately 50 percent sediment capacity. Inspectors should also ensure that the reservoir is draining properly and check the structure, specifically the dewatering device (culvert, spillway, or level spreader) for damage from erosion.

Removal/Abandonment

After the contributing area has been properly stabilized, the detention pond may remain in place (if the pond itself is also fully stabilized), or the pond may be removed and the newly disturbed area shall be stabilized.

References

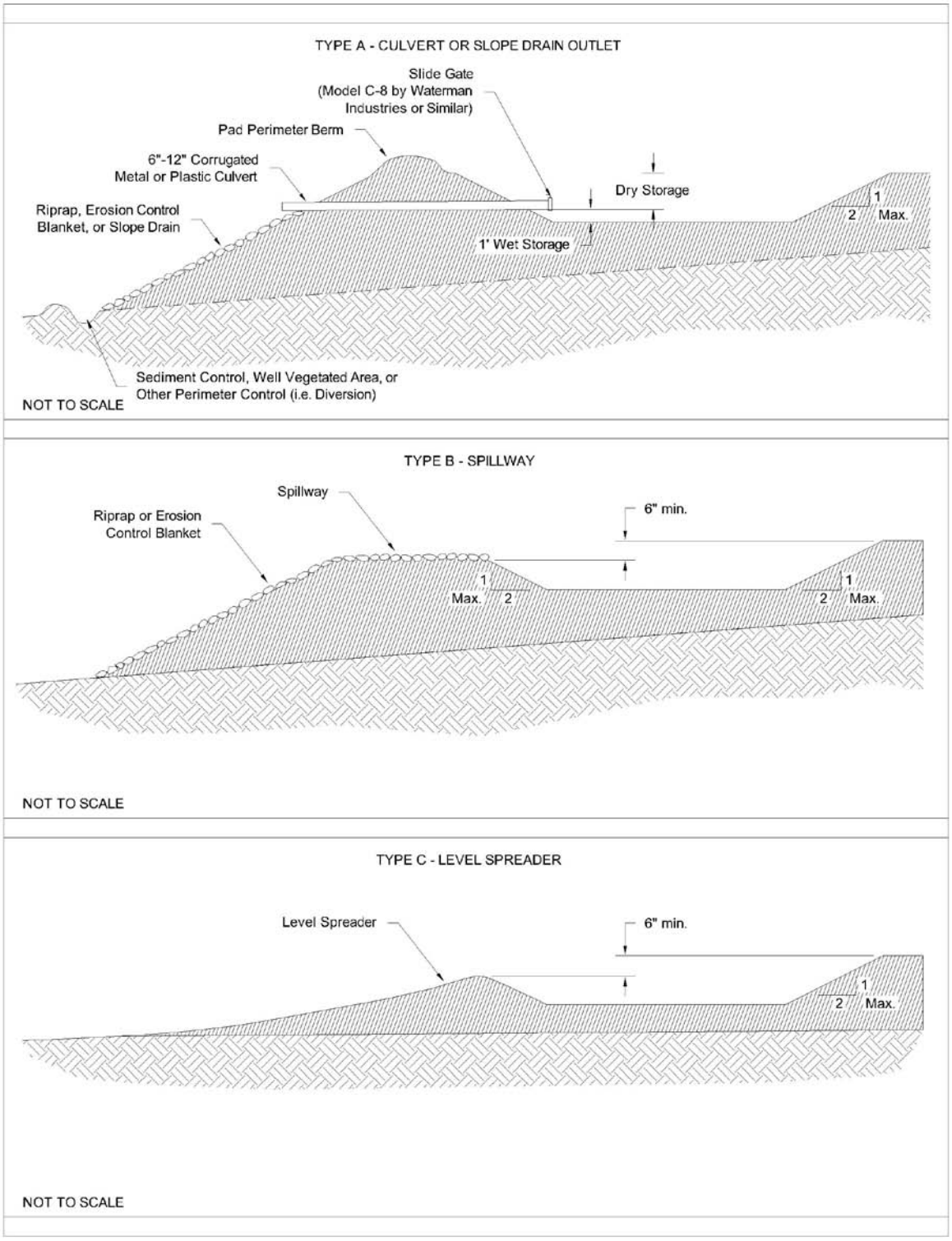
Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. <http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp>

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003 <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Figure DP-1

Detention Pond Installation



Filter Berm (FB)

Specification Section 01570/02370

Description

A filter berm is a temporary ridge made up of natural materials that already occur on the project site such. Slash filter berms use small tree branches, root mats, grass, leaves, stone, or other debris or material naturally available or left over from site clearing and grubbing. Rock filter berms use site gravel, stone, or rock. Both types of filter berms are placed along a level contour to slow, filter, and divert flow and act as an efficient form of sediment control. In some configurations, filter berms are covered with a filter cloth to stabilize the structure and improve barrier efficiency.

Applicability

The drainage area for filter berms must be no greater than 2 acres. In addition, the drainage slope leading down to a filter berm must be no greater than 2:1 and no longer than 100 feet. The following are suitable applications:

- 5 to 7 feet beyond the toe of slopes.
- Along the site perimeter.
- Along streams and channels, or adjacent to roadways.
- Around temporary spoil areas or other small cleared areas.

Limitations

- Intended to be used only in gently sloping areas, and are not appropriate for high-velocity flow areas.
- Slash filter berms have limited usefulness because they are constructed of materials that decompose.
- A large amount of material is needed to construct a useful filter berm. Therefore, filter berms are only applicable to sites where there is enough slash material from clearing and grubbing or rock material to form a sufficiently sized berm.
- May be difficult to remove after construction.

Design criteria

No formal design is required.

Construction specifications

Minor deviations from the following construction specifications are acceptable as long as performance oriented specifications are maintained. The performance oriented specification for filter berms is that sediment is not observed on the down gradient side of the berm. If sediment is observed on the down gradient side of the berm, the filter berm should be maintained or re-installed.

Slash filter berms

See Figure FB-1 for installation details.

1. Place material cleared from the site across the slope or swale. Material with a diameter larger than 6 inches should not be used.
2. Cut up brush if necessary and compact to avoid large voids within the barrier.
3. The barrier mound should be at least 2 feet high and 5 feet wide at its base.
4. It is recommended, but not required, that the mound be covered with a filter fabric barrier to hold the material in place and increase sediment barrier efficiency. If using a filter fabric cover, bury the edge in a trench 4 inches deep and 6 inches wide on the drainage side of the barrier. This is done to secure the fabric and create a barrier to sediment while allowing stormwater to pass through the water-permeable filter fabric. The fabric should be extended just over the peak of the brush mound and secured on the down-slope edge of the fabric by fastening it to twine or small-diameter rope that is staked securely.

Rock filter berms

See Figure FB-2 for installation details.

1. Place filter berm along a level contour. Use well-graded, angular site gravel or crushed rock of medium to large diameter with larger rocks on the bottom.
2. If desired, cover with geotextile fabric or wire screen (especially if concentrated flows are expected) to help keep berm in tack. Anchor fabric or wire by placing under the berm or use stakes.
3. Trenching is not required.
4. Berms should be spaced according to the steepness of the slope, with berms spaced closer together as the slope increases.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. If channels form through void spaces in the barrier, the barrier should be reconstructed to eliminate the channels. Ensure that sediment has not built up and that no damage has been done by vehicles. Regular inspection should indicate the frequency of sediment removal needed. Accumulated sediment should be removed from the uphill side of the barrier when sediment height reaches between 1/3 and 1/2 the height of the barrier. Sediment should be disposed of and the filter material and/or fabric should be replaced if necessary. It is important that repairs be performed at the first sign of deterioration to ensure that the berm is functioning properly.

Removal/Abandonment

Filter berms may be removed after uphill drainage areas are stabilized. Rock and brush may also be left in place only if it does not cause any landscaping problems. Remove all manmade materials (wire, fabric, and/or stakes).

References

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Figure FB-1

Slash Filter Berm Installation

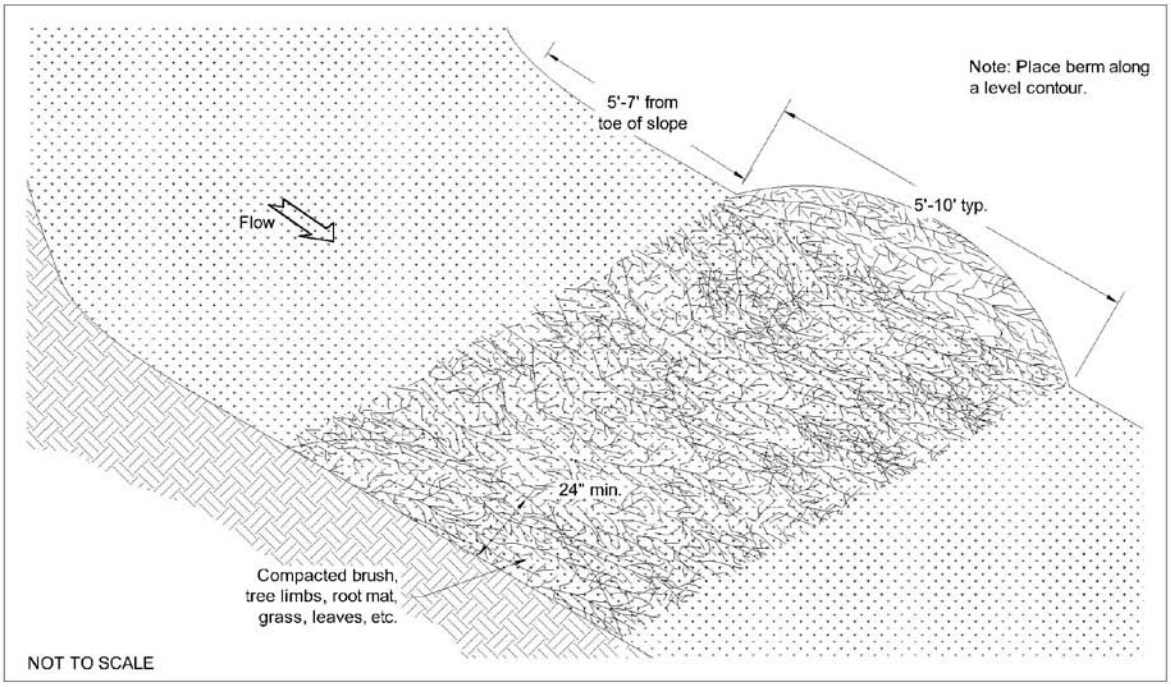
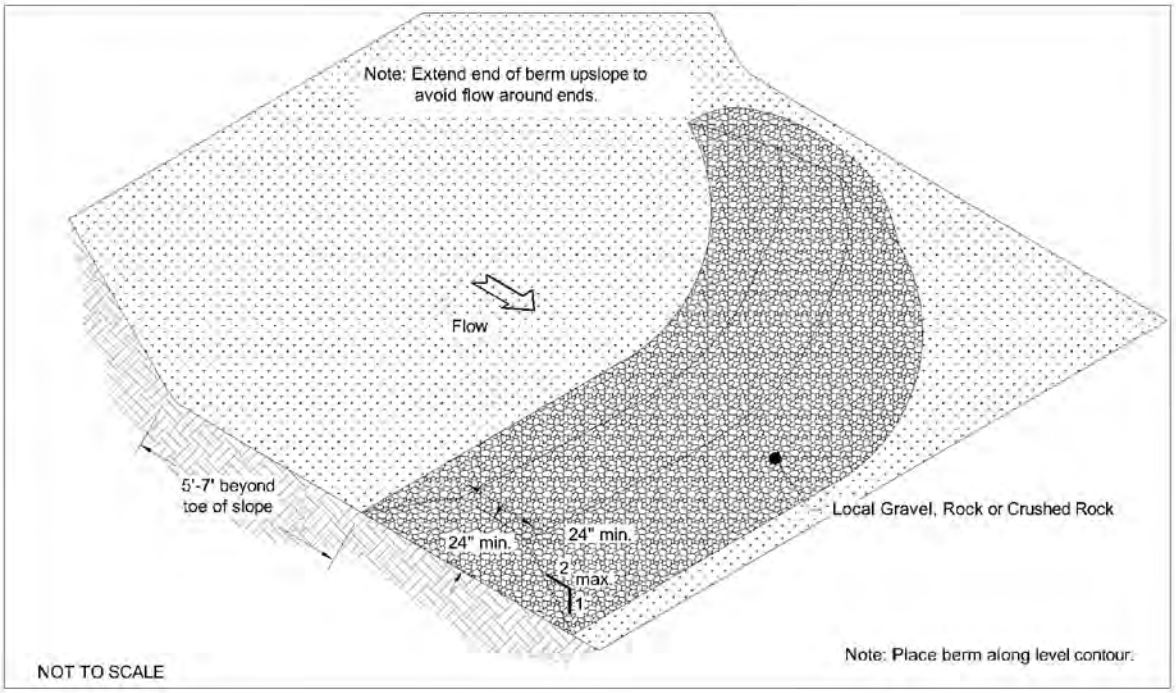


Figure FB-2
Rock Filter Berm Installation



Rumble Strip (RS)

Specification Section 01570/02370

Description

A rumble strip (also known as a stabilized construction entrance or a tracking pad) is a pad of gravel over filter cloth where construction traffic leaves a site. The purpose of a rumble strip is to minimize the amount of tracked mud and dust that leaves a site. As a vehicle drives over the gravel pad, mud and sediment are removed from the vehicle's wheels and off-site transport of soil is reduced. The gravel pad also reduces erosion and rutting on the soil beneath the stabilization structure. Filter fabric, if used, separates the gravel from the soil below, preventing the gravel from being ground into the soil. The fabric also reduces the amount of rutting caused by vehicle tires by spreading the vehicle's weight over a larger soil area than just the tire width.

