Appendix 5: Stormwater Management Plan

FIELD WIDE STORMWATER MANAGEMENT PLAN FOR CONSTRUCTION ACTIVITIES

WATTENBERG GAS FIELD DRILLING PROGRAM
COLORADO

REVISED
SEPTEMBER 2012

Prepared for:

ENCANA OIL & GAS (USA) INC.
Longmont, Colorado

encana™
natural gas

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September 2012

Prepared for:

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1.0 CERTIFICATION [PART I.F.1.C]

Encana Oil & Gas (USA) Inc. (Encana) has prepared this Field Wide Stormwater Management Plan for Construction Activities (SWMP) for the Wattenberg Gas Field (WGF) Drilling Program in the Wattenberg Field, Colorado.

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.

Signature _____ Date _____

Name _____

Title _____

2.0 INTRODUCTION

On June 30, 2005, the State of Colorado stormwater regulation went into effect to require Colorado Discharge Permit System (CDPS) permits from the Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (WQCD) for stormwater discharges from construction activities associated with small construction activity for oil and gas sites that disturb between one and five acres. As part of that requirement, this Stormwater Management Plan (SWMP) has been prepared to identify possible pollutant sources to stormwater and to set out Best Management Practices (BMPs) to reduce or eliminate possible water quality impacts.

The five-year stormwater general permit COR-030000 was re-issued and became effective on July 1, 2007. Encana applied for coverage under the stormwater general permit and was issued COR-034778 for the Wattenberg Gas Field Drilling Program on July 1, 2002. The application and permit number were renewed at the re-issuance of the general permit. Copies of the permit documents are included in this SWMP as Appendix A.

3.0 SWMP ADMINISTRATOR [PART I.C.3.A]

The SWMP Administrator for Encana is responsible for the developing, implementing, maintaining, and revising the SWMP. The SWMP Administrator has the authority to dedicate the financial and human resources to implement the SWMP. The SWMP Administrator is:

Mr. Matthew Harrison - Environmental Coordinator, Longmont, CO

Longmont Main Office: 303-774-3900

Direct: 303-774-3962

The SWMP Administrator will manage the SWMP Team. Other foremen or designated personnel may also assist in stormwater inspections and maintenance of records. Overall, the SWMP Team is responsible for:

- Implementing spill/upset clean up procedures;
- Notification to local authorities and local residents in the event that a significant release of stormwater and sediment leaves a pad area;
- Coordinating various stages of BMPs and implementation;
- Conducting inspections;
- Maintenance of all records; and
- Coordination of a preventive maintenance program and housekeeping measures.

The Field-Wide SWMP will be retained at Encana's Longmont office, and continuously updated and kept current.

4.0 SITE DESCRIPTION [PART I.C.1]

4.1 Nature of Construction Activity [PART I.C.1.a]

Encana is one of the nation's leading independent energy companies engaged in the exploration, development, production, and marketing of crude oil and natural gas. Encana currently owns or leases oil and natural gas mineral rights in the Wattenberg Field in the Denver-Julesburg (DJ) Basin, Colorado. The area includes more than one county, and lies within Townships 5 North to 2 South, and Ranges 63 West to 69 West. Individual pad sites within the permitted area range from approximately ¾ acre to seven acres in size, including site-specific access roads and flowlines. A topographic map of the project area is provided as Figure 1.

4.2 Sequence of Major Activities [PART I.C.1.b]

The overall development of oil and natural gas pad sites is generally accomplished in three distinct work phases: construction, production and abandonment. The work completed and sequence of events for each phase is briefly discussed below.

Approximately ¾ acres to seven acres of surface terrain is disturbed during the construction of a new pad site. The construction phase includes the following sequence of activities: pad construction, well drilling, well completion, gas flowline installation, access road building, and well pad reclamation.

The production phase includes the operation and maintenance activities during natural gas production. The typical equipment on a pad site during the production phase consists of a wellhead, a separation unit, one or more 300-barrel (typical) capacity aboveground tanks for condensate (if needed), and a sump for storing produced water or condensate. Oil and gas wells in the field are projected to produce for approximately 20 to 30 years.

When the natural gas production of a well is exhausted it will be abandoned. Well abandonment includes plugging and capping the well and removal of all surface equipment. The pad area will be reclaimed by contouring disturbed soils to conform to the surrounding terrain.

Oil and gas activity types requiring ground surface disturbance include: a new drill site, a facility site, a refrac site, and an excavation/other site. Each of these types is described as follows:

- A new drill site includes pad construction, well drilling, well completion, gas flowline installation, access road building and well pad reclamation. Pad reclamation is accomplished by backfilling the reserve pit (if applicable), contouring disturbed soils to conform to the surrounding terrain, replacing the stockpiled top soil, and seeding of disturbed soil areas in order to reestablish coverage vegetation.

- A facility site includes pad construction, tank and sump installation (if applicable), gas flowline installation, access road building and pad reclamation. Pad reclamation is accomplished by contouring disturbed soils to conform to the surrounding terrain, replacing the stockpiled top soil, and seeding of disturbed soil areas in order to reestablish coverage vegetation.

- A refrac site may include pad construction to enlarge the area for frac tank and equipment placement, and/or tank installation. Reclamation is accomplished by contouring disturbed soils to conform to the surrounding terrain, and seeding of disturbed soil areas in order to reestablish coverage vegetation.

- An excavation/other site include excavation for a variety of reasons. Excavation areas will be reclaimed by backfilling and contouring the disturbed area to conform to the surrounding terrain and seeding of disturbed soil areas in order to reestablish coverage vegetation.

For stormwater regulation purposes, construction sites have been divided into the following stormwater stages: Active, Interim Stabilization, and Final Stabilization.

Details regarding the stormwater stages are provided later in Section 8.2 of this plan.

4.3 Area Disturbed [PART I.C.1.c]

The specific area disturbed at each individual pad site is listed in Encana's site-specific database called SWMP Database Central Administrative Switchboard (DCAS), which includes Stormwater Inspection Management Site History Reports (Appendix B). A total of all current acreage disturbed under this permit is also kept in the database.

4.4 Soil Description [PART I.C.1.d]

The DJ Basin is a large area covering several counties. Topsoil varies within the WGF Drilling Program area, and is primarily classified as loam, sandy loam, clay loam, Adena-Colby association, and Wiley-Colby complex, according to the U.S. Natural Resources Conservation Service (http://websoilsurvey.nrcs.usda.gov/app/). Percentages of each type of topsoil vary widely throughout the area, with it being primarily sandy loam and loam in nearly equal percentages, in the north portion of the Weld County area. The central portion of the Weld County area is dominated by sandy loam. The southwest portion of Weld County is dominated by clay loam and the Wiley-Colby complex with 1 to 5 percent slopes. The topsoil in Boulder County, in the southwest portion of the WGF Drilling Program area, is primarily loam.

Specific soil type data at each pad site are entered on the site-specific SWMP DCAS Maps as an indication of erosion potential, but were not necessarily used in BMP design.

4.5 Vegetation Description [PART I.C.1.e]

The well pads in the basin are primarily surrounded by low shrubs and brush rangeland, tall grass, short grass prairie land, sand dune complexes, and crop land. In some cases, pads are surrounded by urban land, but this is less common. Pre-disturbance ground cover varies from 0 to 75 percent. Specific vegetation data at each pad site are entered on the site-specific SWMP DCAS Maps.

4.6 Description of All Potential Pollution Sources [PART I.C.1.F AND I.C.3.b]

The location and description of all potential pollution sources are discussed in detail in Section 6.1 and summarized in Table 1.

4.7 Non-Stormwater Discharges [PART I.C.1.g AND I.D.3]

The following is a summary list of non-stormwater discharges which are allowed under the stormwater permit:

- Discharges from emergency fire-fighting activities or a fire hydrant;
- Landscape irrigation or return flow;
- Concrete washout;
- Dewatering (if necessary and permitted); and
- Uncontaminated springs.

Encana does not anticipate any significant non-stormwater discharges at the pad sites.

4.8 Receiving Waters [PART I.C.1.h]

Receiving water bodies within the permitted area include various named and unnamed creeks and rivers including the South Platte and St. Vrain Rivers, Little Thompson, Boulder, and Coal Creeks and their tributaries. Site-specific nearest water body information for each pad site is entered on the site-specific SWMP DCAS Maps. Nearest water body information is gathered from the following website: http://cogcc.state.co.us/infosys/Maps/gismain.cfm.

The majority of Encana pads sites and access roads do not intrude or encroach on any wetland acreage. If a wetland is designated to be within a pad construction area, Encana will obtain permits from Army Corp of Engineers, as appropriate.

5.0 SITE MAPS [PART I.C.2]

The site information is kept on Encana's secure stormwater website, which includes stormwater data and reports. The stormwater website is intended to manage and track all site-specific stormwater records for Encana.

For the purposes of this SWMP, the site-specific information required to be included in the SWMP (Appendix B) will actually be comprised of the Encana's SWMP DCAS. The site-specific information is updated from the SWMP DCAS onto the stormwater website during the course of the stormwater inspections. In addition to the site-specific SWMP DCAS Inspection Reports, the SWMP DCAS can produce reports to manage and track the needed BMP repairs. These reports are provided to the BMP contractor on a regular basis, to document and maintain stormwater requirements.

Pad construction site boundaries; ground surface disturbances; areas of cut and fill; storage areas for building materials, equipment, soil or waste; locations of dedicated asphalt or concrete batch plants (if applicable); structural BMP locations; non-structural BMP locations (as applicable); locations of springs, streams, wetlands or other surface waters; wellhead locations; and other pertinent site specifics are shown on maps attached to the site-specific SWMP DCAS Inspection Reports (Appendix B). Example base maps of typical pad construction sites have been included as a reference in Appendix C. Site specific features may be hand-drawn.

6.0 STORMWATER MANAGEMENT CONTROLS [PART I.C.3]

6.1 Identification of Potential Pollutant Sources [PART I.C.3.b]

To identify, evaluate, and assess potential sources of stormwater runoff pollutants that may be at a pad site, the following activities and pollutant sources were evaluated:

- Disturbed and stored soils;
- Vehicle tracking controls;
- Management of contaminated soils;
- Loading and unloading operations;
- Outdoor storage activities;
- Vehicle and equipment maintenance and fueling;
- Dust or particulate generating processes or activities;
- Routine maintenance activities;
- On-site waste management practices;
- Concrete truck washing;
- Dedicated concrete and asphalt batch plants;
- Non-industrial waste sources; and
- Potential spills.

6.1.1 Disturbed and Stored Soils [PART I.C.3.b.1]

Disturbed soil and excavated materials will be stored on or next to the pad. Topsoil and other soils will be stockpiled separately. Disturbed soil re-grading will be completed as soon as possible after drill rigs are removed from the pad site areas. During reclamation, all earth

disturbing activities from construction will be re-graded and contoured to blend into the adjoining landscape.

Materials excavated will be utilized as backfill when practical. An exception may be excess rock generated by rock blasting excavation activities. In these areas, some select backfill materials may be required to protect the project area. Excess rock may be pushed into rock filter dikes, used in energy dissipation zones below culverts, constructed into rock check dams within grassed swales, or distributed over a portion of the project area. Excavation in especially sensitive areas may be conducted according to special techniques as specified by the landowner/agency representative.

6.1.2 Vehicle Tracking Controls [PART I.C.3.b.2]

Properly constructed and graveled roads and pads provide the best off-site tracking control. Access road entrances adjacent to paved county roads are graveled to prevent or minimize any off-site soil tracking from pad areas or access roads. In some instances, cattle guards and tire washing procedures are used to drop off caked mud before the vehicle exits the site area. When necessary, paved roads are swept near pad site access areas. In addition, minimizing site access, contractor education, and other sediment control BMPs will be utilized.

6.1.3 Management of Contaminated Soils [PART I.C.3.b.3]

If contaminated soils are excavated at an Encana site, additional BMPs will be employed to ensure containment of any stormwater runoff. In addition, stockpiles of contaminated soil will be removed from the site and disposed of as soon as possible.

6.1.4 Loading and Unloading Operations [PART I.C.3.b.4]

The majority of loading and unloading activities occur during well drilling and well completion activities. Well drilling and completion surfactants, friction reducers, dilute hydrochloric acid, potassium chloride solutions, drilling mud, condensate, and other fluids are transported or unloaded directly into the well from trucks, on site tanks, and/or the reserve pit. Dry drilling mud components are contained in paper bags and are stacked on pallets, which are unloaded using a forklift or by hand. Liquid drilling mud removal operations can include open-top trucks. Removal operations are supervised by Encana personnel to ensure proper care is taken to prevent spillage or leakage from the trucks. In the event of a spill, the SWMP material handling and spill prevention procedures will be followed. Other activities include unloading of drill pipe, completion pipe (casing), and natural gas line pipe, which are not potential pollution sources.

6.1.5 Outdoor Storage Activities [PART I.C.3.b.5]

The most common substances that are stored outdoors on a pad site are: 1) fuel and lubricants used by vehicles and construction equipment; 2) frac fluids (surfactants, friction reducers, hydrochloric acid, and potassium chloride) used during well completion procedures; 3) production water from the well; and 4) produced crude oil and condensates. A list of chemical products typically used at an Encana pad site is included as Table 1. Section 8.1.2 of this plan includes the general housekeeping BMPs for materials storage areas.

6.1.6 Vehicle and Equipment Maintenance and Fueling [PART I.C.3.b.6]

Encana, on occasion, does store diesel fuel at their pad sites. Diesel fuel will be properly stored in secondary containment when present on a site.

6.1.7 Dust or Particulate Generating Processes or Activities [PART I.C.3.b.7]

Dust and/or particulates generated from vehicle traffic on graveled access roads may produce fugitive emissions. Dust and particulate generation is at its highest during dry and hot times of the year. If dust from vehicle traffic on graveled access roads becomes significant, dust suppression procedures will be implemented that include road watering or the application of dust suppressants.

6.1.8 Routine Maintenance Activities [PART I.C.3.b.8]

Routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents and oils are not completed at Encana pad sites. Herbicides will be applied annually in some areas to control noxious weeds. Herbicide application will always be conducted by certified and trained individuals, and with consideration for runoff potential to nearby surface waters.

6.1.9 On-site Waste Management Practices [PART I.C.3.b.9]

All waste from materials imported to the construction site are removed for disposal/recycling to an appropriate licensed disposal/recycling facility. No waste materials will be buried, dumped, or discharged to waters of the state.

6.1.10 Concrete Truck Washing [PART I.C.3.b.10]

Concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment, may be conducted at an Encana sites, although it is not part of regular operations. Pollutants arising from this operation would mainly include a water/concrete mixture, and concrete debris. No waste materials will be buried, dumped, or discharged to waters of the state. Concrete washout is an allowable non-stormwater discharge.

6.1.11 Dedicated Concrete and Asphalt Batch Plants [PART I.C.3.b.11]

No dedicated concrete or asphalt batch plants are located within the Encana Wattenberg Gas Field Drilling Program Area.

6.1.12 Non-Industrial Waste Sources [PART I.C.3.b.12]

Cleanup of trash and discarded materials will be conducted at the end of each work day. Cleanup will consist of patrolling the roadway, access areas, and general work areas in order to pick up trash, debris, scrap, or other discarded materials.

All waste from materials imported to the construction site are removed for disposal/recycling to an appropriate licensed disposal/recycling facility. This also includes sanitary sewage facilities (typically portable), which will be placed, anchored, and maintained with proper care.

No waste materials will be buried, dumped, or discharged to waters of the state.

6.1.13 Potential Spills [PART I.C.3.b.13]

Spills or leaks will be handled by Encana personnel or contractors, according to the principals and practices outlined in Encana's SPCC Plan for the Wattenberg Field, Colorado. The SPCC Plan, while written more specifically for large tank sites, includes general procedures for handling and responding to any spill situation.

On a pad site, spills and leaks can occur from valves, loading and unloading procedures, removing excess water from production tanks, tank or reserve pit overflow, tank leaks or ruptures, separators, knockout tanks, heater treaters, flowlines or piping. Reserve pits are constructed to allow plenty of additional volume to avoid overflow situations. In addition, chemicals potentially stored on site are listed in Section 6.1.5 and in Table 1. Small chemical leaks or spills will also be handled as specified in the Encana SPCC Plan. Additional materials handling is discussed in detail in Section 6.2.4 of this plan. Spills and leaks are documented by Encana and records are kept at the Longmont office or on the COGCC website (http://cogcc.state.co.us/).

6.2 Best Management Practices (BMPs) [PART I.C.3.c]

BMPS for sediment and erosion control will be accomplished through a combination of construction techniques, vegetation and re-vegetation, and structural features. The BMP Manual (Appendix D) or similar guidance will be referenced for assistance with controls or BMPs when needed. Typical configurations of structural controls discussed below and technical drawings are provided in Appendix D. Site-specific drawings are kept in Encana's SWMP DCAS which is intended to manage and track all site-specific stormwater records for Encana.

BMP selection is guided by the selection criteria listed in Table 2. Structural and non-structural BMPs are discussed in the following sections, and are summarized in Table 3.