Applicability

Typically, rumble strips are installed at locations where construction traffic leaves or enters an existing paved road. However, the applicability of site entrance stabilization may be extended to any roadway or entrance where vehicles will access or leave the site.

Limitations

- Although stabilizing a construction entrance is a good way to help reduce the amount of sediment leaving a site, some soil may still be deposited from vehicle tires onto paved surfaces. To further reduce the chance of these sediments polluting stormwater runoff, sweeping of the paved area adjacent to the rumble strip may be needed.
- Sediment traps or other secondary sediment controls are needed to capture that sediment that accumulates at the pad and may run off during storm events.

Design criteria

No formal design is required.

Construction specifications

See Figure RS-1 for installation details.

1. Locate the pad approximately 60 feet back from the entrance at any county road.

2. If the pad is constructed on a crowned road, a roadside ditch with check dams or sediment traps shall be located on both sides of the road to collect runoff from the pad. If the road slopes to only one side of the road then only one roadside ditch with sediment controls will be needed.
3. Place woven or non-woven fabric filter cloth over the entire area prior to placing the stone. Piping of surface water under entrance shall be provided as required.
4. Place a matrix of 1.5" minimum sized stone gravel, or reclaimed or recycled concrete equivalent, to a minimum thickness of six inches, a minimum width of 12 feet (or the width of the road) and a minimum length of 50 feet.
5. All surface water flowing or diverted toward the rumble strip shall be piped across the entrance if needed. If piping is impractical, a mountable berm with 5:1 slopes will be permitted.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Stabilization of rumble strips should be maintained until the remainder of the construction site has been fully stabilized. Stone and gravel might need to be periodically added to each rumble strip to keep the entrance effective. Soil that is tracked off site should be swept up immediately for proper disposal.

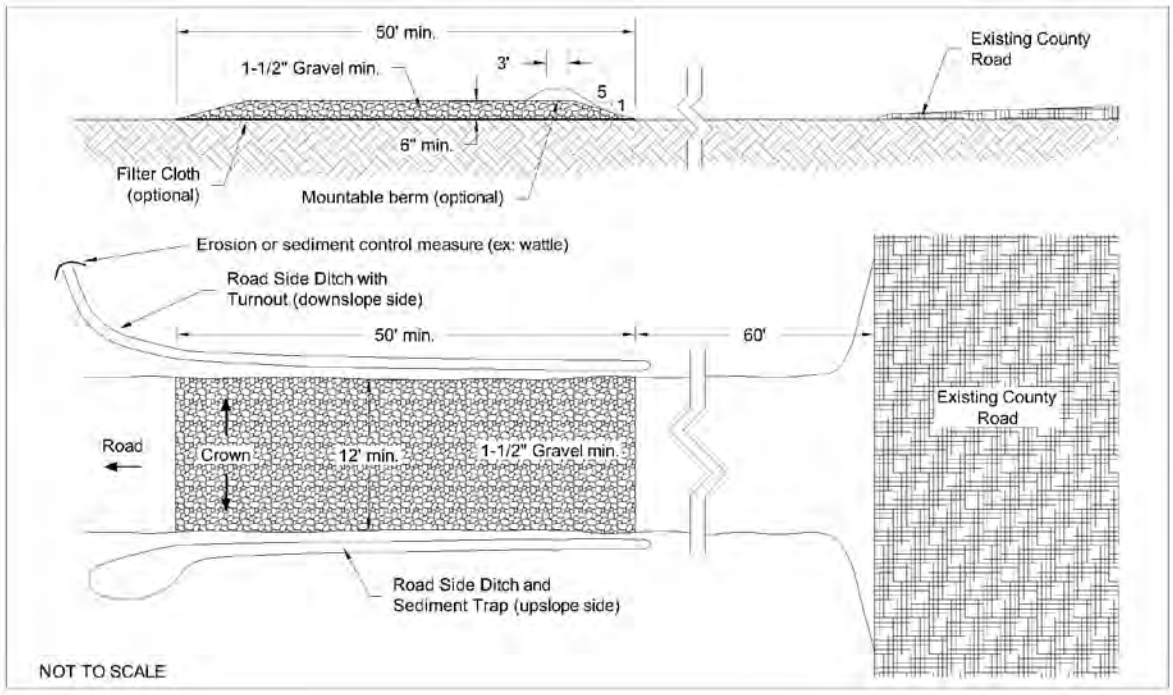
References

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. <http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp>

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Figure RS-1
Rumble Strip Installation



Sediment Trap (ST)

Specification Section 02660

Description

Sediment traps are small to medium sized ponding areas that allow sediment to settle out of runoff water. They are usually installed in natural ground in a drainage way or other point of discharge from a disturbed area. Sediment traps are formed by excavating below grade and/or by constructing an earthen embankment with a lined spillway to slow the release of runoff.

Applicability

Sediment traps are generally temporary control measures used at the outlets of stormwater diversion structures, channels, slope drains, construction site entrance wash racks, or any other runoff conveyance that discharges waters containing erosion sediment and debris. Sediment traps should be used for drainage areas less than 5 acres. Traps may be located in series to allow for backup control in case one trap fails.

Limitations

- Regular maintenance is needed to remove sediment. Traps should be located near roads or where accessible to remove sediment.
- Although sediment traps allow for settling of eroded soils, because of their short detention periods for stormwater they typically do not remove fine particles such as silts and clays.
- Water may remain in trap for extended periods causing an ideal spot for mosquitoes and other insects to gather. Locate the trap in a sunny spot if possible.
- Never construct a sediment trap on a live flowing stream or in wetlands.

Design criteria

Location

Traps should be located at points of discharge from disturbed areas and are usually created by excavating existing natural ground. The location will be determined by the natural terrain, drainage pattern of the runoff, and the accessibility for maintenance. Sediment traps should not be located in areas where their failure due to stormwater runoff excess can lead to further erosive damage of the landscape. Alternative diversion pathways should be designed to accommodate these potential overflows. Sediment trap locations should also allow for easy maintenance access for the periodic removal of accumulated sediment.

Storage capacity

A sediment trap should be designed to maximize surface area for infiltration and sediment settling. This will increase the effectiveness of the trap and decrease the likelihood of backup during and after periods of high runoff intensity. The designed capacity of the sediment trap shall be determined based on site-specific conditions.

Construction specifications

See Figure ST-1 for installation details.

1. If possible, sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.
2. Traps should be located above the floodplain, where possible. If there are space constraints, several small sediment traps may be constructed in series.
3. Area under embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. The pool area shall be cleared.
4. The fill material for the embankment shall be free of roots and other woody vegetation as well as over-sized stones, rocks, organic material or other objectionable material. The embankment shall be compacted by traversing with equipment while it is being constructed. Seeding of the embankment should be performed as soon as possible after construction of the sediment trap. Erosion control blanketing may also be used to cover the embankment in combination with seeding or during time periods when seeding is ineffective.
5. There are two options for dewatering of the sediment trap:
    a. **Spillway -** Dewatering may be achieved through a defined spillway located at least 6-inches lower than the berm of the sediment trap. The spillway shall be stabilized with riprap or erosion control blanket. The spillway shall be discharge into a sediment trapping device or into a well-stabilized area.
    b. **Level spreader –** Dewatering may be achieved through a level spreader, which may extend around as much as half of the sediment trap. A level spreader is a device used to prevent erosion and to improve infiltration by spreading concentrated storm water runoff evenly over the ground at a level contour as shallow flow instead of through channels. This reduces flow speed and increases infiltration. The level spreader may consist of compacted earth, which will be vegetated on completion of construction. However, if erosion is noted during inspections it may be necessary to install aggregate, erosion control blanketing, straw bales, or wattles along the length of the level spreader.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. The primary maintenance consideration for temporary sediment traps is the removal of accumulated sediment from the basin to ensure the continued effectiveness of the sediment trap. Sediments should be removed when the

basin reaches approximately 50 percent sediment capacity. Inspectors should also ensure that the trap is draining properly and check the structure for damage from erosion. The depth of the spillway should be checked and maintained at a minimum of 0.5 feet below the low point of the trap embankment.

Removal/Abandonment

After the contributing area has been properly stabilized, the sediment trap may remain in place (if the trap itself is also fully stabilized), or the sediment trap may be removed and the newly disturbed area shall be stabilized.

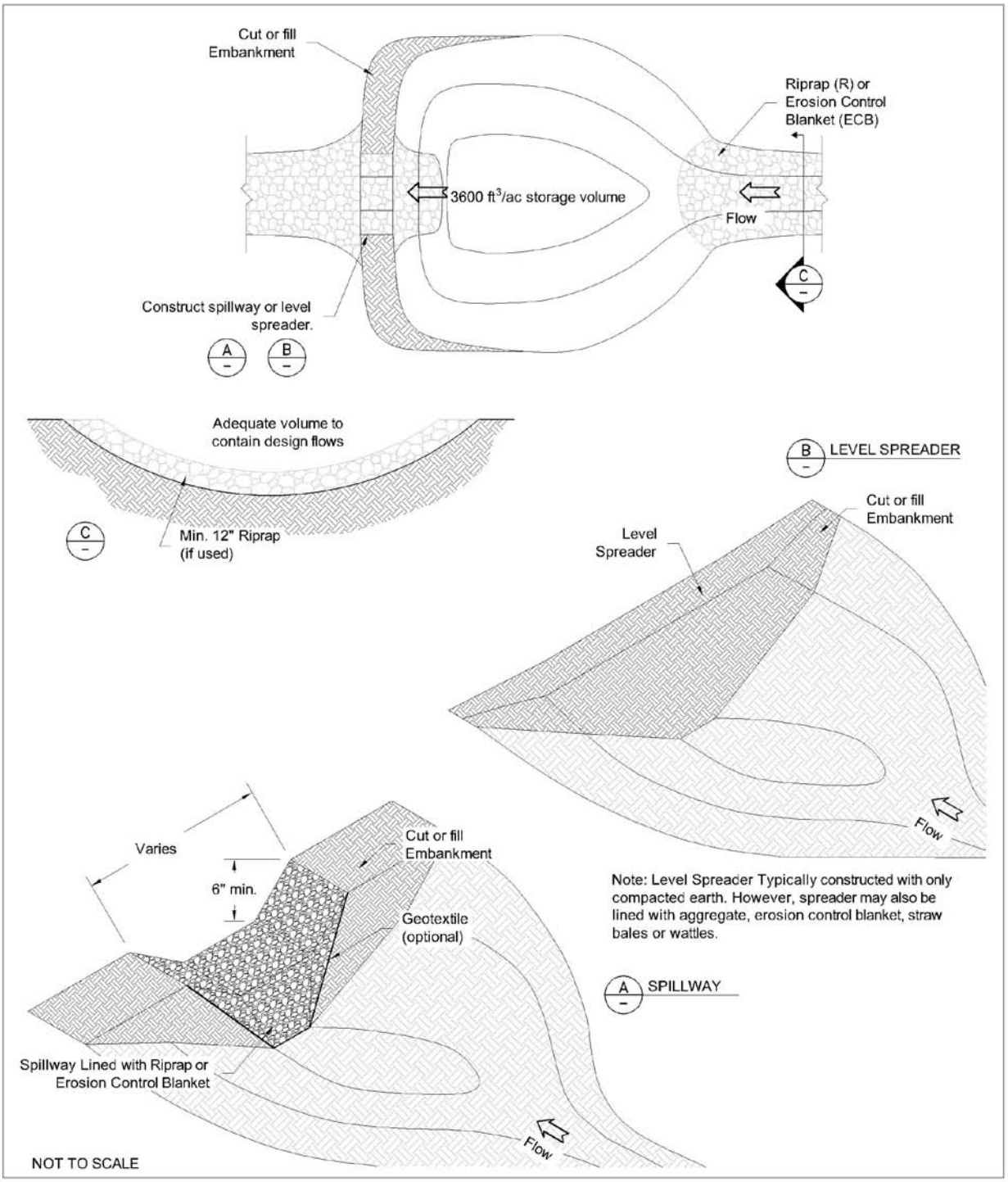
References

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. <http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp>

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

Figure ST-1
Sediment Trap Installation



Silt Fence (SF)

Specification Section 01570/02370

Description

Silt fences are used as temporary perimeter controls around sites where there will be soil disturbance due to construction activities. They consist of a length of filter fabric stretched between anchoring posts spaced at regular intervals along the site perimeter.