6.2.1 Structural Practices for Erosion and Sediment Control [PART I.C.3.c.1]

Structural practices primarily include physical attributes of a pad site, access road or flowline designed to reduce erosion and control stormwater or sediment movement.

6.2.1.1 Erosion Reduction and Control

Construction of a pad requires the removal of vegetative cover and topsoil that increases peak flood flows, water velocity, and the volume of stormwater runoff. An increase in water runoff volume and velocity results in increased erosion. Erosion reduction and control will be accomplished by using the following erosion control methods. These methods include, but are not limited to the following:

- Diversion and control of run-on water;
- Diversion and control of runoff water;

- Vegetation planting and maintenance; and
- Application and maintenance of mulches, blankets, tackifiers, tracking and contouring.

Runoff control procedures that will be used to mitigate and reduce the erosive transport forces of stormwater during and after construction of a pad will include but will not be limited to the following:

- Check dams;
- Earth berms;
- Culvert protection;
- Diversion ditches;
- Slope drains;
- Rock-lined ditch;
- Mulches, with or without a tackifier
- Geotextiles; and
- Erosion Control Blanket/Turf Reinforcement Matting

Existing vegetation cover and topsoil are removed only where necessary for the operation of equipment and construction of the pad. Trees and large shrubs that are not cleared from the pad area will be protected from damage during construction by avoiding them with equipment. For example, the blade of a bulldozer will be in a raised position except for designated areas.

Trees will be cut or trimmed only to facilitate clearing, grading, and safe installation of a pad. Trees outside the area of disturbance will not be cut, but may have overhanging limbs trimmed if necessary.

6.2.1.2 Sediment Reduction and Control

The control and reduction of sediment contained in stormwater runoff will be accomplished by the use of sediment containment systems. Sediment containment systems are hydraulic controls that allow the deposition of suspended particles by gravity. Sediment controls that will be used to mitigate and control sediments generated from the erosive transport forces of stormwater during and after construction of a pad will include but will not be limited to the following:

- Silt Fence
- Straw Bale Dikes
- Straw Wattles

- Sediment Traps/Basins
- Vehicle Tracking Pads
- Continuous Berms
- Continuous Berms with Rock Filter; and
- Slash Berms

6.2.1.3 Detailed Structural Practices

The following structural site management practices are expected to reduce, minimize and control erosion and sediment transport:

- In order to minimize disturbances associated with installation of pads, level and gently sloping terrain outside the project area will not be graded, except where necessary.
- To prevent tracking of sediment (mud and rocks) onto public roads, portions of access roads may be graveled, as appropriate. Other means such as track pads/angular rock or cattle guards may be utilized if appropriate.
- Silt barriers (e.g. brush dams, rock filter dikes, silt fences, hay bales, or water bars) will be installed as needed on down-gradient portions of project areas.
- Side hill cuts (cut slopes) will be kept to a minimum to protect local resources while providing a safe and stable plane for the efficient and safe use of equipment.
- Where conditions warrant, erosion control structures such as berms, water bars, diversion or collection channels, terraces, or culverts will be constructed to divert water away from project areas. These control structures will also reduce soil erosion along and adjoining areas disturbed during construction.
- During construction near perennial streams, lakes or wetlands, the utilization of sedimentation (detention) basins, silt fences, straw bales, or fabric filters may be considered in order to prevent suspended sediments from reaching downgradient watercourses, streams, lakes or wetlands.
- Where appropriate, water bars or sediment filters, such as staked straw bales or silt fences, will be constructed adjacent to crossings to reduce potential sedimentation in streams or wetlands.
- In areas that have steep slopes, water bars or runoff diversions may be installed. When used, water bars will generally begin and end in undisturbed ground at approximately a 2% slope.
- Culverts may be installed at a grade ranging from 2% to 5%. Inlet protection may include inlet aprons and rock armoring around the culvert perimeter while below grade

inlet sumps may be installed to enhance sediment deposition. Outfall protection may include the use of a rock barrier to slow the discharge of runoff water. Culvert pipe or outfall protection will be extended to the toe of the slope on the discharge end.

- During the reclamation of a pad all cut and fill slopes in steep terrain will be graded and contoured to blend into the adjoining landscape. Natural drainage patterns will also be reestablished. When possible cut and fill slopes will be constructed so they are no steeper than a 1 to 3 ratio.

- Reclaimed pads may have a fence constructed around areas that have been seeded. These fences will be installed in order to keep livestock and vehicles off reseeded areas.

Appendix D includes details on BMP installation procedures.

6.2.1.4 Implementation of Structural Practices

The following sediment controls may be utilized at pad areas: vegetative buffers, brush dams, rock filter berms, silt fences, straw bale dikes, water bars, sediment traps, sediment basins, or equivalent sediment controls. These sediment control structures will be installed so as to protect down slope surface waters, wetlands and roads from sediment flow due to runoff from a precipitation or snow melt event.

All graded surfaces, walls, dams and structures, vegetation, erosion and sediment control measures and other protective devices identified in the pad plan will be maintained, repaired, and restored as necessary.

Table 3 contains a summary list of structural BMPs.

6.2.2 Non-Structural Practices for Erosion and Sediment Control [PART I.C.3.c.2]

Sediment and erosion control can be implemented via non-structural BMPs. Non-structural BMPs are BMPs that are not engineered as a stormwater barrier and are capable of limiting the amount of potential pollutants available to reach receiving water bodies. Non-structural BMPs can achieve the same effect as structural BMPs through filtration and the settling of sediment load within a perimeter.

Encana has implemented non-structural practices for stormwater management into their pad site development, including Program Oversight, Construction Site Planning and Management, and Materials Management. Table 3 summarizes the details of such practices.

Construction site planning includes decisions regarding reserve pit placement, planned stockpile placement, and waste storage area placement which take into account potential stormwater runoff issues. Pad sites can include a slope to the reserve pit or a buffer zone of natural vegetation used as a non-structural BMP to inhibit sediment travel offsite and minimize the footprint of the pad. Appendix C includes a typical pad site figure with the use of a buffer zone as a BMP.

6.2.3 Phased BMP Implementation [PART I.C.3.c.3]

The phases of construction or development and stormwater stages are linked to the implementation of structural and non-structural BMPs. For stormwater regulation purposes, construction sites have been divided into the following stormwater stages: Active, Interim Stabilization, and Final Stabilization. Details regarding the stormwater stages are provided later in Section 8.2 of this plan. Stormwater controls to be used for each phase are listed in Table 2.

Pre-construction and Active Construction
During pre-construction, drilling, workover rig activity, and other active construction processes, the focus will be primarily on containment type BMPs and on-flow diversion BMPs. An example would be a continuous berm to contain stormwater pollutants on site.

Interim Stabilization Sites
Construction activities have been completed and areas re-seeded. For interim stabilization, containment BMPs are possibly removed and reclamation types of BMPS are put in place, if needed, to mitigate the potential pollutants.

Final Stabilization Sites
Permanent stormwater BMPs, such as culverts and check dams, will remain in place after final stabilization, if applicable.

Depending upon the type of site, the site terrain, and the phase of construction, different stormwater BMPs will be utilized. Various BMP options are listed in Table 2, and design specifications are shown in the BMP Design Manual (Appendix D).

6.2.4 Material Handling and Spill Prevention [PART I.C.3.c.4]

Hazardous materials and petroleum products used in construction of a pad include: fuel and lubricants for construction equipment and vehicles; small quantities of paints and solvents; water or gel based frac fluids (surfactant, friction reducer, dilute hydrochloric acid, potassium chloride) used during well completion; concrete; fertilizers; produced water; and crude oil/condensate. Quantities of fuel and lubricates will be limited to "as-needed" for the immediate operations underway. Any leaks or spills will be promptly remediated and contaminated materials will be hauled off-site and disposed of/recycled properly.

Materials management practices to be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff are detailed in Encana's SPCC Plan for the Wattenberg Field, Colorado. The SPCC Plan also details procedures for spill containment, remediation, and reporting that will be followed by all Encana personnel.

Material Safety Data Sheets (MSDS) for materials to be used or that are produced are maintained on Encana's online company database and filed at Encana's Longmont office.

6.2.5 Dedicated Concrete or Asphalt Batch Plants [PART I.C.3.c.5]

Encana does not have or subcontract any dedicated concrete or asphalt batch plants for its pad site development or construction. Stormwater at the Encana pad sites will not encounter concrete or asphalt batch plant activities.

6.2.6 Vehicle Tracking Control [PART I.C.3.c.6]

Encana will employ BMPs to minimize vehicle tracking. Further discussion on this topic is under Section 6.1.2 of this SWMP.

6.2.7 Waste Management and Disposal, Including Concrete Washout [PART I.C.3.c.7]

Waste disposal is further discussed in Sections 6.1.9 and 6.1.12 of this plan.

Concrete washout may occur at a few Encana sites, although it is not a part of regular operations. The permit authorizes the conditional discharge of concrete washout water to the ground.

If planned for an Encana site, concrete washout areas will be installed prior to any concrete placement on site. Concrete washouts primarily include small excavations located near the point of concrete masonry placement, and will be constructed using a bermed excavation with appropriate tracking and access control. Concrete washout areas are designed using a flat subsurface pit, and a berm surrounding the sides and back of the concrete washout. Excavated material will be used for the perimeter berm. Smaller, more temporary concrete washouts can be constructed using a mobile disposal unit, geotextile bags, or water tight vessels such as rigid children's pools, small dumpsters, or buckets.

Highly visible signs will be placed at the construction site entrance, washout area and elsewhere as necessary, to clearly indicate the location of the concrete washout area to operators of concrete trucks and pump rigs. Concrete washouts will be inspected to make sure appropriate access control, tracking, and containment is in place. Maintenance includes removal of excess materials and general structural integrity of the installation. Concrete washouts will be cleaned of excess water and solids when the capacity of the washout reaches no more than 50 percent.

A designated concrete washout station will be surrounded by perimeter controls to prevent contaminated stormwater from leaving the area. Waste concrete will be removed or disposed of off-site as needed. Concrete washout areas will remain in place until all concrete for the project is placed.

When concrete washout areas are removed, excavations will be filled with suitable compacted backfill and topsoil, any disturbed areas associated with the installation, maintenance, and/or removal of the concrete washout areas will be roughened, seeded, mulched, and crimped.

6.2.8 Groundwater and Stormwater Dewatering [PART I.C.3.c.8]

Construction dewatering may take place on a limited basis at Encana sites. The permit allows for conditional discharge of construction dewatering to the ground (to infiltrate), however no groundwater from construction dewatering can be discharged as surface runoff or to surface

waters. For large construction projects with planned dewatering activity, Encana will apply for a separate dewatering permit from the state, as required. If dewatering takes place at a site, appropriate BMPs will be installed to ensure no runoff from this activity occurs.

7.0 FINAL STABILIZATION AND LONG-TERM STORMWATER MANAGEMENT [PART I.C.4]

7.1 Reclamation [PART I.C.4.a AND I.C.4.b]

Upon completion of earth disturbing activities, the site will be restored to its original condition using rocks, cut vegetation, and other surface material temporarily stockpiled during construction and will be redistributed as backfill on the project area unless otherwise directed by the landowner or jurisdictional authority. All earth disturbing activities during construction will be re-graded and contoured to blend into the adjoining landscape, and natural drainage patterns will be reestablished. During reclamation, sediment BMPs will remain in use.

Preparation of the topsoil area, including all areas to be seeded will have native topsoil spread to a depth of at least 6-inches (loose depth). Topsoil will be added to cleared and grubbed areas.

Disturbed areas will be seeded using seed mixes appropriate to the location (Table 4), unless the landowner wishes to return the land to agricultural production. Local soil conservation authorities with the U.S. Natural Resources Conservation Service, surface owners and/or reclamation contractors familiar with the area may be consulted regarding the correct seed mix to be utilized.

On terrain where drill seeding is appropriate, seed may be planted using a drill equipped with a depth regulator to ensure proper depth of planting. The seed mix will be evenly and uniformly planted over the disturbed area. Drilling will be used where topography and soil conditions allow operation of equipment to meet the seeding requirements of the species being planted. Broadcast seeding will occur on steep terrain and on areas where the cut vegetation and rocks were redistributed over a right-of-way.

Seeding will be done when seasonal or weather conditions are most favorable according to schedules identified by the jurisdictional authority, reclamation contractor, or landowner. Whenever possible, seeding will be timed to take advantage of moisture, such as early spring or late fall, which will benefit from winter precipitation.

Seed mixes will be planted in the amount specified in pounds of pure live seed/acre (Table 4). No primary or secondary noxious weeds will be in the seed mix.

The reestablishment of vegetative cover as well as watershed stabilization measures will be scheduled during the working season and before the succeeding winter. Re-vegetation will be accomplished as soon as practical following the reclamation of a pad.

Mulch will be laid down during re-vegetation as appropriate. The cut vegetation and rocks will act like mulch in the areas where they are applied. Where straw or hay mulch is applied, the mulch will be applied and crimped into the soil.

Crimp mulching uses hay or straw material that is machine crimped into the soil to provide stability. Crimp mulch may be used on its own as a temporary soil stabilization method, or in conjunction with seeding for final stabilization. Crimp mulch functions as a soil stabilizer by decreasing the velocity of sheet flow. Mulch may be hay or cereal grain straw. Mulch will likely be crimped into the soil using either a drill seeder or notched disk plow to the minimum depth of two inches and a maximum depth of four inches. To maximize effectiveness crimping equipment must run parallel to the contours of the land. Crimp mulch may not be appropriate for slopes that are equal to or greater than 3:1 or in areas with hard or rocky soil in which the crimper cannot penetrate. Maintenance items would include re-grading as necessary and reapplying as appropriate.

Crimp mulch will be used to protect seeded areas on all disturbed areas and steep slopes where the use of erosion control blankets is not specified. Erosion control blanketing may be substituted for crimp mulch on steep slopes or other areas, and substitutions will be noted on the site map.

The need for fertilizers will be determined in conjunction with the landowner. If fertilization is necessary, the rates of application will be based on site-specific requirements of the soil.

A special condition exists for pad sites within crop lands. According to the CDPHE Stormwater Fact Sheet dated July 2007:

> *When portions of an oil and gas site are restored to crop land in accordance with the COGCC rules, and returned to the control of the farmer following interim reclamation, permit coverage is no longer required for those areas, and it is not necessary for the oil and gas site to either stabilize or reassign permit coverage for the area restored to crop land.*

When this condition exists for a pad site, inspections will be discontinued and the site will be removed from the stormwater construction permit program.

7.2 Post-Construction Structural Measures [PART I.C.4.a]

After restoration and reclamation work is complete, required repairs to vegetation, erosion and sediment control BMPs will be completed as required. Permanent water bars, culverts, trench plugs and/or other permanent structural measures may be installed on steep slopes and at wetland and stream crossing boundaries.

7.3 Finally Stabilized [PART I.C.4.c]

According to stormwater regulations, "finally stabilized 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 and a density of at least 70 percent of pre-disturbance levels, and the vegetation cover is capable of providing erosion control equivalent to pre-existing conditions, or equivalent permanent, physical erosion reduction methods have been employed."

A special condition exists for oil and gas pad sites regarding pavement. According to the CDPHE Stormwater Fact Sheet dated July 2007:

> *Areas developed as stabilized unpaved surfaces as needed for operation of the facility after interim reclamation also qualify as "finally stabilized". The term "stabilized unpaved surfaces" 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 must be prepared in such a way as to minimize erosion, such as preventing rill erosion on pad surfaces or roads.*

8.0 INSPECTION AND MAINTENANCE PROCEDURES [PART I.C.5]

8.1 Preventive Maintenance [PART I.D.7]

Preventing stormwater from passing through pad areas where contamination may occur is a key element of preventative maintenance. Another key element of preventative maintenance is the routine inspection and repair of erosion and sediments control structures. Regular cleaning of diversion ditches and other BMPs to keep them free of debris and sediment will be practiced. Spillways and culvert systems will also be routinely cleaned and inspected. These maintenance procedures will help to insure that the stormwater does not leave intended channels.

The following preventive maintenance procedures will be implemented to reduce or eliminate potential stormwater contamination sources that may exist on a pad:

- Storage containers, fuel tanks, and equipment used during construction activities should be visually inspected routinely for obvious leaks. These inspections should be conducted by site and contractor personnel as they perform their routine duties;

- Drums will be properly labeled so an enclosed substance can be quickly identified. OSHA-approved labeling and sign systems will be followed for all secondary containers;

- Erosion damage to the earthen berms, outfalls, silt barriers, collection channel, containment ponds, and any erosion and sediment control will be repaired as soon as practical;

- Areas of stained soil will be inspected in order to identify the sources of the staining. Contaminated soil will be removed and properly disposed;

- Energy dissipating material, such as riprap, will be placed at the stormwater outfalls to prevent erosion damage. Barrow ditches should be free from vegetation and debris which may cause impounding of stormwater; and

- Stormwater management structures will be cleared of debris and repaired when necessary; and surface runoff controls such as curbing, culverts, and ditches will be used to control runoff.

8.1.1 Good Housekeeping [PART I.D.7]

In accordance with BMPs that provide procedures to eliminate contamination, and direct, divert, and contain stormwater, Encana has implemented a number of housekeeping practices. These practices will help prevent soil sediment, trash, and toxic or hazardous substances from entering navigable waters.

Housekeeping practices include regular cleaning, organization and maintenance of pad equipment and erosion and sediment control structures throughout the project. Areas where chemicals are stored and used at the project are stored in buildings or containers where there is no potential for stormwater contact. These areas include producing pads that typically consist of wellheads, separator units, dehydration units, and 300-barrel capacity aboveground stock tanks.

The following items will be addressed in order to maintain a clean and orderly pad during the development, production, and abandonment phases of work:

- Inspect pad areas routinely;
- Correct deficiencies noted during inspections;
- Clean and maintain stormwater management structures and components;
- Routine trash collection and disposal;
- Familiarize employees and contractors with spill clean-up equipment and storage locations; and
- Familiarize employees and contractors with good housekeeping procedures and pad pollution prevention procedures.

8.1.2 Material Storage [PART I.D.7]

Pad sites typically include only outdoor storage of materials. The following good housekeeping practices will be followed at the material storage areas:

- Storage containers will be stored away from direct traffic to prevent accidents. They will also have proper labels;
- Dumpsters and trash receptacles will be enclosed in order to prevent the dissemination of refuse;
- Storage areas will be kept free of refuse;
- Chemical substances used at pads will be properly labeled and will have proper spill containment; and
- Chemical substance containers will be clearly labeled with an MSDS kept on file.

8.1.3 Waste Removal [PART I.D.1.f]

All waste from materials imported to the construction site will be removed for disposal/recycling to an appropriate licensed disposal/recycling facility, including sanitary sewage facilities (typically portable). No wastes of imported materials will be buried, dumped, or purposely discharged to waters of the state. There are no other pollutant sources from areas other than construction areas.

8.2 Inspections [PART I.D.6]

Inspections will be conducted to document the status of erosion and sediment control structures and re-vegetation efforts. Inspection forms will document non-compliance conditions such as uncontrolled releases of mud, muddy water, or measurable quantities of sediment that are found off-site. Required actions or modifications as documented on the SWMP DCAS Inspection Report will be implemented in a timely manner after the inspection. Routine inspections may be conducted at pad areas during all phases of work and after a precipitation-related event. All inspection observations will be recorded on the SWMP DCAS Inspection Report and uploaded onto the stormwater website. Dates that construction activity begins, ceases, or is temporarily idle, as well as the site stage, will be recorded. The form provides a standardized format that will be completed during all inspections, and includes a signature line for the inspector to ensure compliance with the regulations.

For stormwater regulation purposes, construction sites have been divided into stormwater inspection stages: Active, Interim Stabilization, and Final Stabilization. For the purposes of this SWMP, only Active and Interim Stabilization sites will be inspected. Each of these stormwater inspection stages is discussed below. Once a site is finally stabilized, it will be removed from this stormwater construction permit program.

A special condition exists for pad sites within crop lands, which is detailed in Section 7.1 of this plan. When pad sites are being returned to a farmer for agricultural usage, the sites may be removed from the stormwater construction permit program.

Personnel responsible for inspections will be trained to evaluate stormwater management concerns, erosion and sediment control structures, and to evaluate pad and surrounding area vegetation.

8.2.1 14-day Inspection/Active Stage

During construction, this phase of work is classified as the Active phase, according to stormwater regulations. The inspection frequency is every 14 days during the Active phase and after any precipitation or snowmelt event that causes surface erosion.

The pad perimeter, disturbed areas, and any stored materials that are exposed to precipitation will be inspected for evidence of, or the potential for pollutants that may enter the drainage system. Erosion and sediment control systems that are identified on the site-specific SWMP DCAS Inspection Report will be inspected to ensure that they are in good condition and operating properly.

8.2.2 Monthly Inspection/Completed Stage

If a pad is not able to be re-seeded due to weather or seasonal conditions, but construction activities are completed, inspections will be conducted at least once a month. This phase is considered "Completed" according to stormwater regulations. The monthly inspection frequency will be continued until the pad area achieves or reaches final stabilization vegetation conditions, at which time inspections are discontinued. Encana will inspect each site as a "Construction" site until the site has been seeded and considered an "Interim" site.

8.2.3 Monthly Inspection/Interim Stabilization Stage

Encana has defined Interim Stabilization once the pad has been re-seeded. Inspections will be conducted at least once a month.

8.2.4 Final Stabilization Stage

When a pad site has reached final stabilization, it will be removed from the stormwater construction inspection routine.

8.2.5 Winter Conditions

Inspections will not be required at pads where snow cover exists over the entire site for an extended period as long as melting conditions do not exist. Snow cover, as well as snow melting conditions will be documented.

8.2.6 Precipitation Event Inspections

Active pad site inspections will be conducted within 24 hours after a precipitation or snowmelt event that causes surface erosion. If no construction activities will occur at a pad site following a storm event, post-storm event inspections will be conducted prior to re-commencing construction activities, but no later than 72 hours following the storm event. Surface erosion generally occurs when precipitation or snowmelt results in surface water flow. If the precipitation infiltrates, then no inspection is required. In order to determine if surface erosion or surface water flow resulted from a precipitation or snowmelt event, a selected few pads will be evaluated for surface erosion, off-site sediment transportation, and/or off-site release of muddy water. These selected pads may have a worst case surface erosion or sediment transportation scenario. If the selected pad and associated areas do not show any off-site surface erosion, off-site sediment release and transport, or off-site muddy water releases, all of the remaining active and completed pads will not be inspected. Inspection results of the pads will determine or trigger the inspection of all Active pads. Selection of a pad is based on the following criteria:

- A pad that has a cut or fill slope that has a steeper grade than 1:4;
- A pad that has erosion and/or sediment control structures installed; and
- A pad that has vegetation or erosion situations.

8.2.7 Temporarily Idle Sites

If no construction activities will occur following a storm event at a temporarily idle site, post-storm event inspections will be conducted prior to re-commencing construction activities, but no later than 72 hours following the storm event. The occurrence of any such delayed inspection will be documented in SWIM. Routine inspections will still be conducted at least every 14 calendar days.

9.0 EMPLOYEE TRAINING [PART I.A.10]

LTE will inform and train employees who are involved with SWMP activities. Training will cover information and procedures contained in the SWMP and will be conducted on an annual basis. Personnel work responsibilities will be used to identify the appropriate attendees. Safety and environmental elements of the SWMP will also be covered. A Training Log (Appendix E) will be kept and updated on an annual basis.

The following topics may be presented and discussed during SWMP training:

- Introduction to CDPS Stormwater Permit;
- Stormwater regulations;
- Purpose of stormwater permit;
- Requirements of stormwater permit;
- Components of the SWMP;
- Identification of potential pollutant sources;
- BMPs;
- Preventative maintenance;
- Good housekeeping;
- Inspections and maintenance; and
- Record keeping.

10.0 RECORD KEEPING [PART I.D.5.B]

The following record keeping procedures will be implemented in order to provide accurate and complete documentation of events associated with the stormwater management program. A SWMP DCAS Inspection Report is located in Appendix B and will be used for all SWMP inspections. Inspections will be uploaded onto the stormwater website at least once per month. Routine inspections will include the 14-day, monthly, and after a precipitation event.

Records will be maintained on Encana's secure stormwater website and will include the following documentation:

- A complete copy of the stormwater general permit COR-030000;
- Copies of all stormwater related inspection records, site maps, and diagrams will be kept on in the SWIM DCAS, and on the stormwater website;
- Site-specific records will be kept a minimum of three years from final stabilization.
- Spills and leaks documentation;
- All revisions of the SWMP must be kept in the SWMP DCAS and the stormwater website for a minimum of three-years.

11.0 SWMP REVIEW/CHANGES [PART I.D.5.c AND I.D.5.d]

This Field-Wide SWMP will be retained at Encana's Longmont office and on the stormwater website. Encana will amend the SWMP whenever there is a significant change in design, construction, operation, or maintenance, which has a significant effect on the potential for the discharge of pollutants to water of the state, or if the SWMP proves to be ineffective in achieving the general objectives of controlling pollutants in stormwater discharges associated with pad activities. The SWMP is considered a "living document".

TABLES

TABLE 1
CHEMICAL PRODUCT LIST
WATTENBERG GAS FIELD DRILLING PROGRAM

Encan Oil & Gas (USA) Inc.

MSDS Product Name	Product Use/Chemical Description
Premium Copper Compound	Pipe Dope
Marine QD Electronic Cleaner	Aerosol Cleaner
WD-40	Spray Lubricant
Brake Clean	Aerosol Cleaner
White Lithium Grease	Lubricant
Jump Start Starting Fluid	Aerosol - starting fluid
2-K Kerosene	Middle Distillate
Mineral Spirits NE	Lubricant
Methanol	Methyl Alcohol
Ultra-Low Sulfur Diesel	Diesel Fuel
Chevron Rando HD	Hydraulic Oil
Delo 400 Multigrade SAE 15W-40	Motor Oil
Chevron Delo Extended Life PreDiluted 50/50	Antifreeze - Coolant
Chevron Drive Train Fluid HD	Transmission Fluid
Chevron Ultra-Duty rease EP	Grease
HYDRO VIS 50	Sodium Acrylate & Acrylamide Mineral Oil
Acid Magic	Muriatic Acid Replacement
Walnut Shell Medium	Walnut Shells (ALL Grades)
Soda Ash	Sodium Carbonate
Drill Bit Stick	Non-Phenol Ethoyxalates
Sawdust	LCM - Wood
SAPP	Sodium Acid PyroPhospahte
PAC-1	Polyanionic Carboxymethyl Cellulose
Magnafloc 24 (Perol E240	Copolymer Sodium Acrylate Acrylamide
Lime	Calcium Hydroxide
Hydro Vis 30	Anionic Polyacrylamide Emulsion
Hydro thin	Acrylic Copolymer in Aqueous Solution
Cotton Seed Hulls	LCM Cotton Seed Hulls
Cedar fiber	Cellulose Material
Pels Caustic Soda Beads	Sodium Hydroxide/Anhydrous Sodium Hydroxide Caustic Soda
Calcium Nitrate	Hydrated Ammonium Calcium Nitrate Double Salt
Black Hills Bentonite	Hydrous Silicate of Alumina
Barite	Barite (Weighting Additive0
Alcomer 1771	Acrylic Polymer
Magnafloc 338	Flocculation Agent
CD-32	Chemical Dispersant
Cello-Flake	Cellophane
Cement	Cement ALL Types
Static Free	Crystalline Silica
ASA-301	Crystaline Silica Blend
Bentonite	Bentonite Clay
Calcium Chloride	Calcium Chloride Pelltes
Clay Treat-3C	Solution of Quarternary Ammonium
CSE-2	Bonding Agent for Cement
FAW-4	Aqueous Solution
FL-52	Fluid Loss Control
In-Flo 250	Surface Tension Reducer
Fly-Ash (Pozzolan)	Flyash
Inflo-150	Surfactants
NE-118	Blend of Surfactants
NE-940	Blend Polyglycols in Alcohol
S-8	Silica Flour
SAPP	Sodium Acid PyroPhosphate
Sodium Metasilicate	Sodium Metasilicate (anhydrous)

TABLE 2
BMP SELECTION GUIDELINES
WATTENBERG GAS FIELD DRILLING PROGRAM

ENCANA OIL & GAS (USA) INC.

ACTIVE	COMPLETED	INTERIM STABILIZATION	FINAL STABILIZATION
Pads, Flowlines			
Berm	Berm	Berm	Berm
Brush Matting	Brush Matting	Brush Matting	Check Dams
Check Dams	Check Dams	Check Dams	Culverts
Culverts	Culverts	Culverts	Culvert Protection
Culvert Protection	Culvert Protection	Culvert Protection	Diversion Ditch/Ditch&Berm
Diversion Ditch/Ditch&Berm	Diversion Ditch/Ditch&Berm	Diversion Ditch/Ditch&Berm	Drainage Dip
Drainage Dip	Drainage Dip	Drainage Dip	Filter Berm
Erosion Control Blanket	Erosion Control Blanket	Erosion Control Blanket	Gravel Surfacing
Filter Berm	Filter Berm	Filter Berm	Low Water Crossing
Gravel Surfacing	Gravel Surfacing	Gravel Surfacing	Retaining Wall
Land Grading	Level Spreader	Level Spreader	Revegetation
Level Spreader	Low Water Crossing	Low Water Crossing	Riprap
Low Water Crossing	Retaining Wall	Retaining Wall	Roadside Ditches
Retaining Wall	Riprap	Revegetation	Sediment Trap
Revegetation	Roadside Ditches	Riprap	Slope Drain
Riprap	Sediment Trap	Roadside Ditches	Terracing
Roadside Ditches	Silt Fence	Sediment Trap	Water Bar
Sediment Trap	Slope Drain	Silt Fence	
Silt Fence	Straw Bale Barrier	Slope Drain	
Slope Drain	Terracing	Straw Bale Barrier	
Stabilized Construction Entrance	Vegetated Buffer	Terracing	
Straw Bale Barrier	Water Bar	Vegetated Buffer	
Surface Roughening / Ripping	Wattles	Water Bar	
Terracing	Wind Fence	Wattles	
Turnouts		Wind Fence	
Vegetated Buffer			
Water Bar			
Wattles			
Wind Fence			
Access Roads			
Berm	Berm	Berm	Berm
Brush Matting	Brush Matting	Brush Matting	Check Dams
Check Dams	Check Dams	Check Dams	Culverts
Culverts	Culverts	Culverts	Culvert Protection
Culvert Protection	Culvert Protection	Culvert Protection	Diversion Ditch/Ditch&Berm
Diversion Ditch/Ditch&Berm	Diversion Ditch/Ditch&Berm	Diversion Ditch/Ditch&Berm	Drainage Dip
Drainage Dip	Drainage Dip	Drainage Dip	Filter Berm
Erosion Control Blanket	Erosion Control Blanket	Erosion Control Blanket	Gravel Surfacing
Filter Berm	Filter Berm	Filter Berm	Low Water Crossing
Gravel Surfacing	Gravel Surfacing	Gravel Surfacing	Retaining Wall
Land Grading	Level Spreader	Level Spreader	Revegetation
Level Spreader	Low Water Crossing	Low Water Crossing	Riprap
Low Water Crossing	Retaining Wall	Retaining Wall	Roadside Ditches
Retaining Wall	Riprap	Revegetation	Sediment Trap
Revegetation	Roadside Ditches	Riprap	Slope Drain
Riprap	Sediment Trap	Roadside Ditches	Water Bar
Roadside Ditches	Silt Fence	Sediment Trap	

TABLE 2

BMP SELECTION GUIDELINES
WATTENBERG GAS FIELD DRILLING PROGRAM

ENCANA OIL & GAS (USA) INC.

ACTIVE	COMPLETED	INTERIM STABILIZATION	FINAL STABILIZATION
Access Roads (continued)			
Sediment Trap	Slope Drain	Silt Fence	
Silt Fence	Straw Bale Barrier	Slope Drain	
Slope Drain	Vegetated Buffer	Straw Bale Barrier	
Stabilized Construction Entrance	Water Bar	Vegetated Buffer	
Straw Bale Barrier	Wattles	Water Bar	
Surface Roughening/Ripping	Wind Fence	Wattles	
Turnouts	Wind Fence	Wind Fence	
Vegetated Buffer			
Water Bar			
Wattles			
Wind Fence			

Notes:
BMP = Best Management Practice

TABLE 3
STRUCTURAL AND NON-STRUCTURAL BMP CLASSIFICATION
WATTENBERG GAS FIELD DRILLING PROGRAM

ENCANA OIL & GAS (USA) INC.