Applicability

Silt fences are generally applicable to construction sites with relatively small drainage areas. They are appropriate in areas where runoff will be occurring as low-level shallow flow, not exceeding 0.5 cubic feet per second. The drainage area for silt fences generally should not exceed 0.25 acre per 100-foot fence length. Slope length above the fence should not exceed 100 feet. Silt fence may be used as temporary slope breakers to reduce runoff velocity.

Limitations

- Silt fences should not be installed along areas where rocks or other hard surfaces will prevent uniform anchoring of fence posts and entrenching of the filter fabric. This will greatly reduce the effectiveness of silt fencing and can create runoff channels leading off site.
- Silt fences are not suitable for areas where large amounts of concentrated runoff are likely.
- Open areas where wind velocity is high may present a maintenance challenge, as high winds may accelerate deterioration of the filter fabric.
- Silt fences should not be installed across streams, ditches, or waterways.
- When the pores of the fence fabric become clogged with sediment, pools of water are likely to form on the uphill side of fence. Siting and design of the silt fence should account for this and care should be taken to avoid unnecessary diversion of stormwater from these pools that might cause further erosion damage.

Design criteria

No formal design required.

Construction specifications

Minor deviations from the following construction specifications are acceptable as long as performance oriented specifications are maintained. The performance oriented specification for silt fence is that sediment is not observed on the down gradient side of the silt fence. If sediment is observed on the down gradient side of the silt fence, the silt fence should be maintained or re-installed.

1. Use pre-fabricated silt fence and install according to Figure SF-1 or in accordance with manufacturer recommendations.
2. Wood or metal support posts should be spaced no more than 10 feet apart.
3. Extend silt fence across grade and upslope for a short distance.
4. Compact backfill at base of fabric.
5. A trench should be excavated to bury the bottom of the fabric fence at least 6 inches below the ground surface. This will help prevent gaps from forming near the ground surface that would render the fencing useless as a sediment barrier.
6. If using silt fence as temporary slope breakers to reduce runoff velocity, space according to the following table:

Slope (%)	Spacing
5 – 15	250'-350'
>15 – 30	150'-250'
>30	50'-150'

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect silt fences to ensure that they are intact and that there are no gaps at the fence-ground interface or tears along the length of the fence. If gaps or tears which impact the effectiveness of the BMP are found, they should be repaired or the fabric should be replaced immediately. Accumulated sediments should be removed from the fence base when the sediment reaches one-third to one-half the height of the fence. Sediment removal should occur more frequently if accumulated sediment is creating noticeable strain on the fabric and there is the possibility of the fence failing from a sudden storm event.

Removal/Abandonment

Remove silt fences and all accumulated sediment after uphill drainage areas are stabilized by vegetation or other means.

References

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. <http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp>

Environmental Protection Agency (EPA), National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control. Washington, D.C., February, 2003. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm>

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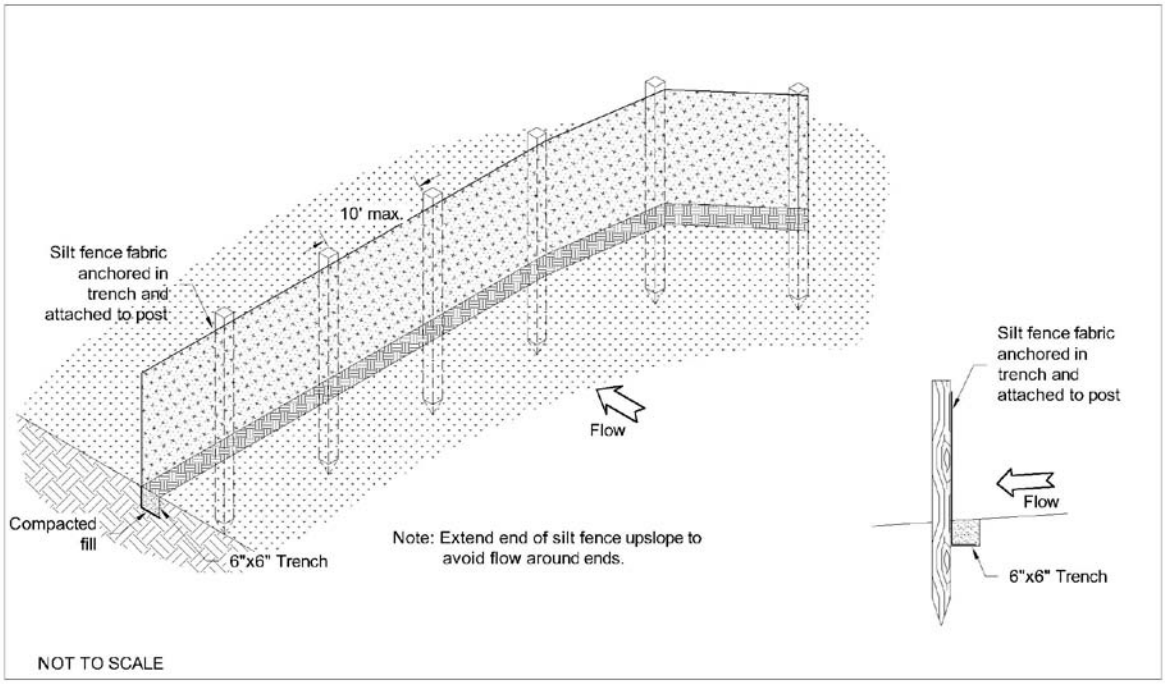
Keller, Gordon, and James Sherar, Low-Volume Roads Engineering, Best Management Practices Field Guide. United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2005. <http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm>

Figure SF-1
Silt Fence Installation



Slash (SL)

Specification Section 02230

Description

Slash is any natural debris or material left over from site clearing and grubbing. Slash may include small tree branches, root mats, grass, leaves, stone, etc... Placement of slash over disturbed areas can help control off-site transport of sediment by slowing the flow of runoff, which minimizes erosion, and trapping sediment until vegetation is established at the sediment source.

Applicability

Slash may be used for the following:

- As a pre-construction BMP.
- To create a filter berm (see Filter Berm BMP).
- As a blanket over any disturbed area, particularly pipeline corridors and areas of fill.
- As outlet protection for culverts.
- As slash mulch (see Mulching BMP).

Limitations

- Material may need to be cut up or broken into smaller pieces.
- Slash does not eliminate the need to revegetate.

Design criteria

No formal design is required.

Construction specifications

1. For slash filter berms, see the Filter Berm (FB) BMP.
2. For slash mulch, see the Mulching (M) BMP.
3. Prior to spreading slash over a disturbed area, the area may be seeded in accordance with the Revegetation BMP.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect for any excessive erosion and replace slash with an alternate BMP if necessary (such as erosion control blanket).

Removal/Abandonment

Removal of slash is not necessary.

Straw Bale Barrier (SBB)

Specification Section 01570/02370

Description

A straw bale barrier is a series of entrenched and staked straw bales placed on a level contour to intercept sheet flows. The barrier reduces runoff velocity and filters sediment laden runoff from small drainage areas of disturbed soil. The barrier may also be used to protect against erosion.

Applicability

Straw bale barriers may be used below disturbed areas subject to sheet and rill erosion where the length of slope above the straw bale barrier does not exceed the following limits:

Constructed Slope	Percent Slope	Slope Length (ft)
2:1	50%	25’
3:1	33%	50’
4:1	25%	75’

Straw bales may be used in the following applications:

- Below the toe of erodible slopes or other small cleared areas
- At the top of slopes to divert runoff away from disturbed slopes
- As sediment traps at outlets to culverts, ditches, turnouts, etc.
- Along the perimeter of a site
- Around temporary stockpiles and spoil areas
- Along streams and channels for both erosion and sediment control
- As check dams across mildly sloped swales or construction roads

Limitations

- For short-term use only
- For use below small drainage areas less than 2 acres

- Decomposes over time
- May be consumed by livestock
- Straw bales must be certified weed free to avoid invasive weeds that may develop and should not be used in areas where weeds are a concern.
- Removal of anchor stakes will be necessary after stabilization is complete
- Not recommended for concentrated flow, live streams, or swales where there is the possibility of a washout

Design criteria

No formal design is required.

Construction specifications

Minor deviations from the following construction specifications are acceptable as long as performance oriented specifications are maintained. The performance oriented specification for a straw bale barrier is that sediment is not observed on the down gradient side of the barrier. If sediment is observed on the down gradient side of the barrier, the straw bales should be maintained or re-installed.

See Figure SBB-1 for installation details.

1. Bales shall be placed in a single row on a level contour with ends of adjacent bales tightly abutting one another. Bales shall be certified weed free.
2. Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
3. All bales shall be either wire-bound or string-tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings.
4. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. Stake the bales with wood or metal stakes.
5. After the bales are staked and chinked (gaps filled by wedging), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier.
6. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake or steel post in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or steel pickets shall be driven a minimum 12 inches deep into the ground to securely anchor the bales.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Close attention should be paid to the repair of damaged or rotting bales, end runs and undercutting beneath bales. Necessary repairs to barriers or replacement of bales should be accomplished promptly. Sediment deposits should be removed when the level of deposition reaches approximately one-half the height of the barrier.

Removal/Abandonment

Straw bale barriers may be removed when they have served their usefulness or may remain in place to decompose over time. Straw bales should not be removed, however, until the upslope areas have been permanently stabilized. Any sediment deposits remaining in place after the straw bale barrier is no longer required should be dressed to conform to the existing grade, prepared and seeded.

References

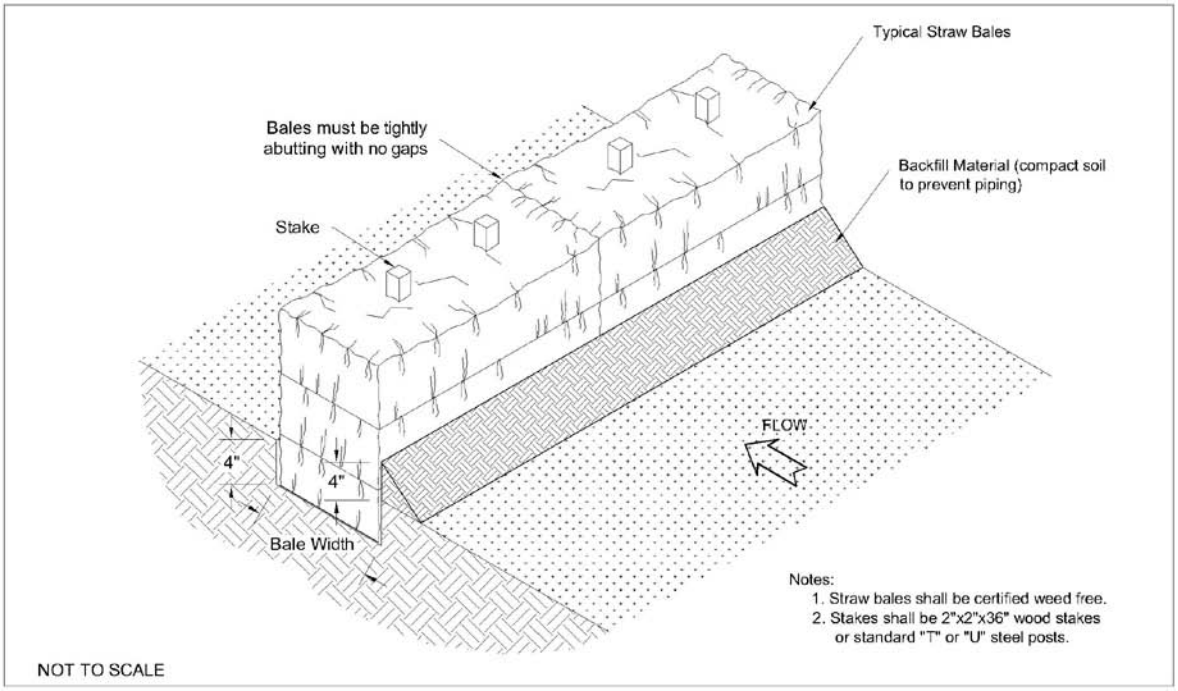
Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. <http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp>

Horizon Environmental Services, Inc, Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites. April 2004.

New York State Department of Environmental Conservation, New York Guidelines for Urban Erosion and Sediment Control. New York. Fourth Edition, 1997.