NON-STRUCTURAL BMPs		
Program Oversight	**Construction Site Planning and Management**	**Good Housekeeeping/Materials Management**
Construction Phase Plan Review	Timing of projects	General Construction Site Waste Management
Contractor Training and Certification	Construction Sequencing	Spill Prevention, Control Plan and Countermeasure
Database Development and Maintenance	Site Operator BMP Inspection and Mainentance Training	
	Preserving Natural Vegetation/Buffer	
	Minimize Initial Pad Site Acreage	
	Slope Pad to the Reserve Pit	

STRUCTURAL BMPs		
Erosion Control	**Sediment Control**	**Runoff Control**
Dust Control	Brush Matting	Berm
Erosion Control Blanket	Filter Berm	Check Dam
Gravel Surfacing	Land Grading	Culverts
Low Water Crossing	Level Spreader	Culvert Protection
Mulching	Sediment Basin	Diversion Ditch/Ditch&Berm
Retaining Wall	Sediment Trap	Drainage Dip
Revegetation	Silt Fence	Roadside Ditch
Riprap	Slope Pad Toward Reserve Pit	Slope Drain
Slope Stabilization	Stabilized Construction Entrance	Turnout
Surface Roughening/Ripping	Straw Bale Barrier	Water Bar
Terracing	Vegetated Buffer	
Vegetated Buffer	Wattle	
	Wind Fence	

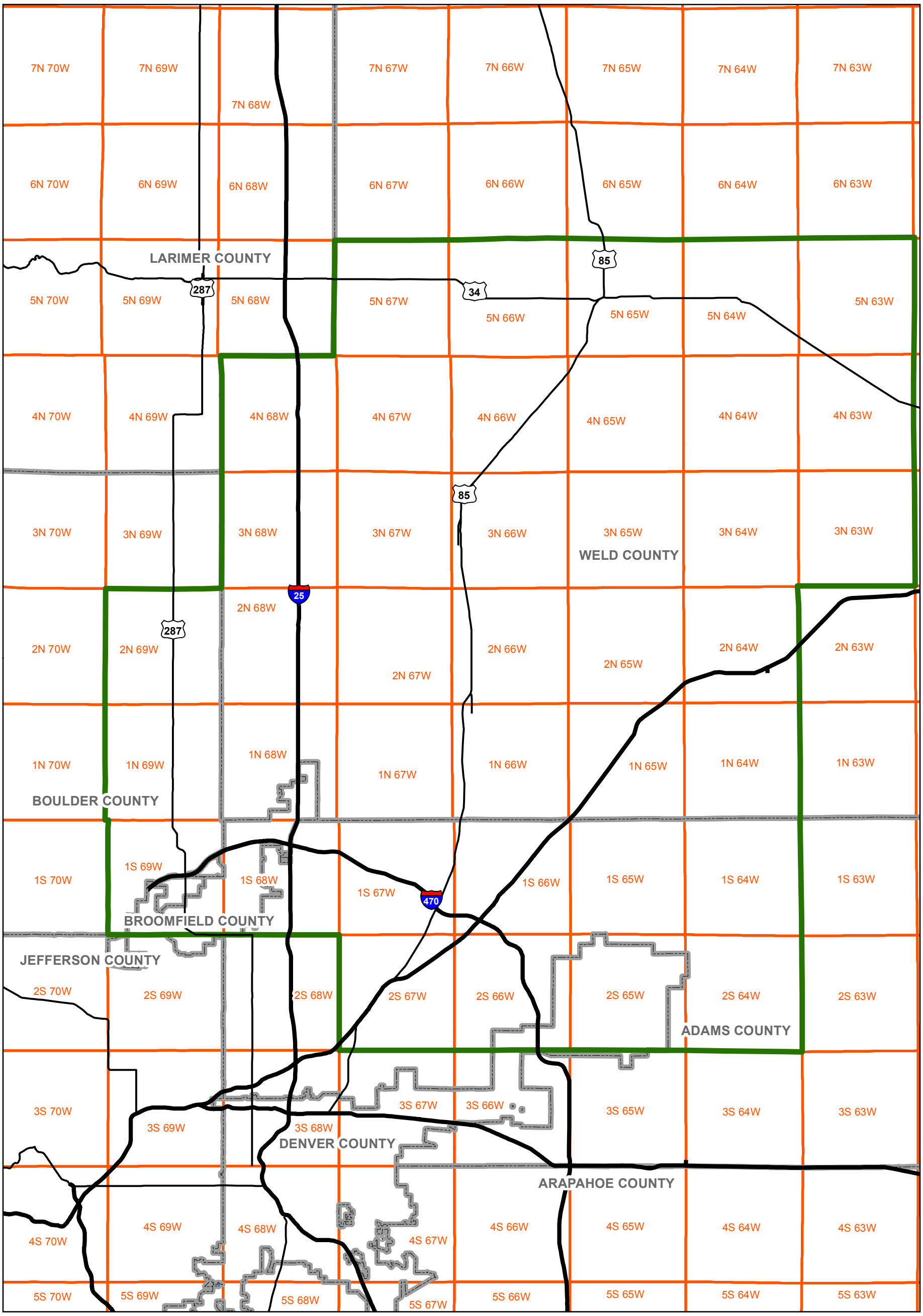
TABLE 4
SEED MIXES AND APPLICATION RATES
WATTENBERG GAS FIELD DRILLING PROGRAM

ENCANA OIL & GAS (USA) INC.

TYPICAL SEED MIX	APPLICATION RATE (lbs/acre)
Rocky Mountain Native Mix	**New Seeding**
(25%) Slender Wheatgrass	Broadcast: 20-25 lbs/acre
(20%) Mountain Brome	Drilled: 15-20 lbs/acre
(15%) Idaho Fescue	
(15%) Blue Grama	**Overseeding**
(15%) Buffalograss	Broadcast: 10-15 lbs/acre
(5%) Greeen Needlegrass	Drilled: 5-10 lbs/acre
(5%) Indian Ricegrass	

Notes:
lbs/acre = pounds per acre
% = percent

FIGURE



LEGEND

- HIGHWAY
- INTERSTATE
- WATTENBERG GAS FIELD PROJECT AREA
- COUNTY BOUNDARY
- TOWNSHIP AND RANGE LINES

0 5 10
Miles

N

FIGURE 1
STORMWATER MANAGEMENT PLAN PERMIT BOUNDARY
WATTENBERG GAS FIELD
COLORADO

ENCANA OIL & GAS (USA) INC.

Path: P:\Encana\GIS\MXD\033411001\0334_11001_WATTENBERG_GASFIELD_SWMP_AREA.mxd

APPENDIX A

STORMWATER GENERAL PERMIT COR-03000 AND WATTENBERG GAS FIELD DRILLING PROGRAM STORMWATER PERMIT COR-034778

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

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 20, 2007

Chris R. Williams, EH & S Group Lead
EnCana Oil & Gas (USA) Inc.,
370 - 17th Street Ste. 1700
Denver, CO 80202
303/623-2300

RE: Final Permit, Colorado Discharge Permit System – Stormwater
Certification No: COR-034778
Wattenberg Gas Field
Statewide County

Local Contact: Chris Roberts, EHS Coord
720/685-8514

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 **COR034778**

This Certification to Discharge specifically authorizes:

EnCana Oil & Gas (USA) Inc.

LEGAL CONTACT:
Chris R. Williams, EH & S Group Lead
EnCana Oil & Gas (USA) Inc.
370 - 17th Street Ste. 1700
Denver, CO 80202
Phone # 303/623-2300
cliff.roberts@encana.com

LOCAL CONTACT:
Chris Roberts, EHS Coord,
Phone # 720/685-8514
chris.r.williams@encana.com

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

Generally North of DIA
, Co

Latitude **40/08/13,** Longitude **104/46/45**
In **Statewide County**

to: various drainages -- South Platte River

Anticipated Activity begins **07/01/2002** continuing through **06/30/2007**
On **999** acres (**5** 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.)

STATE OF COLORADO

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

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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: Wattenberg Gas Field
Located at: Statewide (Portable Plant), Statewide, Statewide County
Permit No.: COR034778

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

CDPS GENERAL PERMIT

STORMWATER DISCHARGES ASSOCIATED WITH
CONSTRUCTION ACTIVITY

AUTHORIZATION TO DISCHARGE UNDER THE

COLORADO DISCHARGE PERMIT SYSTEM

In compliance with the provisions of the Colorado Water Quality Control Act, (25-8-101 et seq., CRS, 1973 as amended) and the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.; the "Act"), this permit authorizes the discharge of stormwater associated with construction activities (and specific allowable non-stormwater discharges in accordance with Part I.D.3 of the permit) certified under this permit, from those locations specified throughout the State of Colorado to specified waters of the State. Such discharges shall be in accordance with the conditions of this permit.

This permit specifically authorizes the facility listed on the certification page (page 1) of this permit to discharge, as of this date, in accordance with permit requirements and conditions set forth in Parts I and II hereof. All discharges authorized herein shall be consistent with the terms and conditions of this permit.

This permit and the authorization to discharge shall expire at midnight, **June 30, 2012.**

Issued and Signed this 31st day of May, 2007

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Janet S. Kieler
Permits Section Manager
Water Quality Control Division

SIGNED AND ISSUED MAY 31, 2007

EFFECTIVE JULY 1, 2007

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PART I

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PART II

PART I

A. COVERAGE UNDER THIS PERMIT

1. **Authority to Discharge**

Under this permit, facilities are granted authorization to discharge stormwater associated with construction activities into waters of the state of Colorado. This permit also authorizes the discharge of specific allowable non-stormwater discharges, in accordance with Part I.D.3 of the permit, which includes discharges to the ground. This includes stormwater discharges from areas that are dedicated to producing earthen materials, such as soils, sand and gravel, for use at a single construction site (i.e., borrow or fill areas). This permit also authorizes stormwater discharges from dedicated asphalt batch plants and dedicated concrete batch plants. (Coverage under the construction site permit is not required for batch plants if they have alternate CDPS permit coverage.) This permit does not authorize the discharge of mine water or process water from such areas.

a) **Applicable Sections:** In accordance with Part I.A.3 of this permit, some parts of this permit do not apply to sites covered under a Qualifying Local Program, as defined in I.A.2.d. For sites not covered by a Qualifying Local Program, all parts of the permit apply except Part I.A.3. The permittee will be responsible for determining and then complying with the applicable sections.

b) **Oil and Gas Construction:** Stormwater discharges associated with construction activities directly related to oil and gas exploration, production, processing, and treatment operations or transmission facilities are regulated under the Colorado Discharge Permit System Regulations (5CCR 1002-61), and require coverage under this permit in accordance with that regulation. However, references in this permit to specific authority under the Federal Clean Water Act (CWA) do not apply to stormwater discharges associated with these oil and gas related construction activities, to the extent that the references are limited by the federal Energy Policy Act of 2005.

2. **Definitions**

a) **Stormwater:** Stormwater is precipitation-induced surface runoff.

b) **Construction activity:** Construction activity refers to ground surface disturbing activities, which include, but are not limited to, clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas. Construction does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility.

c) **Small construction activity:** Stormwater discharge associated with small construction activity means the discharge of stormwater from construction activities that result in land disturbance of equal to or greater than one acre and less than five acres. Small construction activity also includes the disturbance of less than one acre of total land area that is part of a larger common plan of development or sale, if the larger common plan will ultimately disturb equal to or greater than one and less than five acres.

d) **Qualifying Local Program:** This permit includes conditions that incorporate qualifying local erosion and sediment control program (Qualifying Local Program) requirements by reference. A Qualifying Local Program is a municipal stormwater program for stormwater discharges associated with small construction activity that has been formally approved by the Division.

Other Definitions: Definitions of additional terms can be found in Part I.E. of this permit.

3. **Permit Coverage Without Application – for small construction activities under a Qualifying Local Program only**

If a small construction site is within the jurisdiction of a Qualifying Local Program, the operator of the construction activity is authorized to discharge stormwater associated with small construction activity under this general permit without the submittal of an application to the Division.

a) **Applicable Sections**: For sites covered by a Qualifying Local Program, only Parts 1.A.1, 1.A.2, 1.A.3, I.D.1, I.D.2, I.D.3, I.D.4, I.D.7, I.D.8, I.D.11, I.E and Part II of this permit, with the exception of Parts II.A.1, II.B.3, II.B.8, and II.B10, apply.

A. COVERAGE UNDER THIS PERMIT (cont.)

b) **Local Agency Authority:** This permit does not pre-empt or supersede the authority of local agencies to prohibit, restrict, or control discharges of stormwater to storm drain systems or other water courses within their jurisdiction.

c) **Permit Coverage Termination:** When a site under a Qualifying Local Program has been finally stabilized, coverage under this permit is automatically terminated.

d) **Compliance with Qualifying Local Program:** A construction site operator that has authorization to discharge under this permit under Part I.A.3 shall comply with the requirements of the Qualifying Local Program with jurisdiction over the site.

e) **Full Permit Applicability:** The Division may require any operator within the jurisdiction of a Qualifying Local Program covered under this permit to apply for and obtain coverage under the full requirements of this permit. The operator must be notified in writing that an application for full coverage is required. When a permit certification under this permit is issued to an operator that would otherwise be covered under Part I.A.3 of this permit, the full requirements of this permit replace the requirements as per Part I.A.3 of this permit, upon the effective date of the permit certification. A site brought under the full requirements of this permit must still comply with local stormwater management requirements, policies or guidelines as required by Part I.D.1.g of this permit.

4. **Application, Due Dates**

a) **Application Due Dates:** At least **ten calendar days** prior to the commencement of construction activities, the applicant shall submit an application form as provided by the Division, with a certification that the Stormwater Management Plan (SWMP) is complete.

One original completed discharge permit application shall be submitted, by mail or hand delivery, to:

Colorado Department of Public Health and Environment
Water Quality Control Division
WQCD-Permits-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

b) **Summary of Application:** The application requires, at a minimum, the following:

1) The applicant's company name; address; telephone number; and email address (if available); whether the applicant is the owner, developer, or contractor; and local contact information;
2) Project name, address, county and location of the construction site, including the latitude and longitude to the nearest 15 seconds of the approximate center of the construction activity;
3) Legal description or map of the construction site;
4) Estimates of: the total area of the site, the area of the site that is expected to be disturbed, and the total area of the larger common plan of development or sale to undergo disturbance;
5) The nature of the construction activity;
6) The anticipated start date and final stabilization date for the project;
7) The name of the receiving water(s), or the municipal separate storm sewer system and the ultimate (i.e., named) receiving water(s);
8) Certification that the SWMP for the construction site is complete (see Part I.C. below); and
9) The signature of the applicant, signed in accordance with Part I.F.1 of this permit.

5. **Permit Certification Procedures**

If this general permit is appropriate for the applicant's operation, then a certification will be developed and the applicant will be authorized to discharge stormwater under this general permit.

a) **Request for Additional Information**: The Division shall have up to **ten calendar days** after receipt of the above information to request additional data and/or deny the authorization for any particular discharge. Upon receipt of additional information, the Division shall have an additional **ten calendar days** to issue or deny authorization for the particular discharge. (Notification of denial shall be by letter, in cases where coverage under an alternate general permit or an individual permit is required, instead of coverage under this permit.)

A. COVERAGE UNDER THIS PERMIT (cont.)

b) **Automatic Coverage**: If the applicant does not receive a request for additional information or a notification of denial from the Division dated within ten calendar days of receipt of the application by the Division, authorization to discharge in accordance with the conditions of this permit shall be deemed granted.

c) **Individual Permit Required**: If, after evaluation of the application (or additional information, such as the SWMP), it is found that this general permit is not appropriate for the operation, then the application will be processed as one for an individual permit. The applicant will be notified of the Division's decision to deny certification under this general permit. For an individual permit, additional information may be requested, and 180 days may be required to process the application and issue the permit. At the Division's discretion, temporary coverage under this general permit may be allowed until the individual permit goes into effect.

d) **General vs. Individual Permit Coverage**: Any permittee authorized by this permit may request to be excluded from the coverage of this permit by applying for an individual CDPS permit. The permittee shall submit an individual application, with reasons supporting the request, to the Division at least 180 days prior to any discharge.

e) **Local Agency Authority:** This permit does not pre-empt or supersede the authority of local agencies to prohibit, restrict, or control discharges of stormwater to storm drain systems or other water courses within their jurisdiction.

6. **Inactivation Notice**

When a site has been finally stabilized in accordance with the SWMP, the permittee must submit an **Inactivation Notice** form that is signed in accordance with Part I.F.1. of this permit. The Inactivation Notice form is available from the Division and includes:

a) Permit certification number;
b) The permittee's name, address, telephone number;
c) Name, location, and county for the construction site for which the inactivation notice is being submitted; and
d) Certification that the site has been finally stabilized, and a description of the final stabilization method(s).

7. **Transfer of Permit**

When responsibility for stormwater discharges at a construction site changes from one entity to another, the permittee shall submit a completed **Notice of Transfer and Acceptance of Terms** form that is signed in accordance with Part I.F.1. of this permit. The Notice of Transfer form is available from the Division and includes:

a) Permit certification number;
b) Name, location, and county for the construction site for which the Notice of Transfer is being submitted;
c) Identifying information for the new permittee;
d) Identifying information for the current permittee; and
e) Effective date of transfer.

If the new responsible party will not complete the transfer form, the permit may be inactivated upon written request to the Division and completion of the Inactivation Notice if the permittee has no legal responsibility, through ownership or contract, for the construction activities at the site. In this case, the new owner or operator would be required to obtain permit coverage separately.

8. **Reassignment of Permit**

When a permittee no longer has control of a specific portion of a permitted site, and wishes to transfer coverage of that portion of the site to a second party, the permittee shall submit a completed **Notice of Reassignment of Permit Coverage** form that is signed in accordance with Part I.F.1. of this permit. The Notice of Reassignment of Permit Coverage form is available from the Division and includes:

a) Current permit certification number;
b) Identifying information and certification as required by Part I.A.4.b for the new permittee;
c) Identifying information for the current permittee, revised site information and certification for reassignment; and
d) Effective date of reassignment.

A. COVERAGE UNDER THIS PERMIT (cont.)

If the new responsible party will not complete the reassignment form, the applicable portion of the permitted site may be removed from permit coverage upon written request to the Division if the permittee has no legal responsibility, through ownership or contract, for the construction activities at the portion of the site. In this case, the new owner or operator would be required to obtain permit coverage separately.

9. **Sale of Residence to Homeowners**

For residential construction only, when a residential lot **has been conveyed to a homeowne**r and all criteria in paragraphs a through e, below, are met, coverage under this permit is no longer required and the conveyed lot may be removed from coverage under the permittee's certification. At such time, the permittee is no longer responsible for meeting the terms and conditions of this permit for the conveyed lot, including the requirement to transfer or reassign permit coverage. The permittee remains responsible for inactivation of the original certification.

a) The lot has been sold to the homeowner(s) for private residential use;
b) the lot is less than one acre of disturbed area;
c) all construction activity conducted by the permittee on the lot is completed;
d) a certificate of occupancy (or equivalent) has been awarded to the home owner; and
e) the SWMP has been amended to indicate the lot is no longer covered by permit.

Lots not meeting all of the above criteria require continued permit coverage. However, this permit coverage may be transferred (Part I.A.7, above) or reassigned (Part I.A.8, above) to a new owner or operator.

10. **Permit Expiration Date**

Authorization to discharge under this general permit shall expire on June 30, 2012. The Division must evaluate and reissue this general permit at least once every five years and must recertify the permittee's authority to discharge under the general permit at such time. Therefore, a permittee desiring continued coverage under the general permit must reapply by March 31, 2012. The Division will initiate the renewal process; however, it is ultimately the permittee's responsibility to ensure that the renewal is submitted. The Division will determine if the permittee may continue to operate under the terms of the general permit. An individual permit may be required for any facility not reauthorized to discharge under the reissued general permit.

11. **Individual Permit Criteria**

Various criteria can be used in evaluating whether or not an individual (or alternate general) permit is required instead of this general permit. This information may come from the application, SWMP, or additional information as requested by the Division, and includes, but is not limited to, the following:

a) the quality of the receiving waters (i.e., the presence of downstream drinking water intakes or a high quality fishery, or for preservation of high quality water);
b) the size of the construction site;
c) evidence of noncompliance under a previous permit for the operation;
d) the use of chemicals within the stormwater system; or
e) discharges of pollutants of concern to waters for which there is an established Total Maximum Daily Load (TMDL).

In addition, an individual permit may be required when the Division has shown or has reason to suspect that the stormwater discharge may contribute to a violation of a water quality standard.

B. STORMWATER MANAGEMENT PLAN (SWMP) – **GENERAL REQUIREMENTS**

1. A SWMP shall be developed for each facility covered by this permit. The SWMP shall be prepared in accordance with good engineering, hydrologic and pollution control practices. (The SWMP need not be prepared by a registered engineer.)

B. STORMWATER MANAGEMENT PLAN (SWMP) – **GENERAL REQUIREMENTS** (cont.)

2. The SWMP shall:

   a) Identify all potential sources of pollution which may reasonably be expected to affect the quality of stormwater discharges associated with construction activity from the facility;

   b) Describe the practices to be used to reduce the pollutants in stormwater discharges associated with construction activity at the facility; and ensure the practices are selected and described in accordance with good engineering practices, including the installation, implementation and maintenance requirements; and

   c) Be properly prepared, and updated in accordance with Part I.D.5.c, to ensure compliance with the terms and conditions of this permit.

3. Facilities must implement the provisions of the SWMP as written and updated, from commencement of construction activity until final stabilization is complete, as a condition of this permit. The Division reserves the right to review the SWMP, and to require the permittee to develop and implement additional measures to prevent and control pollution as needed.

4. The SWMP may reflect requirements for Spill Prevention Control and Countermeasure (SPCC) plans under section 311 of the CWA, or Best Management Practices (BMPs) Programs otherwise required by a separate CDPS permit, and may incorporate any part of such plans into the SWMP by reference, provided that the relevant sections of such plans are available as part of the SWMP consistent with Part I.D.5.b.

5. For any sites with permit coverage before June 30, 2007, the permittee's SMWP must meet the new SWMP requirements as summarized in Section II.I of the rationale. Any needed changes must be made by **October 1, 2007**.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS**

The SWMP shall include the following items, at a minimum.

1. **Site Description.** The SWMP shall clearly describe the construction activity, to include:

   a) The nature of the construction activity at the site.
   b) The proposed sequence for major activities.
   c) Estimates of the total area of the site, and the area and location expected to be disturbed by clearing, excavation, grading, or other construction activities.
   d) A summary of any existing data used in the development of the site construction plans or SWMP that describe the soil or existing potential for soil erosion.
   e) A description of the existing vegetation at the site and an estimate of the percent vegetative ground cover.
   f) The location and description of all potential pollution sources, including ground surface disturbing activities (see Part I.A.2.b), vehicle fueling, storage of fertilizers or chemicals, etc.
   g) The location and description of any anticipated allowable sources of non-stormwater discharge at the site, e.g., uncontaminated springs, landscape irrigation return flow, construction dewatering, and concrete washout.
   h) The name of the receiving water(s) and the size, type and location of any outfall(s). If the stormwater discharge is to a municipal separate storm sewer system, the name of that system, the location of the storm sewer discharge, and the ultimate receiving water(s).

2. **Site Map.** The SWMP shall include a legible site map(s), showing the entire site, identifying:

   a) construction site boundaries;
   b) all areas of ground surface disturbance;
   c) areas of cut and fill;
   d) areas used for storage of building materials, equipment, soil, or waste;
   e) locations of dedicated asphalt or concrete batch plants;
   f) locations of all structural BMPs;
   g) locations of non-structural BMPs as applicable; and
   h) locations of springs, streams, wetlands and other surface waters.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS** (cont.)

3. **Stormwater Management Controls.**

The SWMP must include a description of all stormwater management controls that will be implemented as part of the construction activity to control pollutants in stormwater discharges. The appropriateness and priorities of stormwater management controls in the SWMP shall reflect the potential pollutant sources identified at the facility.

The description of stormwater management controls shall address the following components, at a minimum:

a) **SWMP Administrator** - The SWMP shall identify a specific individual(s), position or title who is responsible for developing, implementing, maintaining, and revising the SWMP. The activities and responsibilities of the administrator shall address all aspects of the facility's SWMP.

b) **Identification of Potential Pollutant Sources** - All potential pollutant sources, including materials and activities, at a site must be evaluated for the potential to contribute pollutants to stormwater discharges. The SWMP shall identify and describe those sources determined to have the potential to contribute pollutants to stormwater discharges, and the sources must be controlled through BMP selection and implementation, as required in paragraph (c), below.

At a minimum, each of the following sources and activities shall be evaluated for the potential to contribute pollutants to stormwater discharges, and identified in the SWMP if found to have such potential:

1) all disturbed and stored soils;
2) vehicle tracking of sediments;
3) management of contaminated soils;
4) loading and unloading operations;
5) outdoor storage activities (building materials, fertilizers, chemicals, etc.);
6) vehicle and equipment maintenance and fueling;
7) significant dust or particulate generating processes;
8) routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents, oils, etc.;
9) on-site waste management practices (waste piles, liquid wastes, dumpsters, etc.);
10) concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment;
11) dedicated asphalt and concrete batch plants;
12) non-industrial waste sources such as worker trash and portable toilets; and
13) other areas or procedures where potential spills can occur.

c) **Best Management Practices (BMPs) for Stormwater Pollution Prevention -** The SWMP shall identify and describe appropriate BMPs, including, but not limited to, those required by paragraphs 1 through 8 below, that will be implemented at the facility to reduce the potential of the sources identified in Part I.C.3.b to contribute pollutants to stormwater discharges. The SWMP shall clearly describe the installation and implementation specifications for each BMP identified in the SWMP to ensure proper implementation, operation and maintenance of the BMP.

1) Structural Practices for Erosion and Sediment Control. The SWMP shall clearly describe and locate all structural practices implemented at the site to minimize erosion and sediment transport. Practices may include, but are not limited to: straw bales, wattles/sediment control logs, silt fences, earth dikes, drainage swales, sediment traps, subsurface drains, pipe slope drains, inlet protection, outlet protection, gabions, and temporary or permanent sediment basins.

2) Non-Structural Practices for Erosion and Sediment Control. The SWMP shall clearly describe and locate, as applicable, all non-structural practices implemented at the site to minimize erosion and sediment transport. Description must include interim and permanent stabilization practices, and site-specific scheduling for implementation of the practices. The SWMP should include practices to ensure that existing vegetation is preserved where possible. Non-structural practices may include, but are not limited to: temporary vegetation, permanent vegetation, mulching, geotextiles, sod stabilization, slope roughening, vegetative buffer strips, protection of trees, and preservation of mature vegetation.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS** (cont.)

3) Phased BMP Implementation. The SWMP shall clearly describe the relationship between the phases of construction, and the implementation and maintenance of both structural and non-structural stormwater management controls. The SWMP must identify the stormwater management controls to be implemented during the project phases, which can include, but are not limited to, clearing and grubbing; road construction; utility and infrastructure installation; vertical construction; final grading; and final stabilization.

4) Materials Handling and Spill Prevention. The SWMP shall clearly describe and locate all practices implemented at the site to minimize impacts from procedures or significant materials (see definitions at Part I.E.) that could contribute pollutants to runoff. Such procedures or significant materials could include: exposed storage of building materials; paints and solvents; fertilizers or chemicals; waste material; and equipment maintenance or fueling procedures.

   Areas or procedures where potential spills can occur must have spill prevention and response procedures identified in the SWMP.

5) Dedicated Concrete or Asphalt Batch Plants. The SWMP shall clearly describe and locate all practices implemented at the site to control stormwater pollution from dedicated concrete batch plants or dedicated asphalt batch plants covered by this certification.

6) Vehicle Tracking Control. The SWMP shall clearly describe and locate all practices implemented at the site to control potential sediment discharges from vehicle tracking. Practices must be implemented for all areas of potential vehicle tracking, and can include: minimizing site access; street sweeping or scraping; tracking pads; graveled parking areas; requiring that vehicles stay on paved areas on-site; wash racks; contractor education; and/or sediment control BMPs, etc.

7) Waste Management and Disposal, Including Concrete Washout.

   i) The SWMP shall clearly describe and locate the practices implemented at the site to control stormwater pollution from all construction site wastes (liquid and solid), including concrete washout activities.
   ii) The practices used for concrete washout must ensure that these activities do not result in the contribution of pollutants associated with the washing activity to stormwater runoff.
   iii) Part I.D.3.c of the permit authorizes the conditional discharge of concrete washout water to the ground. The SWMP shall clearly describe and locate the practices to be used that will ensure that no washout water from concrete washout activities is discharged from the site as surface runoff or to surface waters.

8) Groundwater and Stormwater Dewatering.

   i) The SWMP shall clearly describe and locate the practices implemented at the site to control stormwater pollution from the dewatering of groundwater or stormwater from excavations, wells, etc.
   ii) Part I.D.3.d of the permit authorizes the conditional discharge of construction dewatering to the ground. For any construction dewatering of groundwater not authorized under a separate CDPS discharge permit, the SWMP shall clearly describe and locate the practices to be used that will ensure that no groundwater from construction dewatering is discharged from the site as surface runoff or to surface waters.

4. **Final Stabilization and Long-term Stormwater Management**

a) The SWMP shall clearly describe the practices used to achieve final stabilization of all disturbed areas at the site, and any planned practices to control pollutants in stormwater discharges that will occur after construction operations have been completed at the site.

b) Final stabilization practices for obtaining a vegetative cover should include, as appropriate: seed mix selection and application methods; soil preparation and amendments; soil stabilization practices (e.g., crimped straw, hydro mulch or rolled erosion control products); and appropriate sediment control BMPs as needed until final stabilization is achieved; etc.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS** (cont.)

c) Final stabilization is reached when all ground surface disturbing activities at the site have been completed, and 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.

The Division may, after consultation with the permittee and upon good cause, amend the final stabilization criteria in this section for specific operations.

5. **Inspection and Maintenance**

Part I.D.6 of the permit includes requirements for site inspections. Part I.D.7 of the permit includes requirements for BMP maintenance. The SWMP shall clearly describe the inspection and maintenance procedures implemented at the site to maintain all erosion and sediment control practices and other protective practices identified in the SWMP, in good and effective operating condition.

D. TERMS AND CONDITIONS

1. **General Limitations**

The following limitations shall apply to all discharges covered by this permit:

a) Stormwater discharges from construction activities shall not cause, have the reasonable potential to cause, or measurably contribute to an exceedance of any water quality standard, including narrative standards for water quality.

b) Concrete washout water shall not be discharged to state surface waters or to storm sewer systems. On-site permanent disposal of concrete washout waste is not authorized by this permit. Discharge to the ground of concrete washout waste that will subsequently be disposed of off-site is authorized by this permit. See Part I.D.3.c of the permit.

c) Bulk storage structures for petroleum products and any other chemicals shall have secondary containment or equivalent adequate protection so as to contain all spills and prevent any spilled material from entering State waters.

d) No chemicals are to be added to the discharge unless permission for the use of a specific chemical is granted by the Division. In granting the use of such chemicals, special conditions and monitoring may be addressed by separate correspondence.

e) The Division reserves the right to require sampling and testing, on a case-by-case basis, in the event that there is reason to suspect that compliance with the SWMP is a problem, or to measure the effectiveness of the BMPs in removing pollutants in the effluent. Such monitoring may include Whole Effluent Toxicity testing.

f) All site wastes must be properly managed to prevent potential pollution of State waters. This permit does not authorize on-site waste disposal.

g) All dischargers must comply with the lawful requirements of federal agencies, municipalities, counties, drainage districts and other local agencies regarding any discharges of stormwater to storm drain systems or other water courses under their jurisdiction, including applicable requirements in municipal stormwater management programs developed to comply with CDPS permits. Dischargers must comply with local stormwater management requirements, policies or guidelines including erosion and sediment control.

2. **BMP Implementation and Design Standards**

Facilities must select, install, implement, and maintain appropriate BMPs, following good engineering, hydrologic and pollution control practices. BMPs implemented at the site must be adequately designed to provide control for all potential pollutant sources associated with construction activity to prevent pollution or degradation of State waters.

D. TERMS AND CONDITIONS (cont.)

3. **Prohibition of Non-Stormwater Discharges**

a) Except as provided in paragraphs b, c, and d below, **all discharges covered by this permit shall be composed entirely of stormwater associated with construction activity**. Discharges of material other than stormwater must be addressed in a separate CDPS permit issued for that discharge.

b) Discharges from the following sources that are combined with stormwater discharges associated with construction activity may be authorized by this permit, provided that the non-stormwater component of the discharge is identified in the SWMP (see Part I.C.1.g of this permit):

- emergency fire fighting activities
- landscape irrigation return flow
- uncontaminated springs

c) Discharges to the ground of concrete washout water from washing of tools and concrete mixer chutes may be authorized by this permit, provided that:

1) the source is identified in the SWMP;
2) BMPs are included in the SWMP in accordance with Part I.C.3(c)(7) and to prevent pollution of groundwater in violation of Part I.D.1.a; and
3) these discharges do not leave the site as surface runoff or to surface waters

d) Discharges to the ground of water from construction dewatering activities may be authorized by this permit, provided that:

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, as required by Part I.C.3(c)(8); and
4) these discharges do not leave the site as surface runoff or to surface waters.

Discharges to the ground from construction dewatering activities that do not meet the above criteria must be covered under a separate CDPS discharge permit. Contaminated groundwater requiring coverage under a separate CDPS discharge permit may include groundwater contaminated with pollutants from a landfill, mining activity, industrial pollutant plume, underground storage tank, or other source.

4. **Releases in Excess of Reportable Quantities**

This permit does not relieve the permittee of the reporting requirements of 40 CFR 110, 40 CFR 117 or 40 CFR 302. Any discharge of hazardous material must be handled in accordance with the Division's Noncompliance Notification Requirements (see Part II.A.3 of the permit).

5. **SWMP Requirements**

a) **SWMP Preparation and Implementation**: The SWMP shall be prepared prior to applying for coverage under the general permit, and certification of its completion submitted with the application. The SWMP shall be implemented prior to commencement of construction activities. The plan shall be updated as appropriate (see paragraph c, below), below). SWMP provisions shall be implemented until expiration or inactivation of permit coverage.

b) **SWMP Retention Requirements**: A copy of the SWMP must be retained on site unless another location, specified by the permittee, is approved by the Division.

c) **SWMP Review/Changes**: The permittee shall amend the SWMP:

1) when there is a change in design, construction, operation, or maintenance of the site, which would require the implementation of new or revised BMPs; or

2) if the SWMP proves to be ineffective in achieving the general objectives of controlling pollutants in stormwater discharges associated with construction activity; or

D. TERMS AND CONDITIONS (cont.)

3) when BMPs are no longer necessary and are removed.