Figure SBB-1

Straw Bale Installation



Wattles (W)

Specification Section 01570/02370

Description

A wattle (also called a fiber roll) consists of straw, flax, or other similar materials bound into a tight tubular roll. Excelsior log (aspen fiber) is the preferred wattle. When wattles are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Applicability

Wattles may be suitable:

- As slope breakers along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length, reduce runoff velocity, and spread runoff as sheet flow
- At the end of a downward slope where it transitions to a steeper slope
- Along the perimeter of a project in an undisturbed area
- At the overflow locations of sediment traps
- As check dams in unlined ditches
- Around temporary stockpiles

Limitations

- When used in disturbed areas, wattles are not effective unless trenched.
- Wattles placed directly at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20-in. diameter or installations achieving the same protection (i.e. stacked smaller diameter wattles, etc.).

- Difficult to move once saturated.
- If not properly staked and trenched in, wattles could be transported by high flows.
- Wattles have a very limited sediment capture zone.
- Wattles should not be used on slopes subject to creep, slumping, or landslide.
- Wattles should not be used where periodic road or surface maintenance activities are expected.

Design criteria

No formal design is required.

Construction specifications

Minor deviations from the following construction specifications are acceptable as long as performance oriented specifications are maintained. The performance oriented specification for wattles is that sediment is not observed on the down gradient side of the wattle row. If sediment is observed on the down gradient side of the wattle, the wattle should be maintained or re-installed.

Wattles should be either 100% biodegradable prefabricated rolls or rolled tubes of 100% biodegradable erosion control blanket. (If using an erosion control blanket, roll the length of erosion control blanket into a tube of minimum 8 in. diameter and bind roll at each end and every 4 ft along length of roll with jute-type twine.)

See Figure W-1 for wattles used to control erosion along slopes.

1. Locate wattles on level contours spaced as follows:
    a. Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
    b. Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
    c. Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
2. Turn the ends of the wattles up slope to prevent runoff from going around the roll.
3. If wattles are used in a disturbed area, stake wattles into a 2 to 4 in. deep trench with a width equal to the diameter of the wattle. Drive stakes at the end of each wattle and spaced 4 ft maximum on center. If wattles are part of a layered BMP system (3 or more) or if a vegetated buffer (VB) is used and the wattle is placed on undisturbed earth, the wattles may be staked without trenching. Staking must insure continuous contact with the ground.
4. Wattles may be staked more than one wattle deep, if needed.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Repair or replace split, torn, unraveling, or slumping rolls. If the wattle is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates must be periodically removed in order to maintain wattle effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the wattle and the adjacent ground surface.

Removal/Abandonment

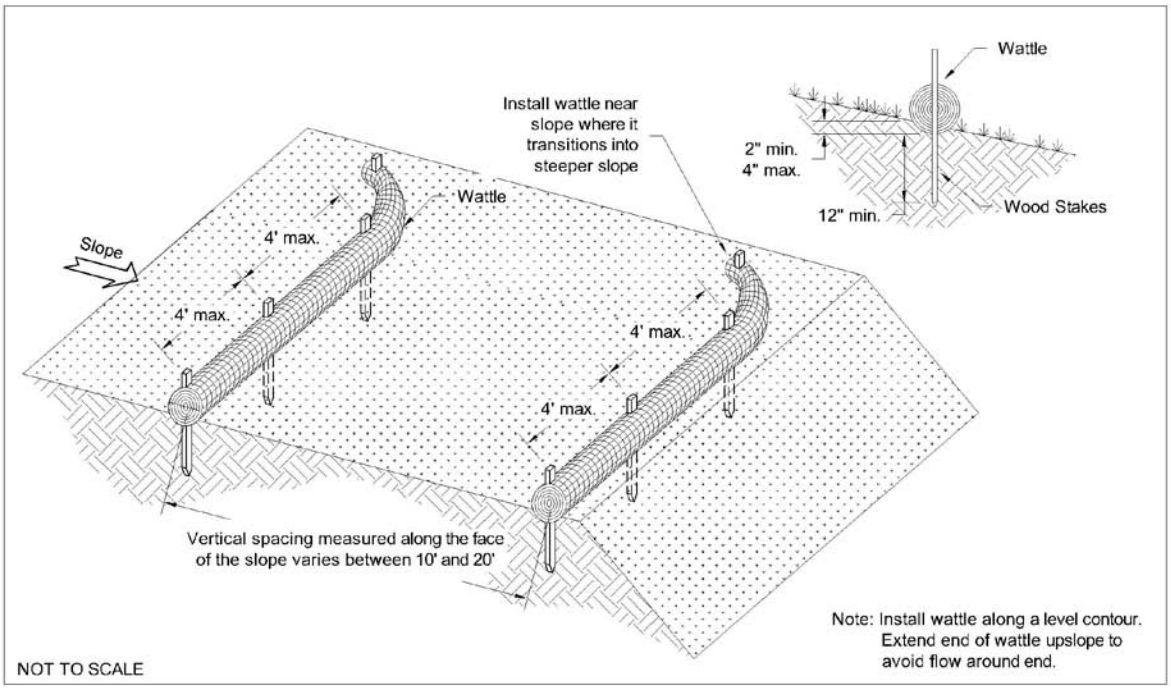
Wattles are typically left to rot in place. However if wattles are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

References

California Stormwater Quality Association, Stormwater Best Management Practice (BMP) Handbook – Construction. January, 2003. <http://www.cabmphandbooks.com/Construction.asp>

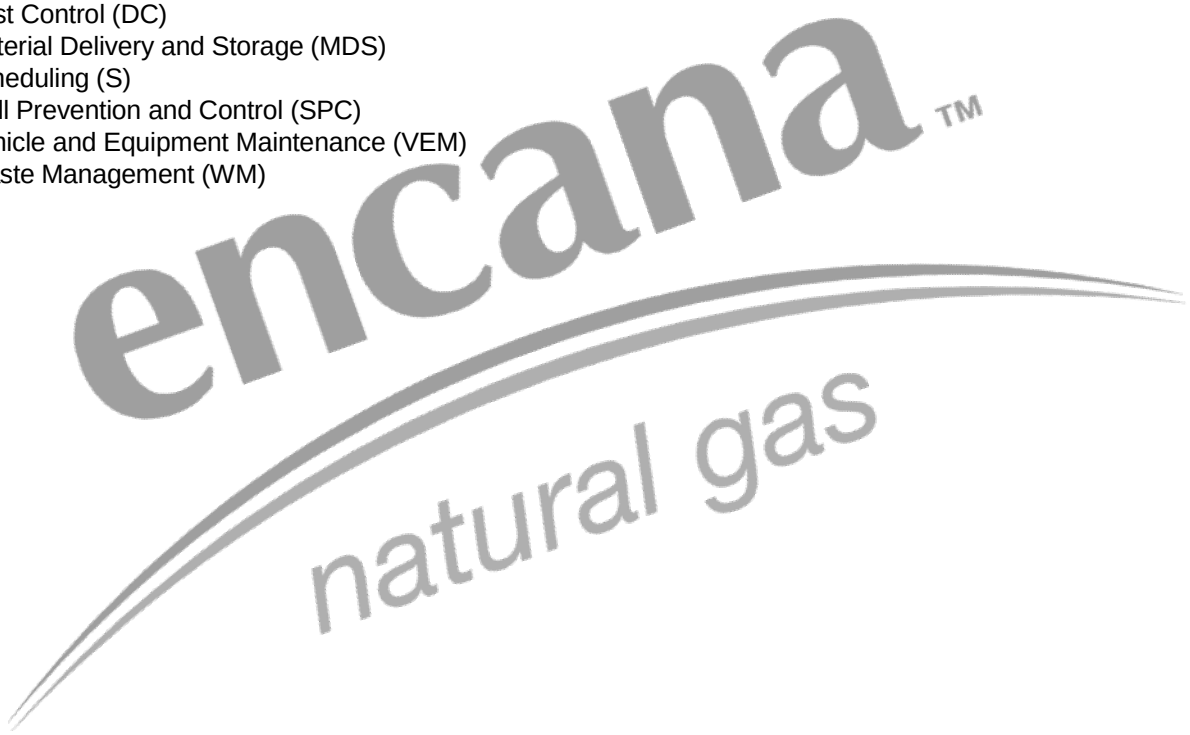
Figure W-1

Wattle Installation



Non-Stormwater BMPs

Dewatering (DW)
Dust Control (DC)
Material Delivery and Storage (MDS)
Scheduling (S)
Spill Prevention and Control (SPC)
Vehicle and Equipment Maintenance (VEM)
Waste Management (WM)



Dewatering (DW)

Specification Section 02240

Description

Dewatering involves the removal and discharge of excess water from construction sites to natural drainages. Excess water may be due to groundwater, accumulated precipitation after a storm event (stormwater), or water used during construction activities (i.e. for the testing of pipelines). Proper removal of excess water helps to prevent potential pollutants (such as sediment or toxic and petroleum products) from entering watercourses. Sediment control from dewatering operations is required on all projects where excess water containing sediment or other pollutants is planned to be discharged. A temporary settling or filtering device should be used to avoid pollutant discharges from dewatering operations.

Applicability

These practices are implemented where groundwater, accumulated precipitation (stormwater), or other water used during construction will be discharged from a site.

Limitations

- Site conditions will dictate design and use.
- A settling device often allows only minimal settling time for sediment particles.
- Multiple sediment control methods shall be used, if necessary, for better sediment removal when site conditions allow.
- The controls discussed in this BMP address sediment only. If the presence of polluted water is identified, dewatering pollution controls should be implemented in accordance with regulatory requirements.

Standards

Groundwater dewatering

1. All dewatering operations must comply with the Stormwater Management Plan and the CDPS General Permit For Construction Dewatering Activities (Permit No. COG-070000).
2. Discharges to the ground of water from construction dewatering activities may be authorized, provided that:
    a. The source is groundwater and/or groundwater combined with stormwater that does not contain pollutants in concentrations exceeding the State groundwater standards in Regulations 5 CCR 1002-41 and 42

b. The source is identified

c. BMPs are utilized

d. These discharges do not leave the site as surface runoff or to surface waters

3. Dewatered groundwater shall be pumped or diverted to a sediment control BMP prior to discharge to the ground.

Stormwater Dewatering

1. All dewatering operations must comply with the Stormwater Management Plan and the CDPS General Permit For Construction Dewatering Activities (Permit No. COG-070000).
2. The discharge of pumped stormwater (not including groundwater or other non-stormwater sources) from excavations, ponds, depressions, etc., to surface water, or to a municipal separate storm-sewer system is allowed as long as the dewatering activity and associated BMPs are implemented in accordance with this manual.
3. Stormwater that collects in open depressions or trenches during construction activities will be dewatered into a settling device (discussed below), an existing sediment control, such as a detention pond, a sediment trap, a perimeter diversion channel, or simply into a well-vegetated area to percolate into the ground and catch suspended sediment. The latter may be authorized if some of the following conditions exist or may occur:

    a. There are no existing sediment controls on location.

    b. The existing controls are overwhelmed.

    c. The dewatering process will cause the controls to improperly function.

4. Stormwater dewatering will be in accordance with Encana's Standard Operating Procedure (SOP) for Dewatering Stormwater from Facilities. Some requirements of the SOP include:

    a. Assure that no visual sheen of oil or presence of other chemicals exists prior to pumping.

    b. All transfer pumps must be equipped with a State approved dewatering filter prior to discharge.

    c. If water has been in contact with drill cuttings, a pH level test must be conducted before working with the accumulated water. A pH of > 9 should be reported immediately to the Environmental Department and additional controls will be instituted prior to water discharge.

    d. A water sample may be required before dewatering activities begin.

Pipeline Dewatering

Once the hydrostatic testing of pipelines has been completed, dewatering of the pipeline will occur.

1. Insert a displacer, commonly referred to as a pig, in the pipeline.
2. Regulate the discharge rate and utilize energy dissipation devices and/or sediment controls as necessary to prevent erosion, streambed scour, suspension of sediments, or excessive stream flow.

Specifications

One of several types of dewatering structures may be constructed depending on site conditions and type of operation:

1. Water may be pumped or directed into existing stormwater sediment controls (such as sediment traps) capable of handling the volume and flow rate of dewatered water.
2. Water may be pumped or directed into a temporary settling device as described below.

3. Water may be land applied to approved non-wetland vegetation areas and allowed to soak into the soil.
4. Water may be hauled away from the project for disposal in accordance with applicable laws and regulations.

If existing stormwater sediment controls are used to control water, the applicable sections of this BMP Manual shall be followed.