SWMP changes shall be made prior to changes in the site conditions, except as allowed for in paragraph d, below. SWMP revisions may include, but are not limited to: potential pollutant source identification; selection of appropriate BMPs for site conditions; BMP maintenance procedures; and interim and final stabilization practices. The SWMP changes may include a schedule for further BMP design and implementation, provided that, if any interim BMPs are needed to comply with the permit, they are also included in the SWMP and implemented during the interim period.

d) **Responsive SWMP Changes**: SWMP changes addressing BMP installation and/or implementation are often required to be made in response to changing conditions, or when current BMPs are determined ineffective. The majority of SWMP revisions to address these changes can be made immediately with quick in-the-field revisions to the SWMP. In the less common scenario where more complex development of materials to modify the SWMP is necessary, SWMP revisions shall be made in accordance with the following requirements:

1) the SWMP shall be revised as soon as practicable, but in no case more than 72 hours after the change(s) in BMP installation and/or implementation occur at the site, and

2) a notation must be included in the SWMP prior to the site change(s) that includes the time and date of the change(s) in the field, an identification of the BMP(s) removed or added, and the location(s) of those BMP(s).

6. **Inspections**

Site inspections must be conducted in accordance with the following requirements and minimum schedules. The required minimum inspection schedules do not reduce or eliminate the permittee's responsibility to implement and maintain BMPs in good and effective operational condition, and in accordance with the SWMP, which could require more frequent inspections.

a) **Minimum Inspection Schedule:** The permittee shall, at a minimum, make a thorough inspection, in accordance with the requirements in I.D.6.b below, at least once 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. Provided the timing is appropriate, the post-storm inspections may be used to fulfill the 14-day routine inspection requirement. A more frequent inspection schedule than the minimum inspections described may be necessary, to ensure that BMPs continue to operate as needed to comply with the permit. The following conditional modifications to this Minimum Inspection Schedule are allowed:

1) **Post-Storm Event Inspections at Temporarily Idle Sites** – If no construction activities will occur following a storm event, post-storm event inspections shall be conducted prior to re-commencing construction activities, but no later than 72 hours following the storm event. The occurrence of any such delayed inspection must be documented in the inspection record. Routine inspections still must be conducted at least every 14 calendar days.

2) **Inspections at Completed Sites/Areas** – For sites or portions of sites that meet the following criteria, but final stabilization has not been achieved due to a vegetative cover that has not become established, the permittee shall make a thorough inspection of their stormwater management system at least once every month, and post-storm event inspections are not required. This reduced inspection schedule is *only* allowed if:

i) all construction activities that will result in surface ground disturbance are completed;
ii) all activities required for final stabilization, in accordance with the SWMP, have been completed, with the exception of the application of seed that has not occurred due to seasonal conditions or the necessity for additional seed application to augment previous efforts; and
iii) the SWMP has been amended to indicate those areas that will be inspected in accordance with the reduced schedule allowed for in this paragraph.

D. TERMS AND CONDITIONS (cont.)

3) **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 surface erosion do not exist. This exception 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. The following information must be documented in the inspection record for use of this exclusion: dates when snow cover occurred, date when construction activities ceased, and date melting conditions began. Inspections, as described above, are required at all other times.

When site conditions make the schedule required in this section impractical, the permittee may petition the Division to grant an alternate inspection schedule.

b) **Inspection Requirements**

1) **Inspection Scope** - The construction site perimeter, all disturbed areas, material and/or waste storage areas that are exposed to precipitation, discharge locations, and locations where vehicles access the site shall be inspected for evidence of, or the potential for, pollutants leaving the construction site boundaries, entering the stormwater drainage system, or discharging to state waters. All erosion and sediment control practices identified in the SWMP shall be evaluated to ensure that they are maintained and operating correctly.

2) **Inspection Report/Records** - The permittee shall keep a record of inspections. Inspection reports must identify any incidents of non-compliance with the terms and conditions of this permit. Inspection records must be retained for three years from expiration or inactivation of permit coverage. At a minimum, the inspection report must include:

i) The inspection date;
ii) Name(s) and title(s) of personnel making the inspection;
iii) Location(s) of discharges of sediment or other pollutants from the site;
iv) Location(s) of BMPs that need to be maintained;
v) Location(s) of BMPs that failed to operate as designed or proved inadequate for a particular location;
vi) Location(s) where additional BMPs are needed that were not in place at the time of inspection;
vii) Deviations from the minimum inspection schedule as provided in Part I.D.6.a above;
vii) Description of corrective action for items iii, iv, v, and vi, above, dates corrective action(s) taken, and measures taken to prevent future violations, including requisite changes to the SWMP, as necessary; and
viii) After adequate corrective action(s) has been taken, or where a report does not identify any incidents requiring corrective action, the report shall contain a signed statement indicating the site is in compliance with the permit to the best of the signer's knowledge and belief.

c) **Required Actions Following Site Inspections** – Where site inspections note the need for BMP maintenance activities, BMPs must be maintained in accordance with the SWMP and Part I.D.7 of the permit. Repair, replacement, or installation of new BMPs determined necessary during site inspections to address ineffective or inadequate BMPs must be conducted in accordance with Part I.D.8 of the permit. SWMP updates required as a result of deficiencies in the SWMP noted during site inspections shall be made in accordance with Part I.D.5.c of the permit.

7. **BMP Maintenance**

All erosion and sediment control practices and other protective measures identified in the SWMP must be maintained in effective operating condition. Proper selection and installation of BMPs and implementation of comprehensive Inspection and Maintenance procedures, in accordance with the SWMP, should be adequate to meet this condition. BMPs that are not adequately maintained in accordance with good engineering, hydrologic and pollution control practices, including removal of collected sediment outside the acceptable tolerances of the BMPs, are considered to be no longer operating effectively and must be addressed in accordance with Part I.D.8, below. A specific timeline for implementing maintenance procedures is not included in this permit because BMP maintenance is expected to be proactive, not responsive. Observations resulting in BMP maintenance activities can be made during a site inspection, or during general observations of site conditions.

D. TERMS AND CONDITIONS (cont.)

8. **Replacement and Failed BMPs**

Adequate site assessment must be performed as part of comprehensive Inspection and Maintenance procedures, to assess the adequacy of BMPs at the site, and the necessity of changes to those BMPs to ensure continued effective performance. Where site assessment results in the determination that new or replacement BMPs are necessary, the BMPs must be installed to ensure on-going implementation of BMPs as per Part I.D.2.

Where BMPs have failed, resulting in noncompliance with Part I.D.2, they must be addressed as soon as possible, immediately in most cases, to minimize the discharge of pollutants.

When new BMPs are installed or BMPs are replaced, the SWMP must be updated in accordance with Part I.D.5(c).

9. **Reporting**

No scheduled reporting requirements are included in this permit; however, the Division reserves the right to request that a copy of the inspection reports be submitted.

10. **SWMP Availability**

A copy of the SWMP shall be provided upon request to the Division, EPA, or any local agency in charge of approving sediment and erosion plans, grading plans or stormwater management plans, and within the time frame specified in the request. If the SWMP is required to be submitted to any of these entities, it must include a signed certification in accordance with Part I.F.1 of the permit, certifying that the SWMP is complete and meets all permit requirements.

All SWMPs required under this permit are considered reports that shall be available to the public under Section 308(b) of the CWA and Section 61.5(4) of the Colorado Discharge Permit System Regulations. The permittee shall make plans available to members of the public upon request. However, the permittee may claim any portion of a SWMP as confidential in accordance with 40 CFR Part 2.

11. **Total Maximum Daily Load (TMDL)**

If a TMDL has been approved for any waterbody into which the permittee discharges, and stormwater discharges associated with construction activity have been assigned a pollutant-specific Wasteload Allocation (WLA) under the TMDL, the Division will either:

a) Ensure that the WLA is being implemented properly through alternative local requirements, such as by a municipal stormwater permit; or

b) Notify the permittee of the WLA, and amend the permittee's certification to add specific BMPs and/or other requirements, as appropriate. The permittee may be required to do the following:

   1) Under the permittee's SWMP, implement specific management practices based on requirements of the WLA, and evaluate whether the requirements are being met through implementation of existing stormwater BMPs or if additional BMPs are necessary. Document the calculations or other evidence that show that the requirements are expected to be met; and

   2) If the evaluation shows that additional or modified BMPs are necessary, describe the type and schedule for the BMP additions/revisions.

Discharge monitoring may also be required. The permittee may maintain coverage under the general permit provided they comply with the applicable requirements outlined above. The Division reserves the right to require individual or alternate general permit coverage.

E. ADDITIONAL DEFINITIONS

For the purposes of this permit:

1. **Best Management Practices (BMPs)**: schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, pollution prevention, and practices to control site runoff, spillage or leaks, waste disposal, or drainage from material storage.

2. **Dedicated asphalt plants and concrete plants**: portable asphalt plants and concrete plants that are located on or adjacent to a construction site and that provide materials only to that specific construction site.

3. **Final stabilization**: when all ground surface disturbing activities at the site have been completed, and 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.

4. **Municipal separate storm sewer system**: a conveyance or system of conveyances (including: roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains), owned or operated by a State, city, town, county, district, or other public body (created by state law), having jurisdiction over disposal of sewage, industrial waste, stormwater, or other wastes; designed or used for collecting or conveying stormwater.

5. **Operator**: the entity that has day-to-day supervision and control of activities occurring at the construction site. This can be the owner, the developer, the general contractor or the agent of one of these parties, in some circumstances. It is anticipated that at different phases of a construction project, different types of parties may satisfy the definition of 'operator' and that the permit may be transferred as the roles change.

6. **Outfall**: a point source at the point where stormwater leaves the construction site and discharges to a receiving water or a stormwater collection system.

7. **Part of a larger common plan of development or sale**: a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules.

8. **Point source**: any discernible, confined and discrete conveyance from which pollutants are or may be discharged. Point source discharges of stormwater result from structures which increase the imperviousness of the ground which acts to collect runoff, with runoff being conveyed along the resulting drainage or grading pattern.

9. **Pollutant**: dredged spoil, dirt, slurry, solid waste, incinerator residue, sewage, sewage sludge, garbage, trash, chemical waste, biological nutrient, biological material, radioactive material, heat, wrecked or discarded equipment, rock, sand, or any industrial, municipal or agricultural waste.

10. **Process water**: any water which, during manufacturing or processing, comes into contact with or results from the production of any raw material, intermediate product, finished product, by product or waste product. This definition includes mine drainage.

11. **Receiving Water**: any classified stream segment (including tributaries) in the State of Colorado into which stormwater related to construction activities discharges. This definition includes all water courses, even if they are usually dry, such as borrow ditches, arroyos, and other unnamed waterways.

12. **Significant Materials** include, but are not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with stormwater discharge.

13. **Stormwater**: precipitation-induced surface runoff.

F. GENERAL REQUIREMENTS

1. **Signatory Requirements**

a) All reports required for submittal shall be signed and certified for accuracy by the permittee in accordance with the following criteria:

1) 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 form 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 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.

b) **Changes to authorization**. If an authorization under paragraph a) of this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph a) of this section must be submitted to the Division, prior to or together with any reports, information, or applications to be signed by an authorized representative.

c) **Certification**. Any person signing a document under paragraph a) of this section shall make the following certification:

"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."

2. **Retention of Records**

a) The permittee shall retain copies of the SWMP and all reports required by this permit and records of all data used to complete the application to be covered by this permit, for three years after expiration or inactivation of permit coverage.

b) The permittee shall retain a copy of the SWMP required by this permit at the construction site from the date of project initiation to the date of expiration or inactivation of permit coverage, unless another location, specified by the permittee, is approved by the Division.

3. **Monitoring**

The Division reserves the right to require sampling and testing, on a case-by-case basis (see Part I.D.1.e), for example to implement the provisions of a TMDL (see Part I.D.11 of the permit). Reporting procedures for any monitoring data collected will be included in the notification by the Division of monitoring requirements.

If monitoring is required, the following definitions apply:

a) The **thirty (30) day average** shall be determined by the arithmetic mean of all samples collected during a thirty (30) consecutive-day period.

b) A **grab** sample, for monitoring requirements, is a single "dip and take" sample.

PART II

A. MANAGEMENT REQUIREMENTS

1. **Amending a Permit Certification**

The permittee shall inform the Division (Permits Section) in writing of changes to the information provided in the permit application, including the legal contact, the project legal description or map originally submitted with the application, or the planned total disturbed acreage. The permittee shall furnish the Division with any plans and specifications which the Division deems reasonably necessary to evaluate the effect on the discharge and receiving stream. If applicable, this notification may be accomplished through submittal of an application for a CDPS process water permit authorizing the discharge. The SWMP shall be updated and implemented prior to the changes (see Part I.D.5.c).

Any discharge to the waters of the State from a point source other than specifically authorized by this permit or a different CDPS permit is prohibited.

2. **Special Notifications - Definitions**

a) **Spill:** An unintentional release of solid or liquid material which may cause pollution of state waters.

b) **Upset:** An exceptional incident in which there is unintentional and temporary noncompliance with permit discharge limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

3. **Noncompliance Notification**

a) The permittee shall report the following instances of noncompliance:

1) Any noncompliance which may endanger health or the environment;

2) Any spill or discharge of hazardous substances or oil which may cause pollution of the waters of the state.

3) Any discharge of stormwater which may cause an exceedance of a water quality standard.

b) For all instances of noncompliance based on environmental hazards and chemical spills and releases, all needed information must be provided orally to the Colorado Department of Public Health and Environment spill reporting line (24-hour number for environmental hazards and chemical spills and releases: 1-877-518-5608) within 24 hours from the time the permittee becomes aware of the circumstances.

For all other instances of noncompliance as defined in this section, all needed information must be provided orally to the Water Quality Control Division within 24 hours from the time the permittee becomes aware of the circumstances.

For all instances of noncompliance identified here, a written submission shall also be provided within 5 calendar days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of:

1) The noncompliance and its cause;

2) The period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue;

3) Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

A. MANAGEMENT REQUIREMENTS (cont.)

4. **Submission of Incorrect or Incomplete Information**

Where the permittee failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or report to the Division, or relevant new information becomes available, the permittee shall promptly submit the relevant application information which was not submitted or any additional information needed to correct any erroneous information previously submitted.

5. **Bypass**

a) A bypass, which causes effluent limitations (i.e., requirements to implement BMPs in accordance with Parts I.B.3 and I.D.2 of the permit) to be exceeded is prohibited, and the Division may take enforcement action against a permittee for such a bypass, unless:

1) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities (e.g., alternative BMPs), retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if the permittee could have installed adequate backup equipment (e.g., implemented additional BMPs) to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance; and

3) The permittee submitted notices as required in "Non-Compliance Notification," Part II.A.3.

6. **Upsets**

a) **Effect of an Upset:** An upset constitutes an affirmative defense to an action brought for noncompliance with permit limitations and requirements if the requirements of paragraph b of this section are met. (No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.)

b) **Conditions Necessary for a Demonstration of Upset:** A permittee who wishes to establish the affirmative defense of upset shall demonstrate through properly signed contemporaneous operating logs, or other relevant evidence that:

1) An upset occurred and that the permittee can identify the specific cause(s) of the upset;

2) The permitted facility was at the time being properly operated;

3) The permittee submitted notice of the upset as required in Part II.A.3. of this permit (24-hour notice); and

4) The permittee complied with any remedial measures required under 40 CFR Section 122.41(d) of the federal regulations or Section 61.8(3)(h) of the Colorado Discharge Permit System Regulations.

c) **Burden of Proof:** In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

7. **Removed Substances**

Solids, sludges, or other pollutants removed in the course of treatment or control of discharges shall be properly disposed of in a manner such as to prevent any pollutant from such materials from entering waters of the State.

8. **Minimization of Adverse Impact**

The permittee shall take all reasonable steps to minimize any adverse impact to waters of the State resulting from noncompliance with any terms and conditions specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

A. MANAGEMENT REQUIREMENTS (cont.)

9. **Reduction, Loss, or Failure of Stormwater Controls**

The permittee has the duty to halt or reduce any activity if necessary to maintain compliance with the permit requirements. Upon reduction, loss, or failure of any stormwater controls, the permittee shall, to the extent necessary to maintain compliance with its permit, control production, or remove all pollutant sources from exposure to stormwater, or both, until the stormwater controls are restored or an alternative method of treatment/control is provided.
It shall not be a defense for a permittee in an enforcement action that it would be necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

10. **Proper Operation and Maintenance**

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

B. RESPONSIBILITIES

1. **Inspections and Right to Entry**

The permittee shall allow the Director of the State Water Quality Control Division, the EPA Regional Administrator, and/or their authorized representative(s), upon the presentation of credentials:

a) To enter upon the permittee's premises where a regulated facility or activity is located or in which any records are required to be kept under the terms and conditions of this permit;

b) At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit and to inspect any monitoring equipment or monitoring method required in the permit; and

c) To enter upon the permittee's premises to investigate, within reason, any actual, suspected, or potential source of water pollution, or any violation of the Colorado Water Quality Control Act. The investigation may include, but is not limited to, the following: sampling of any discharge and/or process waters, the taking of photographs, interviewing permittee staff on alleged violations and other matters related to the permit, and access to any and all facilities or areas within the permittee's premises that may have any effect on the discharge, permit, or any alleged violation.