If a settling device is utilized, the following design criteria shall be followed:

Straw Bale/Silt Fence Pit

- It is recommended that the structure consist of an excavated basin surrounded by a perimeter control such as wattles, hay bales, or silt fence (see Figure DW-1). Install wattles, hay bales, or a silt fence as described in applicable sections of this BMP Manual.
- The following formula should be used to determine the storage volume of the sediment tank:

  Pump discharge (gpm) x 16 = cubic feet of storage required
- The excavated area should be a minimum of 3 feet below the base of the perimeter control. The excavated portion will serve for wet storage, and the remainder will provide dry storage.
- When water reaches the outlet crest, pumping must stop until the water drains down to the elevation of the excavated area.
- The remaining water may be removed only after a minimum of 6 hours of sediment settling time. This effluent should be pumped across an area with established vegetation or through a silt fence prior to entering a watercourse.
- When the excavated area becomes filled to one-half of the excavated depth, accumulated sediment should be removed and properly disposed of.

Sediment Filter Bag

- A filter bag, constructed of non-woven geotextile material (to provide adequate filtering ability to capture the larger soil particles from the pumped water), will be clamped around the dewatering pump discharge hose so that all of the pumped water passes through the bag.
- The filter bag should be used in combination with a straw bale/silt fence pit when located within 50 feet of a stream. When the distance to a stream is greater than 50 feet, the bag may be placed on well-vegetated area, or on an aggregate pad. The bag should never be placed on bare soil.
- The capacity of the bag should be adequate to handle the dewatering pump discharge, and should be based on the bag manufacturer's recommendation.
- When used in conjunction with a straw bale/silt fence pit, a filter bag may be operated until the water in the pit reaches the crest of the emergency overflow.
- When placed on either a stone pad or well-vegetated area, the bag may be operated until such time the discharge from the bag reaches a stream.
- When the bag has been completely filled with sediment it should be cut open, sediment regraded in place, and immediately stabilized with an erosion control.

A settling device and/or sediment control may not be needed if the water is discharged to a well stabilized, on-site, vegetated area. The stabilized area should be capable of filtering sediment while at the same time withstanding the velocity of the discharged water without eroding. A minimum filtering length of 75 feet is recommended for the stabilized area.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. If using a settling device, sediments should be removed once they have accumulated to one-half of the excavated depth and properly disposed of. Sediment removal from dewatering devices shall be stabilized at the project site at pre-designated locations or shall be disposed of properly.

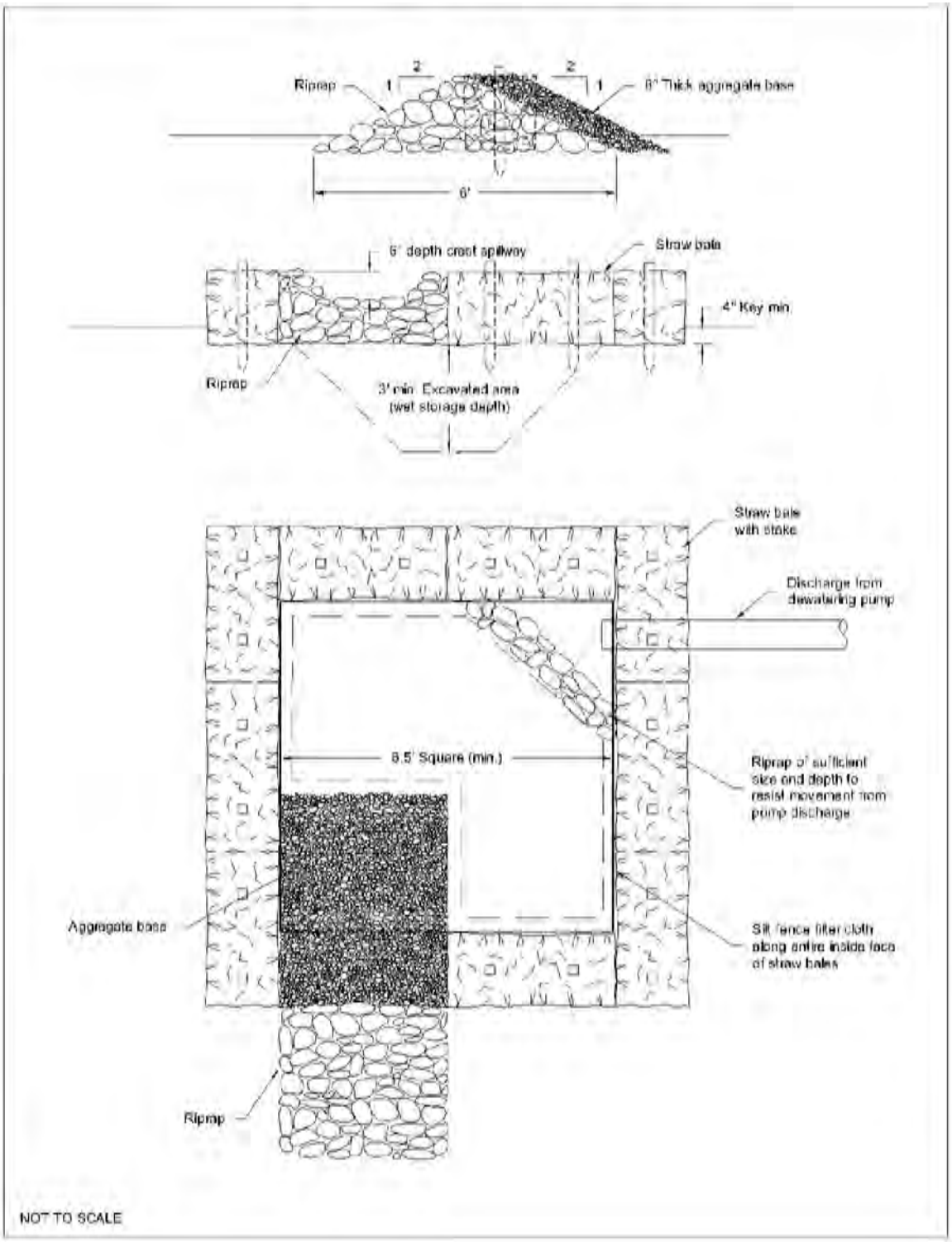
References

Arizona Department of Transportation (ADOT), Erosion and Pollution Control Manual. 2005.

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp

Federal Energy Regulatory Commission (FERC), Upland Erosion Control, Revegetation, and Maintenance Plan. January 2003.

Figure DW-1
Settling Device Installation



Dust Control (DC)

Specification Section 01570

Description

Dust control involves practices such as applying water or dust palliatives (such as magnesium chloride) to be implemented during construction operations to prevent dust and wind erosion from exposed soil surfaces. Other dust control practices not discussed within this BMP include the use of speed restrictions, regular road maintenance, restriction of construction activity during high-wind days, road surfacing, and wind breaks and barriers.

Applicability

These practices are limited to exposed soil where wind erosion is expected. Dust palliatives (such as magnesium chloride) are typically used after spring rains and before winter snows.

Limitations

The effectiveness of this application can be limited by soil, temperature, and wind velocity.

Standards and specifications

Irrigation practices can be applied to a project site until the soil is moist and can be repeated as necessary. However, the soil shall not be oversaturated causing runoff to flow from the project site. The distribution system shall be equipped with a proper spray system to ensure even water distribution. When a distribution system is unavailable, at least one mobile unit shall be available at all times to apply water or a dust palliative to the project site. All non-potable tanks, pipes, and other conveyances shall be marked “non-potable water - do not drink.”

Seeding, mulching, soil binder, and grading techniques are also temporary methods to prevent dust and wind erosion. Refer to the applicable BMPs.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect protected areas for adequate protection and signs of degradation. Perform spot-checks to ensure dust and wind erosion control techniques are properly implemented.

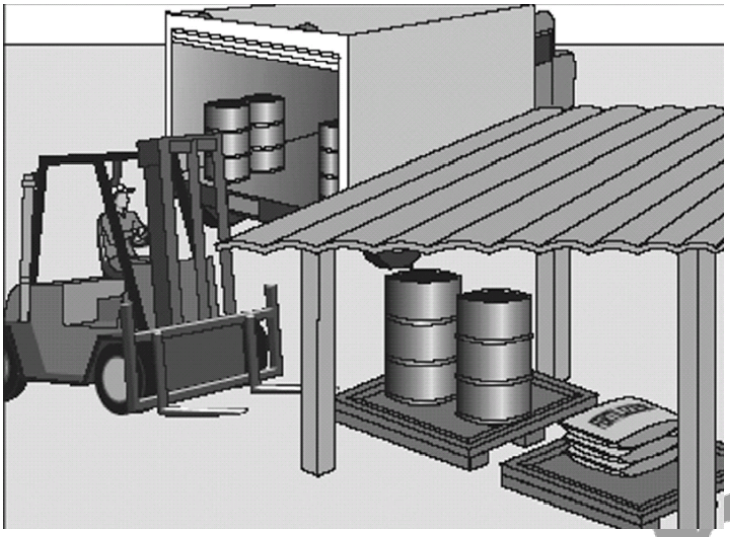
References

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp

Colorado Oil and Gas Commission (COGCC) Rules and Regulations <http://cogcc.state.co.us/>

Material Delivery and Storage (MDS)

Specification Section 01570



Description

These practices are to be implemented for proper handling, delivery, and storage of materials in order to prevent spills or leaks into the storm drains or watercourses.

Applicability

These practices are implemented at all construction sites where delivery and storage of materials may be detrimental to the environment. Materials of concern are not limited to soil, pesticides, herbicides, fertilizers, petroleum products, asphalt and concrete components, and hazardous chemicals such as acids, paints, solvents, adhesives, and curing compounds.

Limitations

Space limitation may preclude indoor storage. Storage sheds must meet building and fire code requirements.

Standards and specifications

Deliver and loading/unloading areas

- Keep an accurate, up-to-date inventory of material delivered and stored on site.
- Minimize hazardous material storage on site.
- Employees trained in emergency spill clean-up procedures should be present when dangerous materials or liquid chemicals are unloaded.
- Cover loading and unloading areas to reduce exposure of materials to rainfall.
- Routinely check vehicles and equipment such as valves, pumps, flanges, and connections for leaks.
- Direct off-site stormwater flows away by grading, berming, or curbing the area around the loading/unloading area.

Storage and material handling areas

- Designate storage areas at the project site.
- Locate the storage area away from the storm drain system and watercourses.

- Provide curbs or dikes around the perimeter of material storage areas to prevent run-on from adjacent areas as well as runoff of stormwater from the material storage areas.
- Prevent spills or leakage of liquid materials from contaminating soil (i.e., soaking into the ground) by placing storage areas on impervious surfaces.
- Stockpile soil in accordance with the Stockpiling BMP for topsoil and subsoil.
- Store materials indoors within existing structures or sheds when available.
- Material safety data sheets (MSDS) shall be made available for all materials.
- Training for proper material handing and storage techniques shall be required.
- Provide sufficient separation between storage containers to allow cleanup and emergency response.
- Chemically incompatible materials should not be stored together or in the same storage facility.
- Label all materials properly and maintain current legible labels; also maintain a current inventory of all material delivered and stored.
- Do not store hazardous chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and when possible, under cover in secondary containment.
- Keep hazardous chemicals in their original containers and keep them well labeled.

Spill Clean-up

- Immediately contain and cleanup any spills according to the Spill Prevention and Control BMP as well as the Spill Prevention and Control Countermeasures (SPCC) Plan.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose of any hazardous materials or contaminated soil.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect equipment and vehicles for leaks. Maintain an ample supply of cleanup materials at all designated storage and handling areas where leaks and spills are likely to occur. Spot-check material storage and handling areas for compliance. Material storage areas shall be checked for accumulation of non-labeled materials and spills. Containment structures or other perimeter controls shall be inspected and repaired when signs of degradation are visible.

References

Arizona Department of Transportation (ADOT), Erosion and Pollution Control Manual. 2005.

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp

Scheduling (S)

Specification Section 01570

Description

Develop a schedule for every project that includes sequencing (phasing) of construction activities in conjunction with the implementation of construction site BMPs in order to reduce the amount and duration of soil exposed by construction activities. The purpose is to minimize erosion of disturbed soils by wind, rain, runoff, and vehicle tracking by reducing the amount and duration of soil exposed to erosion and ensuring that BMPs are implemented in a timely manner as construction proceeds.

Applicability

- Construction activities shall be planned to minimize the amount of disturbed land exposed to erosive conditions.
- Stabilization measures shall be installed and maintained as work progresses, not just at the completion of construction.

Standards and specifications

- Schedule the installation of temporary and permanent controls as specified in the Construction General Permit.
- The schedule of construction activities and concurrent application of temporary and permanent BMPs is developed as part of the SWMP or PCSWMP.
- Schedule clearing and grubbing activity to allow existing vegetation to remain in place as long as possible.
- Where possible, schedule construction for the dry seasons.
- For larger projects, the contractor shall not expose more than 750,000 square feet in any location until temporary or permanent BMPs have been installed.
- Schedule shall include dates for significant long-term operations or activities that may have planned non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, bridge cleaning, etc.
- Schedule shall include dates for installation of permanent drainage systems and runoff diversion devices. These devices should be installed as early as possible in the construction process.
- The schedule shall include non-stormwater BMPs, waste management, and materials pollution control BMPs.