2. **Duty to Provide Information**

The permittee shall furnish to the Division, within the time frame specified by the Division, any information which the Division may request to determine whether cause exists for modifying, revoking and reissuing, or inactivating coverage under this permit, or to determine compliance with this permit. The permittee shall also furnish to the Division, upon request, copies of records required to be kept by this permit.

3. **Transfer of Ownership or Control**

Certification under this permit may be transferred to a new permittee if:

a) The current permittee notifies the Division in writing when the transfer is desired as outlined in Part I.A.7; and

b) The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage and liability between them; and

c) The current permittee has met all fee requirements of the Colorado Discharge Permit System Regulations, Section 61.15.

B. RESPONSIBILITIES (cont.)

4. **Modification, Suspension, or Revocation of Permit By Division**

All permit modification, inactivation or revocation and reissuance actions shall be subject to the requirements of the Colorado Discharge Permit System Regulations, Sections 61.5(2), 61.5(3), 61.7 and 61.15, 5 C.C.R. 1002-61, except for minor modifications.

a) This permit, and/or certification under this permit, may be modified, suspended, or revoked in whole or in part during its term for reasons determined by the Division including, but not limited to, the following:

1) Violation of any terms or conditions of the permit;

2) Obtaining a permit by misrepresentation or failing to disclose any fact which is material to the granting or denial of a permit or to the establishment of terms or conditions of the permit;

3) Materially false or inaccurate statements or information in the application for the permit;

4) Promulgation of toxic effluent standards or prohibitions (including any schedule of compliance specified in such effluent standard or prohibition) which are established under Section 307 of the Clean Water Act, where such a toxic pollutant is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit.

b) This permit, and/or certification under this permit, may be modified in whole or in part due to a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge, such as:

1) Promulgation of Water Quality Standards applicable to waters affected by the permitted discharge; or

2) Effluent limitations or other requirements applicable pursuant to the State Act or federal requirements; or

3) Control regulations promulgated; or

4) Other available information indicates a potential for violation of adopted Water Quality Standards or stream classifications.

c) This permit, or certification under this permit, may be modified in whole or in part to include new effluent limitations and other appropriate permit conditions where data submitted pursuant to Part I indicate that such effluent limitations and permit conditions are necessary to ensure compliance with applicable water quality standards and protection of classified uses.

d) At the request of the permittee, the Division may modify or inactivate certification under this permit if the following conditions are met:

1) In the case of inactivation, the permittee notifies the Division of its intent to inactivate the certification, and certifies that the site has been finally stabilized;

2) In the case of inactivation, the permittee has ceased any and all discharges to state waters and demonstrates to the Division there is no probability of further uncontrolled discharge(s) which may affect waters of the State.

3) The Division finds that the permittee has shown reasonable grounds consistent with the Federal and State statutes and regulations for such modification, amendment or inactivation;

4) Fee requirements of Section 61.15 of the Colorado Discharge Permit System Regulations have been met; and

5) Applicable requirements of public notice have been met.

For small construction sites covered by a Qualifying Local Program, coverage under this permit is automatically terminated when a site has been finally stabilized.

B. RESPONSIBILITIES (cont.)

5. **Permit Violations**

Failure to comply with any terms and/or conditions of this permit shall be a violation of this permit.

Dischargers of stormwater associated with industrial activity, as defined in the EPA Stormwater Regulation (40 CFR 122.26(b)(14) and Section 61.3(2) of the Colorado Discharge Permit System Regulations, which do not obtain coverage under this or other Colorado general permits, or under an individual CDPS permit regulating industrial stormwater, will be in violation of the federal Clean Water Act and the Colorado Water Quality Control Act, 25-8-101, as amended. Failure to comply with CDPS permit requirements will also constitute a violation.

6. **Legal Responsibilities**

The issuance of this permit does not convey any property or water rights in either real or personal property, or stream flows, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority granted by Section 510 of the Clean Water Act.

7. **Severability**

The provisions of this permit are severable. If any provisions of this permit, or the application of any provision of this permit to any circumstance, are held invalid, the application of such provision to other circumstances and the application of the remainder of this permit shall not be affected.

8. **Renewal Application**

If the permittee desires to continue to discharge, a permit renewal application shall be submitted at least ninety (90) days before this permit expires. If the permittee anticipates that there will be no discharge after the expiration date of this permit, the Division should be promptly notified so that it can inactivate the certification in accordance with Part II.B.4.d.

9. **Confidentiality**

Except for data determined to be confidential under Section 308 of the Federal Clean Water Act and Colorado Discharge Permit System Regulations, Section 61.5(4), all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division. The permittee must state what is confidential at the time of submittal.

Any information relating to any secret process, method of manufacture or production, or sales or marketing data which has been declared confidential by the permittee, and which may be acquired, ascertained, or discovered, whether in any sampling investigation, emergency investigation, or otherwise, shall not be publicly disclosed by any member, officer, or employee of the Commission or the Division, but shall be kept confidential. Any person seeking to invoke the protection of this section shall bear the burden of proving its applicability. This section shall never be interpreted as preventing full disclosure of effluent data.

10. **Fees**

The permittee is required to submit payment of an annual fee as set forth in the Water Quality Control Act. Failure to submit the required fee when due and payable is a violation of the permit and will result in enforcement action pursuant to Section 25-8-60l et. seq., C.R.S. l973 as amended.

B. RESPONSIBILITIES (cont.)

11. **Requiring an Individual CDPS Permit**

The Director may require the permittee to apply for and obtain an individual or alternate general CDPS permit if:

a) The discharger is not in compliance with the conditions of this general permit;

b) Conditions or standards have changed so that the discharge no longer qualifies for a general permit; or

c) Data/information become available which indicate water quality standards may be violated.

The permittee must be notified in writing that an application for an individual or alternate general CDPS permit is required. When an individual or alternate general CDPS permit is issued to an operator otherwise covered under this general permit, the applicability of this general permit to that operator is automatically inactivated upon the effective date of the individual or alternate general CDPS permit.

APPENDIX B

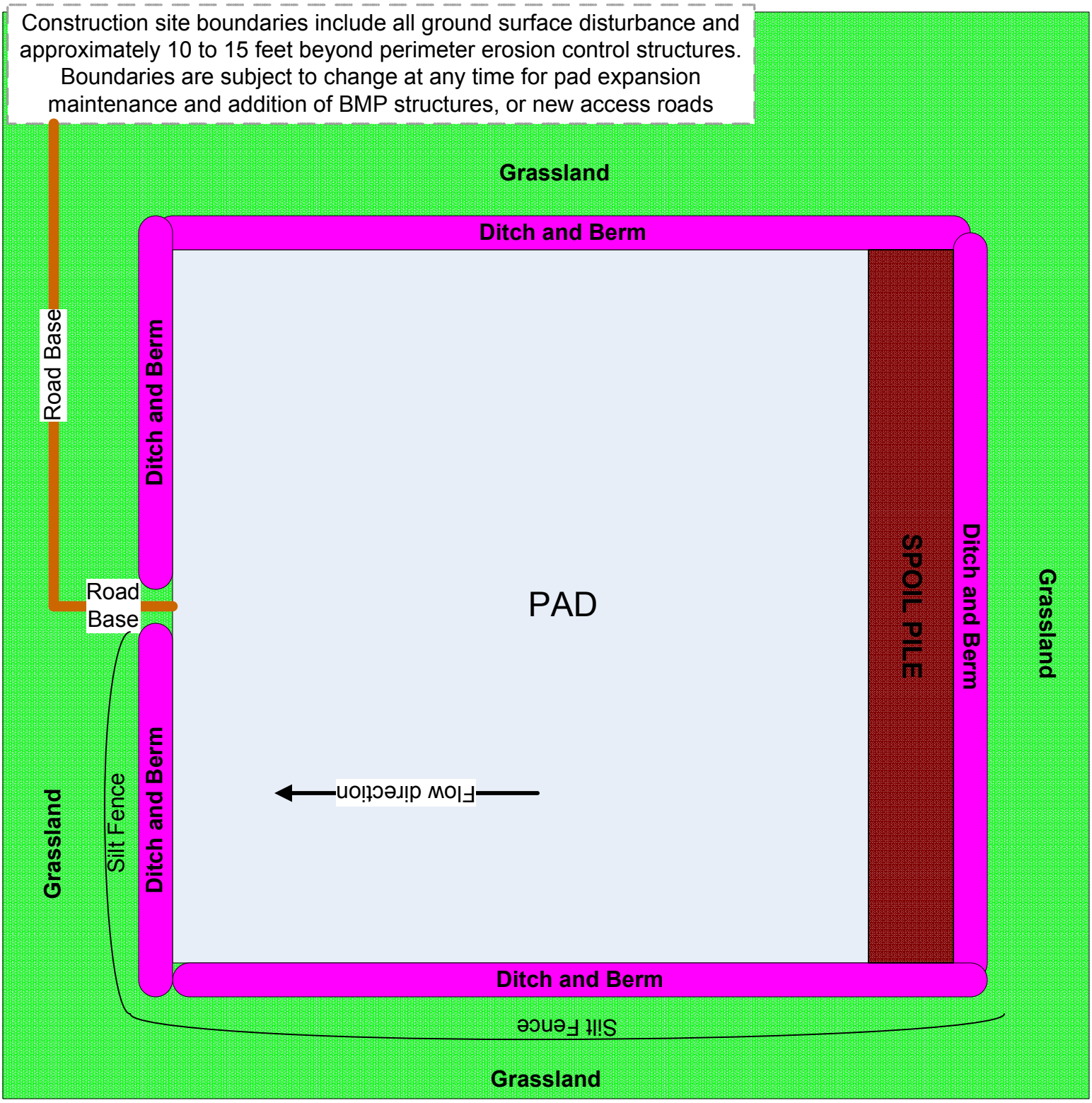
SITE SPECIFIC INFORMATION

(SEE SWMP DATABASE CENTRAL ADMISTRATIVE SWITCHBOARD OR STORMWATER WEBSITE FOR INSPECTION REPORTS AND MAPS)

APPENDIX C

EXAMPLE BASE MAPS

WELL NAME:	Example				**API#:**	05-123-XXXXX		
	QTR/QTR	**NENW**	**SEC**	**12**	**TWN**	**2N**	**RNG**	68W
LAT/LONG:	**40.158790/-104.956380**							
DIRECTIONS								
WCR 24 & Brich , E .25, S. .2 into.								
PRE-CONSTRUCTION VEGETATION DESCRIPTION AND COVERAGE PERCENT								
70% Grassland								
TOPOGRAPHY								
0-1 % slopes								
TOTAL DISTURBED AREA (sqft)								
140,000								
SOIL TYPE								
Vona loamy sand								
NEAREST RECEIVING WATERS								
NAME	**un-named stream**							
DIRECTION	East							
DISTANCE	.25 miles							
NON-STORMWATER DISCHARGE								
NAME								
DIRECTION								
DISTANCE								
POTENTIAL DRAINAGE AREA								
NAME								
DIRECTION								
DISTANCE								
MAP GENERATED BY	Brett Forkner							
SITE CONSTRUCTION COMPANY	In and Out							
COMMENTS								



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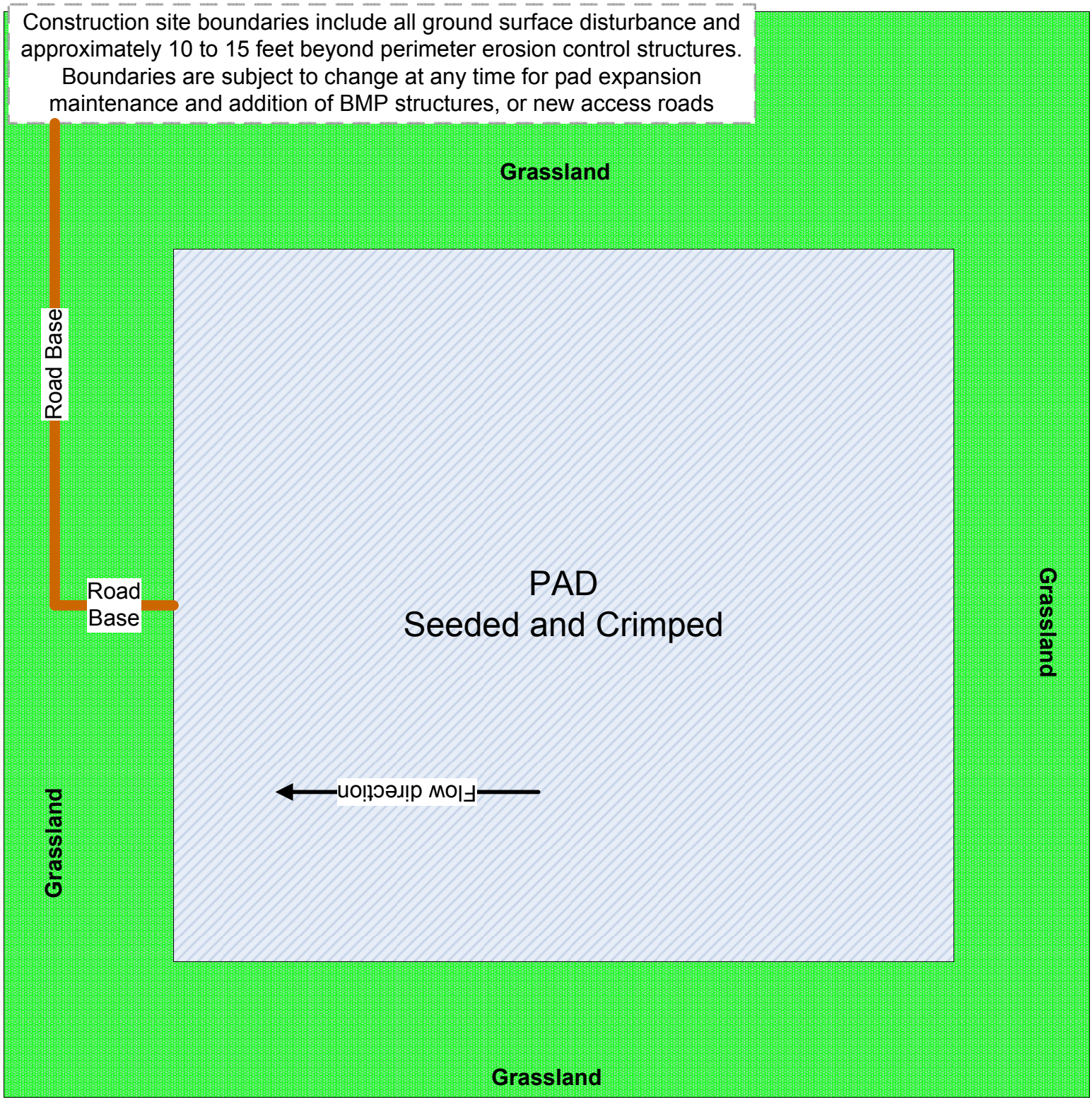
DATE	2/22/2010	**TO**	5/5/2010				
WELL NAME		Example			**API #**	05-123-XXXX	
QTR/QTR	NENW	**SEC**	12	**TWN**	2N	**RGE**	68W
DIRECTIONS							
WCR 24 & Brich , E .25, S. .2 into.							
COMMENTS							
70% Grassland							



DATE	5/5/2010	**TO**	9/19/2010				
WELL NAME		Example			**API #**	05-123-XXXX	
QTR/QTR	NENW	**SEC**	12	**TWN**	2N	**RGE**	68W
DIRECTIONS							
WCR 24 & Brich , E .25, S. .2 into.							
COMMENTS							
70% Grassland							