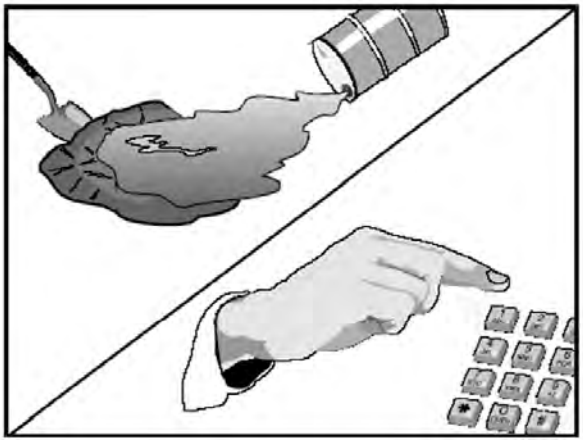
- Stabilize non-active areas as specified in the Construction General Permit.
- Monitor weather forecast and adjust construction schedule to allow for the implementation of soil stabilization and sediment controls on all disturbed areas prior to the onset of rain.
- Where possible, avoid performing maintenance in the winter.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Verify that work is progressing in accordance with the schedule. The schedule must be updated when changes are warranted or when directed by the Engineer.

References

Arizona Department of Transportation (ADOT), Erosion and Pollution Control Manual. 2005.



Description

These practices are implemented to prevent and control spills to ensure that spills and leaks do not result in water quality impacts.

Applicability

This BMP applies to all construction activities. Spill prevention and control measures shall be implemented any time chemicals or hazardous substances are used, stored, or handled.

Limitations

The measures described in this BMP are general. Appropriate practices for specific materials used, stored, or handled on a project site should be identified by site personnel.

Standards and specifications

The following general design guidelines can be implemented for spill prevention and control measures for various activities and areas:

- Identify materials delivered, handled, stored, and used at a project site.
- Identify project areas and activities potentially susceptible to spills. Areas and activities that are most vulnerable to spills include: transportation facilities, loading and unloading areas, fuel and chemical storage areas, process activities, dust or particulate generating processes, and waste disposal activities.
- Develop spill response procedures.

Spill Prevention Control and Countermeasures (SPCC) Plan

A Spill Prevention Control and Countermeasures (SPCC) Plan has been developed and will be implemented for certain products that are stored at the site. The SPCC Plan identifies areas where spills can occur on site, specifies material handling procedures and storage requirements, and identifies spill cleanup procedures. The purpose of this plan is to establish standard operating procedures and the necessary employee training to minimize the likelihood of accidental releases of pollutants that can contaminate stormwater runoff. Spill prevention is prudent both environmentally and economically, since spills increase operating costs and lower productivity.

Emergency spill cleanup plans should include the following information:

- A description of the facility including the nature of the facility activity and general types and quantities of chemicals stored at the facility.
- A site plan showing the location of storage areas for chemicals, location of storm drains, site drainage patterns, fire-fighting equipment and water source locations, and the location and description of any devices used to contain spills such as positive control valves.
- Notification procedures to be implemented in the event of a spill, such as, posting phone numbers of key personnel and appropriate regulatory agencies.
- Instructions regarding cleanup procedures.
- Designating personnel with overall spill response cleanup responsibility.
- A summary of the plan should be written and posted at appropriate points in the building (i.e., project trailer and areas with a high spill potential), and shall identify the spill cleanup coordinators, location of cleanup kits, and phone numbers of regulatory agencies to be contacted in the event of a spill.
- Cleanup of spills should begin immediately. No emulsifier or dispersant should be used. In fueling areas, absorbent materials should be packaged in small bags for easy use, and small drums should be available for storage of absorbent and/or used absorbent. Absorbent materials shall not be washed into the floor drain or storm sewer.

Cleanup response procedures

Response guidelines have been identified below for contractors responding to spills that may potentially result in an illicit discharge. It is the contractor's responsibility to have all emergency phone numbers available at the construction site as well to notify the proper response agencies in a timely manner. It is also the contractor's responsibility to ensure timely and proper cleanup of any spill.

Minor spills

For **non–hazardous materials** such as gasoline, paint, or oil that may be spilled in **small quantities** which do not enter state waters or pose a potential to do so, the following measures shall be implemented:

1. Use absorbent materials to contain spills. Do not hose down spill area with water or bury the spill.
2. Recover spilled materials.
3. Clean the contaminated area of residuals and/or properly dispose of the absorbent material.

Semi-significant spills

For **non-hazardous materials** that qualify as a **semi-significant spill** or spills of any size which do not enter state waters or pose a potential to do so and can be controlled by the first responder along with the aid of other personnel, the following measures shall be implemented:

1. Notify the project foreman immediately. The foreman should notify the resident engineer.
2. Contain the spills to prevent spreading.
3. If the spills occur on paved or impermeable surfaces, clean-up using "dry" methods (adsorbent materials, cat litter, and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
4. If the spill occurs in a dirt area, immediately contain it by constructing an earthen dike. Dig up and properly dispose of contaminated material.
5. If the spills occur during rain, cover affected area if possible.

Significant spills

For **non-hazardous materials** that qualify as a **significant spill** or spills of any size that enter state waters or have the potential to do so, the following measures shall be implemented:

1. Contact the Colorado Department of Public Health and Environment (CDPHE) Environmental Emergency Spill Reporting Line (1-877-518-5608) within 24 hours of the spill event. A written notification to the CDPHE-Emergency Management Program (EMP) is necessary within 5 days.
2. Contact the Colorado State Patrol 24-hour hotline (1-303-239-4501) if the spill is on a state highway.
3. Notify the project foreman and maintenance personnel on patrol immediately and follow up with a written report.
4. If possible, cleanup the spill immediately. Use absorbent materials if the material is on an impermeable surface. Construct an earthen dike to contain a spill on dirt areas. If rainfall is present at the time of the spill, cover the spill with a tarp to prevent contaminating runoff.

Hazardous spills

For all spills involving **hazardous materials**, the following measures shall be implemented:

1. Contact the local emergency response team by dialing 911.
2. Contact the CDPHE-EMP 24 Environmental Emergency Spill Reporting Line (1-877-518-5608) within 24 hours of the spill event. A written notification to the CDPHE-EMP is necessary within 30 days.
3. Contact the Colorado State Patrol 24-hour hotline (1-303-239-4501) if the spill is on a state highway.
4. Report spills to project foreman and maintenance personnel on patrol and follow up with a written report.
5. Construction personnel shall not try to clean up the spill.
6. Cleanup spill immediately; a licensed contractor or HazMat team shall be used to properly clean up spills.

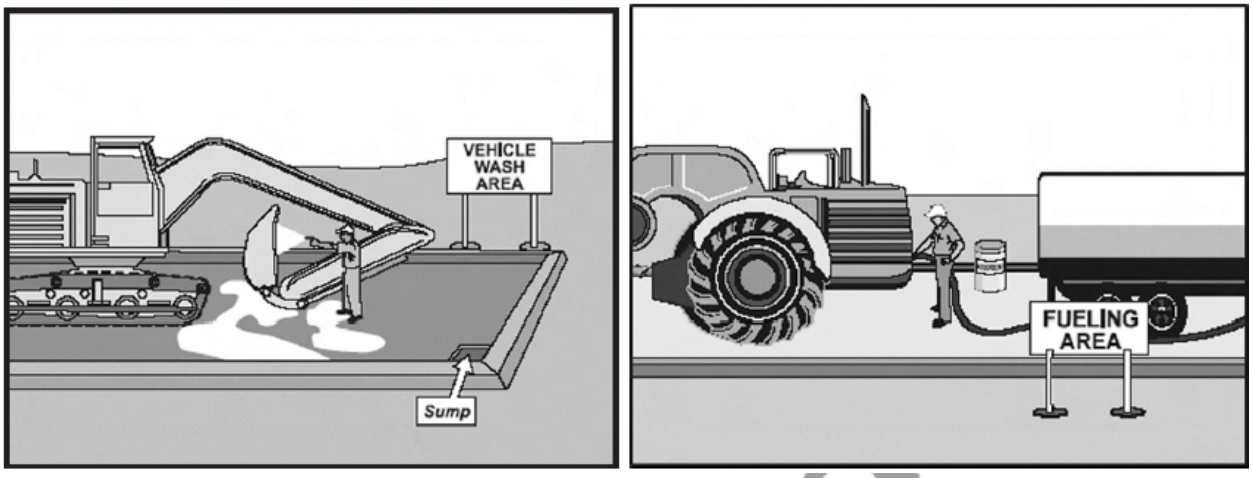
Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Inspect equipment and vehicles for leaks. Maintain an ample supply of cleanup materials at all designated maintenance areas where leaks and spill are likely to occur. Spot-check material storage and handling areas for compliance. Material storage and use areas shall be checked for accumulation of non-labeled materials and spills. Identify spills or leaks into to the storm drain at or near work areas. Containment structures or other perimeter controls shall be inspected and repaired when signs of degradation are visible.

References

Arizona Department of Transportation (ADOT), Erosion and Pollution Control Manual. 2005.

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide.



Description

Procedures and practices used to minimize or eliminate the discharge of pollutants during the following operations:

- Cleaning of vehicles and equipment prior to or during use on project site.
- Fueling of vehicles.
- Maintenance of vehicles and equipment.

Applicability

These procedures are applied on all construction sites where vehicle and equipment cleaning, fueling, and/or maintenance take place. Procedures specified in the Encana Wildlife Mitigation Plan may also apply to some aspects of vehicle and equipment maintenance.

Limitations

Only use on-site vehicle and equipment fueling when it is impractical to send vehicles and equipment off site to be refueled. Comply with local codes and ordinances regarding the disposal of fluids and consumables, and the on-site maintenance of equipment.

Standards and specifications

Vehicle and equipment cleaning

- On-site vehicle and equipment washing is discouraged, but may be necessary to eliminate spread of invasive species to areas outside of project site.
- Cleaning of vehicles and equipment with soap, solvents, or steam shall not occur on the project unless the Engineer has been notified in advance and the resulting wastes are fully contained and disposed of outside of the highway right-of-way in conformance with the Standard Specifications. Resulting wastes shall not be discharged or buried.
- When equipment/vehicle washing/cleaning must occur on site and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning shall have the following characteristics and shall be arranged with the Erosion Control Coordinator:
  - A washout area shall be an excavated pit, which will later be backfilled or where the concrete wash can harden and be properly disposed of.

- Locate wash out areas close to the active construction site on the project.
- Locate wash out pits away from storm drains, open ditches, or receiving waters.
- Use only when necessary.
- When cleaning vehicles/equipment with water use as little water as possible. Consider using high pressure sprayers, which require less water.

Vehicle and equipment fueling

- When fueling must occur on site, the contractor shall select and designate an area to be used, subject to approval by the Engineer.
- Federal, state, and local requirements shall be observed for any stationary aboveground storage tanks.
- Spill prevention, containment, and countermeasures shall be included in the Stormwater Management Plan (SWMP) if the volume of project site fuel in a single container exceeds 660 gallons, or if the total fuel storage volume at any one site exceeds 1,320 gallons.
- Designated fueling areas shall be protected from stormwater runoff and shall be located at least 50 feet from downstream drainage facilities or watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and/or dikes to prevent run-on, runoff and to contain spills.
- Absorbent spill clean-up materials and spell kits shall be available in fueling areas and on fueling trucks and shall be disposed of properly after use.
- Drip pans or absorbent pads shall be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Nozzles used in vehicle and equipment fueling shall be equipped with an automatic shut-off to control drips. Fueling operations shall not be left unattended. Fuel tanks shall not be "topped off."
- Mobile fueling involves fueling earthmoving or excavation equipment from a tank truck or some other container that is moved around the site. Mobile fueling of construction equipment throughout the site shall be minimized. Whenever practical, equipment shall be transported to the designated fueling area. If mobile fueling is required, the following procedures shall be followed:
  - Secondary containment equipment used during mobile fueling should be sized to contain the *most likely* volume of fuel to be spilled during a fuel transfer.
  - Portable containment equipment (such as small plastic basins or "doggie ponds") should be positioned to catch any fuel spills due to overfilling the equipment and any other spills that may occur at or near the fuel filler port to that equipment. The selection of containment equipment and its positioning and use should take into account all of the drip points associated with the fuel filling port and the hose from the fuel delivery truck.
  - Personnel must attend to the fueling process to ensure that any spills will be of limited volume.

Vehicle and equipment maintenance

- Plan for the proper recycling or disposal of used oils, hydraulic fluids, gear lubricants, batteries, and tires.
- Use appropriate, leak-proof containers for fuels, oils, and lubricants to provide for proper disposal.
- Use steam or high-pressure water instead of thinners and solvents to wash down equipment. Wash water and detergents can be disposed of in the sanitary sewer system after grit is removed, after checking with local authorities.

- Use drip pans or absorbent pads under equipment during maintenance that involves fluids.
- Equipment maintenance and wash-out areas should be located at least 50 feet away from drainages.
- Provide spill containment areas around stored oil and chemical drums.
- Provide a contained wash-out area to wash down heavy equipment.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP. Vehicles and equipment shall be inspected for leaky gaskets and damages hoses. Leaks shall be repaired immediately or problem vehicles or equipment shall be removed from the project site. Any damaged hoses shall be repaired or replaced as needed. Fueling areas and storage tanks shall be inspected. Immediately clean up spills and properly dispose of contaminated soil and cleanup materials. Inspect equipment maintenance areas and wash-out areas. Inspect fluid containers for leaks. Repair leaky fluid containers immediately.

References

Arizona Department of Transportation (ADOT), Erosion and Pollution Control Manual. 2005.

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp

Waste Management (WM)

Specification Section 01570

Description

Stormwater runoff from areas where construction wastes are stored or disposed can be polluted. Wastes leached or spilled from management areas may build up in soils or on other surfaces and be carried by stormwater runoff. The optimal approach to reduce the potential for stormwater contamination from wastes is to reduce the amount generated and, consequently, the amount stored on site. The following types of waste management are covered under this BMP:

Concrete waste management: Practices to be used in order to minimize and prevent concrete waste associated with construction activities from entering storm drains and watercourses. Concrete waste may be generated where concrete trucks or concrete-coated equipment are washed on site, where slurries containing concrete are generated, or where mortar-mixing areas exist.

Solid waste management: Practices to be used in order to minimize and prevent solid waste associated with construction activities from entering storm drains and watercourses. Solid waste can be classified as non-hazardous solid material including: concrete, rock, debris, soil, wood, vegetative material, plastic, fabrics, mortar, metal scraps, Styrofoam, and general litter such as but not limited to beverage containers and plastic wrappers.

Sanitary and septic waste management: Practices to be used in order to minimize and prevent sanitary and septic waste associated with construction activities from entering storm drains and watercourses.

Liquid waste management: Practices to be used in order to minimize and prevent liquid waste associated with construction activities from entering storm drains and watercourses.

Hazardous waste management: Practices to be used in order to prevent hazardous waste associated with construction activities from entering storm drains and watercourses. Hazardous wastes may be discovered or generated (by lead paint removal operations) and are designated as hazardous by the Code of Federal Regulations or Colorado state laws.

Contaminated waste management: Practices to be used in order to minimize and prevent pollutants from contaminated soils from leaching into watercourses or drainage systems.

Applicability

Facilities or designated construction work areas where each type of waste is discovered or generated.

Limitations

During the non-rainy season or in arid portions of the state, temporary stockpiling of non-hazardous solid waste may not require stringent drainage control measures. The engineer for the project shall determine if drainage control measures are warranted for a specific construction site where non-hazardous solid waste is being stockpiled.

Liquid waste management does not apply to solid wastes, hazardous wastes, concrete slurries/wastes, dewatering operations, sanitary/septic wastes, or permitted allowable non-stormwater discharges. Disposal of some liquid wastes may be subject to regulations or requirements of other permits secured for the construction site.

This BMP provides general hazardous waste management guidelines, but does not relieve the contractor from full responsibility of complying with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes. It is the contractor's full responsibility to identify all hazardous waste generated at the project site.

The contractor is responsible for identifying pollutant-specific handling and disposal procedures for contaminated soils at the project site.

Standards

The SWMP shall clearly describe and locate the practices implemented at the site to control stormwater pollution from all types of construction site waste.

Concrete waste
Waste generated from concrete activities shall not be allowed to flow into drainage ways, inlets, or receiving waters. All concrete washout activities shall be in accordance with the CDPS General Permit for Stormwater Discharges Associated with Construction Activity (Permit No. COR-030000).

Concrete waste shall be placed in a temporary concrete washout facility.

- Concrete washout facilities will be comprised of an excavation with erosion bales and construction fences along the perimeter. The facility may be similar to the settling device used for dewatering (see Figure DW-1). The bottom of the excavation must be proven to be at least 5 vertical feet above groundwater or, alternatively, the excavation must be lined with either a clay or synthetic liner that is designed to control seepage. The facilities shall be maintained in good condition to contain all liquid and concrete waste generated by operations at a project site.
- Proper signage such as "Concrete Washout" shall be placed near concrete washout facilities to inform construction personnel of the location of designated concrete washout facilities.
- Temporary concrete washout facilities shall be located 50 horizontal feet from drainageways, inlets, and receiving waters unless otherwise approved by the engineer.
- Adding solvents, flocculents, or acid to washwater is prohibited.
- Whenever a concrete washout area is within 300 feet of the access to a road or highway, a stabilized construction entrance must be built as part of the washout, or at the entrance to the road or highway.
- Hardened concrete waste shall be properly disposed of following solid waste management procedures.

- Removal of temporary facilities, including the solid concrete waste and the material used to construct the facilities, shall be the responsibility of the contractor, who shall remove the waste from the project site and dispose of it properly following guidelines outlined in solid, liquid waste management and any applicable regulations.

Solid waste

- Litter shall be minimized at all construction sites and collected on a weekly basis into water-tight dumpsters. Trash receptacles shall be provided in various locations within the construction site boundaries. Bear-proof containers shall be used, if necessary.
- Collected trash shall not be placed near drainage inlets or watercourses.
- A trash hauling contractor shall be used to properly dispose of the collected waste in a timely manner. Dumpster washout at the construction site is not permissible.
- Priority shall be given to remove waste and debris from drainage inlets, trash racks, and ditches in order to prevent clogging of the stormwater system.
- Waste storage areas shall be pre-approved by the engineer.
- Storage areas for solid waste shall be located at least 50 feet from drainageways and watercourses, and shall not be located in areas susceptible to frequent flooding. Sediment barriers such as berms, dikes, or other temporary diversion structures shall be used to prevent stormwater runoff from contacting stored solid waste at the project site.
- Solid waste shall be segregated properly into various categories for recycling or disposal. Proper disposal is required for each waste category. The contractor shall make every attempt to recycle useful vegetation, packaging material, and surplus construction materials when practical.
- Most construction materials can be recycled at recycling facilities.

Septic and sanitary waste

- Temporary sanitary facilities shall be located away from drainage ways, inlets, receiving waters, areas of high traffic, and areas susceptible to flooding or damage by construction equipment.
- Temporary sanitary facilities shall be properly connected into a sanitary sewer system where permissible to prevent illicit discharges. Authorized sanitary sewer system connections shall comply with local health agency, county, and sanitary sewer district requirements.
- Wastewater generated from sanitary facilities shall not be allowed to flow into drainageways, inlets, or receiving waters.
- Only licensed sanitary/septic waste haulers shall be used to properly dispose of waste from temporary sanitary facilities.
- In project areas susceptible to strong winds, temporary sanitary facilities shall be secured to prevent overturning.

Liquid waste

- The contractor shall oversee and enforce all liquid waste measures and will instruct all employees and subcontractors on the identification of hazardous and non-hazardous liquid waste, and non-hazardous handling, storage, and proper disposal.
- The contractor shall hold regular safety meetings to ensure proper liquid waste measures are being adhered to and efforts are being made to minimize the amount of liquid waste produced.
- The contractor shall ensure compliance with all liquid waste management procedures and practices.
- Liquid wastes generated from operational procedures such as drilling residue and fluids shall not be allowed to flow into drainageways, inlets, or receiving waters.

- All liquid wastes shall be contained in designated areas such as sediment basins, holding pits, or portable tanks. Designated containment areas shall be located away from drainageways, inlets, receiving waters, areas of high traffic, and areas susceptible to flooding.
- Precautions shall be taken to ensure that proper spill prevention and control measures are being implemented to avoid accidental spills.
- If a liquid waste is released or spilled, capture the liquid with proper cleanup methods. Do not allow the liquid waste to flow uncontrolled or into drainageways, inlets, and receiving waters. Use diverting methods such as temporary dikes to control the spill and direct it to containment areas for capture.
- The contractor shall be responsible for adhering to all permit requirements, federal, state, and local regulations for properly disposing liquid waste.

Hazardous waste

The following are general guidelines provided for planning the management of hazardous wastes.

- Hazardous waste storage, transportation, and disposal shall comply with 49 CFR 172, 173, 178, 179, and 261-263, and state regulations.
- Special materials and equipment may be required to manage wastes that are corrosive, combustible, flammable, oxidizer, poison, toxic, or reactive. Clearly label all waste containers with the appropriate description of the wastes being contained.
- Hazardous wastes shall be segregated and incompatible or reactive wastes shall be disposed of properly in a manner to prevent fires and explosion. Always consult the health and safety officer, engineer, and/or project manager prior to mixing hazardous wastes for disposal. Hazardous waste shall be segregated properly into various categories such as liquids, semi-liquids, and solids.
- Select the most appropriate disposal container to store the hazardous waste. Additionally, select a container that is compatible with the hazardous material being stored. For instance, use plastic or plastic-lined steel drums for storing corrosive materials. Corrosive materials will react with steel and cause the waste to be released from the drum. Always consult the engineer or project manager to ensure that the container and waste are compatible.
- Waste containers shall be stored and managed in temporary containment facilities that shall meet the following requirements:
  - A spill containment volume 1.5 times the volume of all containers
  - Impervious to the materials contained for a minimum contact time of 72 hours
  - Free of accumulated rainwater or spills, with sufficient separation provided between stored containers to allow for spill cleanup
  - Incompatible, ignitable, and reactive materials shall not be stored in the same temporary containment facility
  - “Caution: Flammable Material” signs must be posted near containment areas to prevent fires or explosions
- The following management guidelines are recommended for containment facilities:
  - Keep containers closed at all times except when adding or removing waste from the container. Use a funnel or hose to transfer wastes to drums.
  - You must open, handle, and store containers to prevent ruptures or leaks. Make sure to open drums with a spark-proof wrench.
  - If the container begins to leak or you notice dents or bulges, transfer the waste to another container.

- Locate containment areas away from high-traffic areas, waterways, drainage inlets, sensitive habitats, and areas prone to flooding or ponding.
- Waste residuals from equipment or brushes shall be cleaned in designated containment areas and shall not be allowed to seep into soils causing soil contamination or to discharge into watercourses or drainageways.
- Secondary containment needs to be provided for all hazardous waste containers. In addition, containment berms shall be used in fueling and maintenance areas where the potential for spills is high.
- Hazardous waste containment areas shall be pre-approved by the engineer and/or project manager.
- It is the contractor's responsibility to ensure that all hazardous waste discovered or generated at a project site is disposed of properly by a licensed hazardous material disposal contractor/facility utilizing properly completed Uniform Waste Manifest forms. The contractor is responsible for not exceeding hazardous waste storage requirements mandated by the state or other localities.
- Additional disposal guidelines for non-hazardous solid and liquid waste are included in Sections WM 2 and WM 4, respectively.

Contaminated waste
The following are general guidelines provided for planning the management of contaminated soils.

- The contractor is responsible for reviewing relevant environmental reports, appropriate plans, and project special provisions for contaminated soils information. The contractor shall also take initiative to further inform the engineer of any potential or identified contaminated soils on the project site.
- Contractor and employees are responsible for meeting safety training requirements mandated by 29 CFR 1910.120 prior to performing any construction work or excavation at projects sites where contaminated soils have been classified as hazardous materials.
- The contractor is responsible for following all rules and regulations applicable to the excavation, handling, transport, and disposal of contaminated and hazardous materials. The applicable rules and regulations are not limited to the standards of Occupational Safety and Health Administration, U.S. Environmental Protection Agency, U.S. Department of Transportation (USDOT), Colorado Department of Public Health and Environment (CDPHE), and local agencies.
- Contaminated soils should be placed in a lined and bermed area.
- Surround the perimeter of the exclusion zone with a security fence for safety.
- Collect impacted soil samples and complete a characterization analysis.
- Collect non-reusable protective equipment used at the project site and dispose of it properly. Additionally, treat and/or dispose of wastewater from decontamination procedures.
- Contaminated soil shall be transported to a licensed disposal facility on vehicles registered for that purpose.
- When an underground storage tank is discovered at a construction site, coordinate with the regional environmental project manager for guidance on handling and disposal procedures.
- Preventive measures, such as berms, freeze walls, cofferdams, and grout curtains, should be installed to prevent stormwater runoff or groundwater from mixing with hazardous materials or underground tank excavations. Water exposed to contaminated areas should be placed in water-tight holding tanks, tested, and properly disposed.

Maintenance considerations

The frequency of inspections should be in accordance with the SWMP or PCSWMP.

The contractor shall monitor concrete activities to ensure proper waste management techniques are being utilized. Maintenance of temporary concrete washout facilities shall include removing hardened concrete and proper disposal. It is recommended that facilities be cleaned out once they are 75 percent full, or new facilities shall be constructed to provide additional concrete waste storage.

Check for and remove litter and debris from drainage grates and other drainage structures. Provide cover for dumpsters and waste containers to prevent entry of rainwater and loss of contents by high winds.

Inspect perimeter controls, containment structures, berms, covers, and liners. Repair or replace as needed to function properly.

The contractor shall be responsible for monitoring on-site contaminated storage and disposal procedures.

References

Arizona Department of Transportation (ADOT), Erosion and Pollution Control Manual. 2005.

Colorado Department of Transportation (CDOT), Erosion Control and Stormwater Quality Guide. 2002. http://www.dot.state.co.us/environmental/envWaterQual/wqms4.asp

Appendix F

Oil and Gas Construction Field Permit Certification NOTICE OF AMENDMENT OF PERMIT COVERAGE and/or Final Stabilization Certification

STATE OF COLORADO

Oil and Gas Construction Field Permit Certification

NOTICE OF AMENDMENT OF PERMIT COVERAGE

Terminating coverage for a portion of a permitted area

GENERAL PERMIT FOR

STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITY

This form is for construction activities associated with oil and gas construction only. The form is applicable to field permit certifications **only**, and is **not** applicable to construction activities for other sectors, such as residential, commercial, or transportation. Additional options for administration and amendments for construction permits, including for activities not associated with oil and gas, is available on the Division's permitting web page, coloradowaterpermits.com (follow the link to "Stormwater Permitting," and then "Construction Stormwater").

This form is to be used to amend an oil and gas field permit certification under Colorado's Stormwater Construction Permit, to terminate permit coverage when **all of the following conditions have been met**:

1. The permit certification to be amended is a field permit certification for construction associated with oil and gas construction. The field permit covers all construction activities disturbing over one acre, or that are part of a common plan of development exceeding one acre, within the applied-for field.
2. The area is a distinct and separate area where construction has been completed and is not part of a specific facility, such as a single well pad or road segment, where construction is ongoing.
3. The area must be **Finally Stabilized**. An area is Finally Stabilized when all ground surface disturbing activities at the site have been completed, and all disturbed areas have been either built on, paved or equivalently hard-armored, or a uniform vegetative cover has been established with an individual plant density of at least 70 percent of pre-disturbance levels.

Upon acceptance of this notice by the Water Quality Control Division (the Division), the permit certification will be automatically amended to exclude the specific portion described in the notice. **The current permittee will not receive a revised certification**. The corrected information will be placed in the permit file. In order to receive notification of the Division's receipt of this information, it is up to the permittee to request verification of delivery from the carrier (i.e., by sending certified mail).

If the Area Has Not Been Finally Stabilized: This form is only for terminating an area that has been finally stabilized. If the area has not been finally stabilized the permittee must either maintain permit coverage, or can reassign permit coverage to another entity that owns or has operational control over that area. The Division's Notice of Reassignment of Permit Coverage form should be used. The form is available at coloradowaterpermits.com

Stormwater Management Plan (SWMP): The permittee must maintain a SWMP that accurately reflects the activities and BMPs for the areas for which they will have permit coverage. Therefore, the SWMP must be updated to reflect the changes described in this form. Appendix A of the General Permit Application and SWMP Guidance for Stormwater Discharges Associated with Construction Activity (available from the Division's web site at coloradowaterpermits.com) contains the requirements for the SWMP.

Failure by the permittee to maintain a SWMP in accordance with this guidance is a violation of the permit. Additional guidance for multi owner/operator development is also available in the Stormwater Fact Sheet for Construction, available from the Division's web site.

Notice Due Dates: At least **ten days** prior to the requested effective date for permit coverage to end, the permittee shall submit this form to the Division. This form may be reproduced, and is also available from the Division's web site at coloradowaterpermits.com.

Permit Fee: There are no new permit fees associated with amending the construction permit certification.

Application Completeness: All items on the form must be completed accurately and in their entirety or the notice will be deemed incomplete, and processing of the form will not begin until all information is received. A map of the revised area **must** be included that clearly indicates the area with continued coverage under the permit certification, and the area excluded. (Do **not** include a copy of the SWMP.) One original copy of the completed form (**no faxes or e-mails**), signed by the current permittee, shall be submitted, only to:

Colorado Department of Public Health and Environment
Water Quality Control Division - Permits
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

If you have questions on completing this application, you may contact the Division at cdphe.wqstorm@state.co.us or (303) 692-3517.

SITE MAP INSTRUCTIONS

Site Map: A Site Map **must** be provided. The map must clearly define the boundaries of the area to be excluded from permit coverage relative to that with continued coverage. The level of detail that must be provided will depend on the nature of the project, and must be adequate to determine during a field audit what construction activities are still covered under the issued certification. Two maps (a vicinity map and excluded site boundary map) may be necessary to provide sufficient detail to meet this requirement for large field areas. Maps must not exceed 8 ½ x 17 inches. Do not submit grading plans or other blueprints as the site map.

Colorado Department of Public Health & Environment
Water Quality Control Division
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

FOR AGENCY USE ONLY

REC_____ _____ _____
EFF _____ _____ _____
YEAR MONTH DAY

Amendment notice for
Oil and Gas Construction Field Permit Certification
CONSTRUCTION STORMWATER DISCHARGE GENERAL PERMIT CERTIFICATION

Please print or type. Form must be filled out completely.

Certification Number: **COR-03** 1234 ___ ___ ___

Permittee (Company) Name: _____

Permittee Address: _____

Phone No. _____

Field Permit Certification Information (refer to your permit certification):

Field Permit Site/Facility Name: _____ County(s): _____

Contact Person: _____

Contact Person Phone No.: _____ Contact Person Email: _____

Information on Area to be Excluded from Permit Coverage:

Site Map: **Must include Site Map indicating the boundaries of the area to be excluded from permit coverage.**

Refer to the Site Map Instructions on page ii of this form. Maps must be folded to 8½ x 11 inches.

Map enclosed? Yes ☐ No ☐

Summary of work performed and **description of final stabilization for the area shown in the attached map**:

_____

_____

I certify under penalty of law that by the date of my signature below, at the **identified construction site area,** all disturbed soils have been finally stabilized; all temporary erosion and sediment control measures have been removed; all construction and equipment maintenance wastes have been disposed of properly; and all elements of the Stormwater Management Plan have been completed.

I understand that by submitting this notice of amendment, I am no longer authorized to discharge stormwater associated with construction activity by the general permit, **for this specific area**. I understand that discharging pollutants in stormwater associated with construction activities to the waters of the State of Colorado, where such discharges are not authorized by a CDPS permit, is unlawful under the Colorado Water Quality Control Act and the Clean Water Act.

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (See 18 U.S.C 1001 and 33 U.S.C. 1319.)

Signature of Permit Applicant (Legally Responsible Party) Date Signed

Name (printed) Title

Encana SWMP – Final Stabilization Certification

Date: _____

Site ID: _____

Type of Area:

- ☐ Well Pad
- ☐ Access Road to Well Pad
- ☐ Other Road
- ☐ Pipeline
- ☐ Other Facility _____

"The above referenced site has reached final stabilization. All ground surface disturbing activities have been completed, including the removal of all temporary BMPs, and all disturbed areas have been either built on, or a uniform vegetative cover has been established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed."

_____

Printed name Title

_____

Signature Date

Appendix G

Inspection and Maintenance Report Form

EnCana SWMP Inspection and Maintenance Report Form

Area Inspected (Site ID): _____

Title of Inspector: Name of Inspector: Date:

Type of Area: Well Pad ☐ Access Road to Well Pad ☐ Other Road ☐ Pipeline ☐ Other Facility:_____

Phase of Construction: ☐ Preconstruction ☐ onstruction ☐ rilling ☐ ompletions
☐ Reoccupy ☐ erm Reclamation ☐ inal Reclamation

Type of Inspection: ☐ Active (14 days since last inspection) ☐ ompleted (1 month since last inspection)
☐ Active (Within 24 hours of a rain/snowmelt event that causes surface erosion or 72 hours for temporarily idle sites)
☐ Winter Conditions Exist

Site Specific Information

Approximate area of site to be disturbed (acres): Receiving Water(s):

Soil Type(s):

Ecosystem/Vegetation Type(s):

Other Site Specific Information:

Vegetation Observations

Site Revegetated: Yes ☐ No ☐ Current Vegetation: _____%

Pre-disturbance Vegetation: _____% (estimate from undisturbed surrounding areas)

Vegetation Growth uniform and at least 70% of pre-disturbance levels: Yes ☐ lo ☐

Best Management Practice (BMP) Check List

Erosion Control:	In Use?	Comments	Drainage Control:	In Use?
Erosion Control Blanket	☐		Berm	☐
Hydraulic Mulching	☐		Culvert	☐
Land Grading - Roads (slopes/gravel/etc)	☐		Culvert Inlet Protection	☐
Mulching	☐		Culvert Outlet Protection	☐
Retaining Wall	☐		Diversion	☐
Revegetation	☐		Drainage Dip	☐
Riprap	☐		Level Spreader	☐
Soil Stabilizers	☐		Roadside Ditches and Turnouts	☐
Stockpiling - Topsoil and Subsoil	☐		Run On Diversion	☐
Surface Roughening	☐		Slope Drain	☐
Terracing	☐		Trench Breaker	☐
Turf Reinforcement Mat	☐		Water Bar	☐
Vegetated Buffer	☐			☐
Wattles	☐			☐
Sediment Control:	**In Use?**	**Comments**	**Sediment Control:**	**In Use?**
Check Dam	☐		Slash	☐
Detention Pond	☐		Stabilized Construction	☐
Filter Berm	☐		Straw Bale Barrier	☐
Sediment Reservoir	☐		Riprap	☐
Sediment Trap	☐		Wattles	☐
Silt Fence	☐			☐
Non-Stormwater Control:	**In Use?**	**Comments**	**Non-Stormwater Control:**	**In Use?**
Dewatering	☐		Dust Control	☐

Location/Observation:				Additional Comments: New BMPs installed , changes, dates performed, etc...)
Site perimeter/discharge points inspected?	Yes ☐	No ☐	N/A ☐	
All disturbed areas inspected?	Yes ☐	No ☐	N/A ☐	
Vehicles entrance(s)/exit(s) inspected?	Yes ☐	No ☐	N/A ☐	
Material storage areas inspected?	Yes ☐	No ☐	N/A ☐	
Acceptable waste management procedures?	Yes ☐	No ☐	N/A ☐	
Acceptable vehicle/equipment maintenance?	Yes ☐	No ☐	N/A ☐	
Any sediment/pollutant discharged off-site?	Yes ☐	No ☐	N/A ☐	
If no change since above inspection (no changes to BMPs or SWMP)				

Date	Signature	Type of Inspection	
		14 day ☐ Monthly ☐ Pptn. Event ☐	
		14 day ☐ Monthly ☐ Pptn. Event ☐	
		14 day ☐ Monthly ☐ Pptn. Event ☐	
		14 day ☐ Monthly ☐ Pptn. Event ☐	
		14 day ☐ Monthly ☐ Pptn. Event ☐	

Signature certifying that the site is in compliance (after all necessary repairs, maintenance, and changes have been made):

_____ _____
Date Signature

Appendix H

Inactivation Form

Colorado Department of Public Health & Environment
Water Quality Control Division
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

FOR AGENCY USE ONLY

REC_____ _____ _____
EFF _____ _____ _____
YEAR MONTH DAY

INACTIVATION NOTICE FOR

CONSTRUCTION STORMWATER DISCHARGE GENERAL PERMIT CERTIFICATION

Please print or type. Form must be filled out completely.

Certification Number: **COR-03** ___ ___ ___ ___ Taxpayer ID or EIN ___ ___ ___ ___ ___ ___ ___ ___ ___

Permittee (Company) Name: _____

Permittee Address: _____

_____

Phone No. ( )

_____

Site/Facility Name: _____

Construction Site Address/Location: _____

_____

County: Contact Person: _____

Summary of work performed and **description of final site stabilization**: _____

_____

_____

_____

I certify under penalty of law that by the date of my signature below, all disturbed soils at the identified construction site have been finally stabilized; all temporary erosion and sediment control measures have been removed; all construction and equipment maintenance wastes have been disposed of properly; and all elements of the Stormwater Management Plan have been completed.

I understand that by submitting this notice of inactivation, I am no longer authorized to discharge stormwater associated with construction activity by the general permit. I understand that discharging pollutants in stormwater associated with construction activities to the waters of the State of Colorado, where such discharges are not authorized by a CDPS permit, is unlawful under the Colorado Water Quality Control Act and the Clean Water Act.

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (See 18 U.S.C 1001 and 33 U.S.C. 1319.)

_____

Signature of Permit Applicant (Legally Responsible Party) Date Signed

_____

Name (printed) Title

9/97/cn/in