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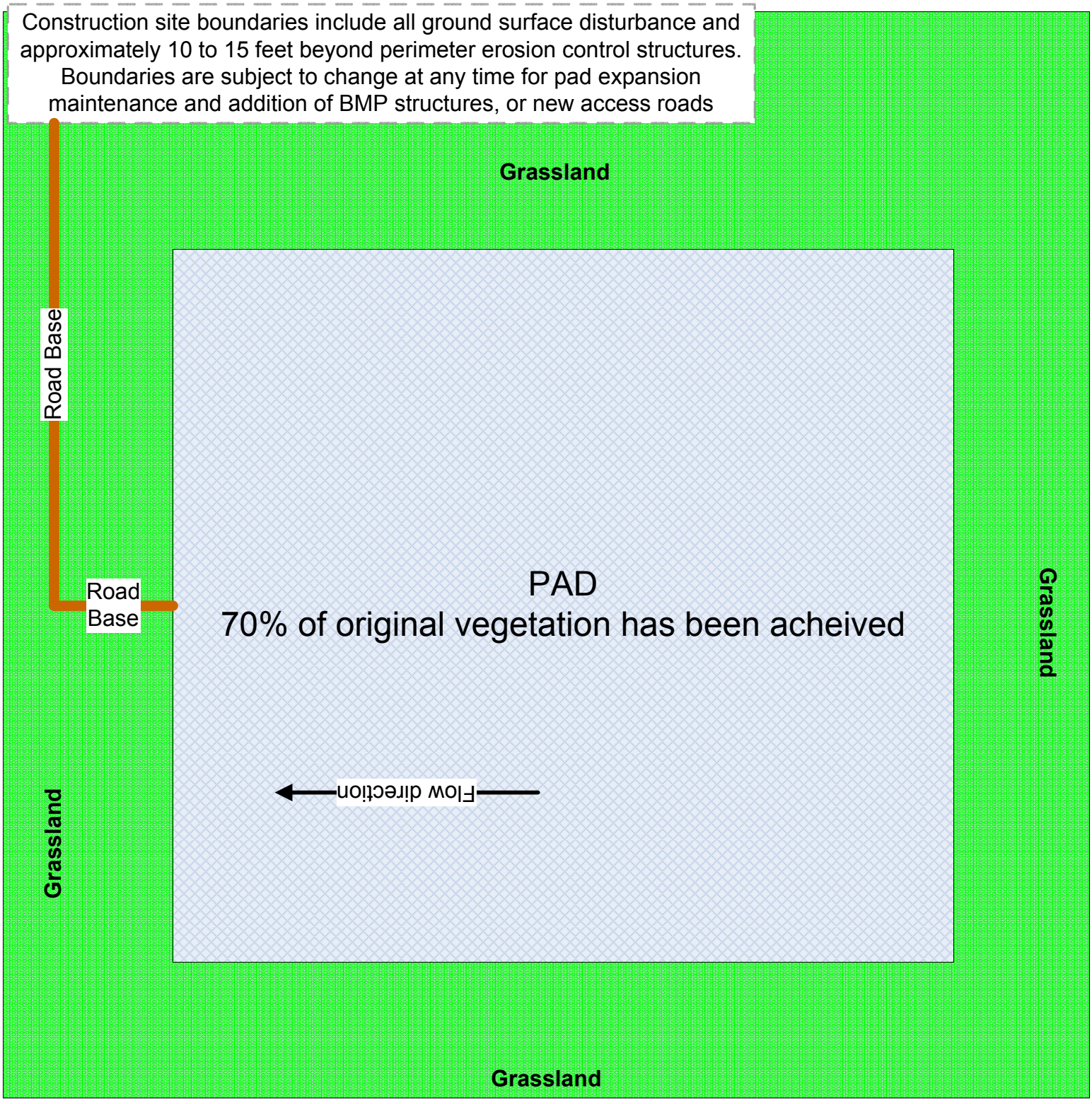

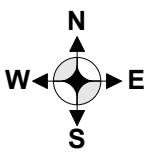

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DATE	9/19/2010	**TO**					
WELL NAME		Example			**API #**	05-123-XXXX	
QTR/QTR	NENW	**SEC**	12	**TWN**	2N	**RGE**	68W
DIRECTIONS							
WCR 24 & Brich , E .25, S. .2 into.							
COMMENTS							
70% Grassland							

APPENDIX D

BMP MANUAL AND TECHNICAL DRAWINGS

Stormwater Manual of BMPS

Table of Contents

Section **Page**

Berm (B)

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 water 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 into a sediment trapping device, divert clean water away from disturbed areas, and to provide a safe slope barrier for vehicle traffic.

Applicability
Berms 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. With regular maintenance, earthen berms have a useful life span of approximately 18 months. Berms are applicable for:

- Along the outside shoulder of an in-sloped road to ensure runoff from the roadway drains inward and to protect the fill slope from continual disturbance during road blading and maintaining;
- Up slope of cut or fill slopes to divert flows away from disturbed areas;
- Down slope of cut or fill slopes to divert on-site runoff into a stabilized outlet or sediment trapping device; and
- Along the outside shoulder of a road to provide vehicle safety.

Limitations
- Berms may erode if not properly maintained, compacted, and or stabilized with vegetation. Berms which are adjacent to concentrated flows may require other means of stabilization.
- If a berm crosses a vehicle roadway or entrance, its effectiveness may be reduced. Wherever possible, berms should be designed to avoid crossing vehicle pathways.

Design Criteria
No formal design is required.

Construction Specifications

- Prior to berm construction, remove all trees, brush, stumps, and other objects in the path of the berm. Fill may consist of topsoil or subsoil excavated during the construction of nearby roads or well pads.
- All berms shall have positive drainage to a stabilized outlet so runoff does not collect in ponds on the up-slope side of the berm, but instead flows along the berm until it reaches a stabilized outlet. Field location should be adjusted as needed. The stabilized outlet may be a well-vegetated area, a well pad detention pond, or a sediment control such as a silt fence or sediment trap where sediment can settle out of the runoff before being discharged to surface water.
- Berms should be constructed prior to commencement of major up-slope land disturbance. This will maximize the effectiveness of the structure as a stormwater control device.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). 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.

Removal

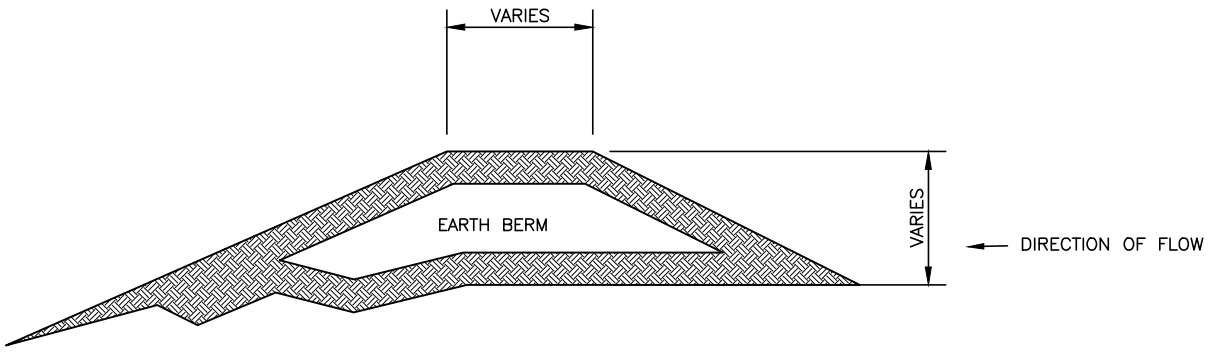
Berms should remain in place and in good condition until all up-slope disturbed areas are permanently stabilized. There is no need to formally remove the berm on completion of stabilization until interim or final reclamation.

References

United States 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/index.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

FIGURE B-1
Earth Berm



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Brush Matting (BM)

Description
Brush Matting consists of a mattress of brush laid on a slope and fastened down with stakes and wire. The brush mat protects the soil on slopes from erosive forces through the generation of a dense stand of wood vegetation.

Applicability
Brush mattresses are used primarily on stream banks where the velocity is less than six feet per second and excessive runoff from stream flow has created erosive conditions. The maximum slope shall be 1.5:1.

Limitations
This practice can resist temporary inundation, but not scour or undercutting.

Design Criteria
No formal design required.

Construction Specifications
- Prepare slope surface by grading to a uniform, smooth surface, clear of obstruction. Slopes should be graded before the brush mattress is installed.
- Lay brush a minimum of three inches thick beginning at the downstream end of the work.
- The butt end of the brush will be placed upstream and plant materials inclined approximately 30 degrees.
- The upstream edge of the mattress will be keyed into the slope 2 feet. Stakes will be driven throughout the mattress on 3-foot centers each way beginning along the toe of the mattress.
- No. 9 wire will be attached to the stakes and tightened to secure the mattress.
- Place large rocks over the end of the mattress to hold in place.
- Sloped areas above the mattress will be shaped and seeded.

Maintenance Considerations
Broken wire or missing stakes should be replaced immediately. Any missing toe material should be replaced.

Removal

Brush matting may remain in place to decompose or be removed after the area has been fully stabilized.

References

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

http://www.dec.state.ny.us/website/dow/toolbox/escstandards

Check Dam (CD)

Description

Check dams are small, temporary dams constructed across a diversion or roadside ditch. Check dams can be constructed using gravel, rock, sandbags, gravel bags, earth with erosion control blanketing, straw bales, or synthetic materials 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 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 diversion 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; and
- 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. Therefore, check dams should be located in areas accessible to maintenance vehicles.
- Leaves have been a significant problem by clogging check dams in the fall. Therefore, this might require 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

- Install straw bale check dams, rock check dams, and other check dams according to Figure CD-1, respectively. Other types of check dams shall have similar designs.
- Check dams should be located in areas accessible to maintenance vehicles for the periodic removal of accumulated sediments.
- Check dams should be installed with careful placement of the construction material. Mere dumping of the check dam material into a channel is not appropriate and will reduce overall effectiveness.
- Check dams can be constructed from a number of different materials. Most commonly, they are made of straw bales or rock. When using rock, the material diameter should be 2 to 15 inches depending on the expected velocity and quantity of runoff within the channel. Wattles or sand/gravel bags may also be used, but only if straw bales or rock is unavailable or is not feasible for the location. Earth collected during excavation of diversions or roadside ditches may also be placed as check dams if covered with erosion control blanketing.
- All check dams should have a maximum height of 3 feet with 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.
- Additional stability can be achieved by implanting the dam material approximately 6 inches into the sides and bottom of the channel.
- In order to be most effective, 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.
- 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 Stormwater Management Plan (SWMP). 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 check dam 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 the dam (measured at the center). Close attention should be made to the repair of damaged or rotting straw bales, end runs, and undercutting beneath bales. Replacement of bales should be accomplished promptly.

Removal

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 rock or other material has been removed.

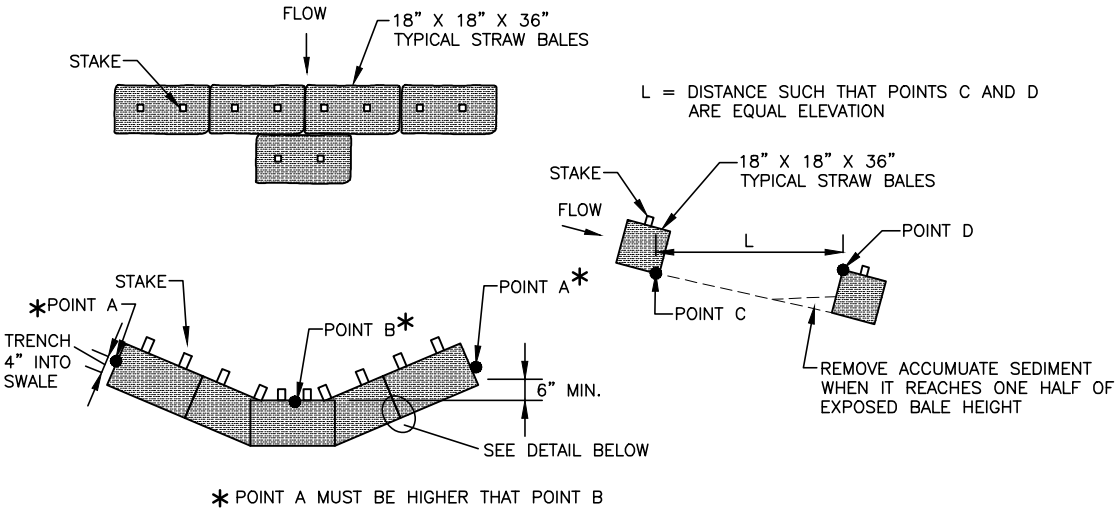
References

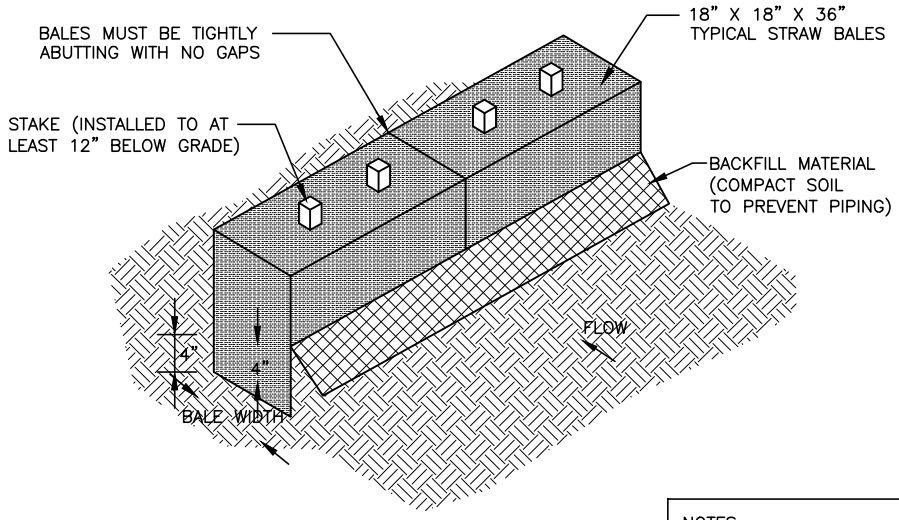
Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide*. 2002. http://www.coloradodot.info/programs/environmental/water-quality/documents/erosion-storm-quality

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003.
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.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
Straw Bale Check Dam Installtion





NOTES:
1 STRAW BALES SHALL BE CERTIFIED WEED FREE.
2. SAKES SHALL BE 2" X 2" X 36" WOOD STAKES OR STANDARD "T" OR "U" STEEL POSTS.

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FIGURE CD-2
Rock Check Dam Installation (Aerial View)

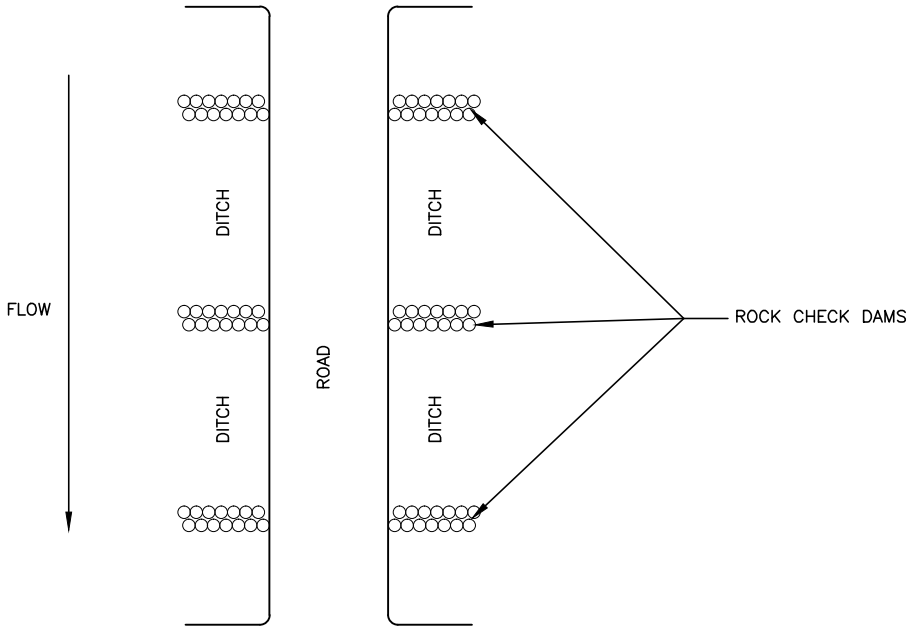
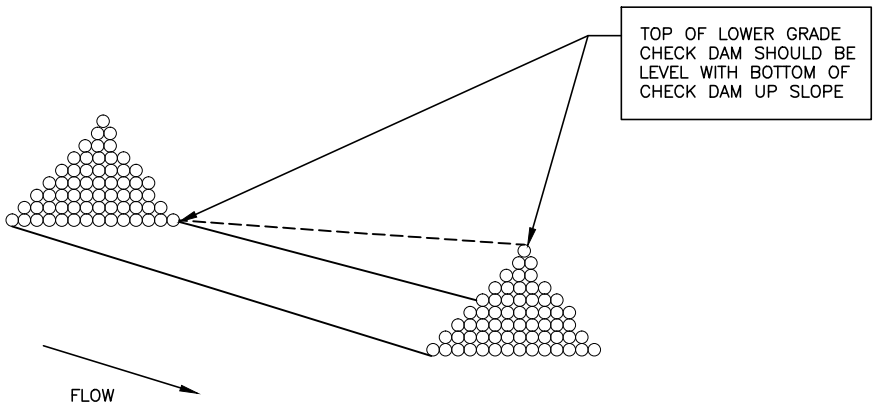


FIGURE CD-3
Rock Check Dam Installation (Ground View)



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Culvert (C)

Description
Culverts are typically constructed of concrete, steel, aluminum, or plastic pipe and are used to direct stream flow or ditch water under a road or construction area.

Applicability
Culverts are ideal on roads with grades of less than 15%. For grades over 15%, it is difficult to slow down the water or remove it from road surface rapidly. On such steep grades, it is best to use frequently spaced relief culverts and drainage crossing culverts, with armored ditches (see RIPRAP [R]). Culverts may be used:

- As drainage crossing culverts in streams and gullies to allow normal drainage to flow under pathways and roads;
- 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; and
- Culverts placed in natural drainages may be utilized for ditch relief.

Limitations
- Undersized culverts are susceptible to plugging and will require cleaning.
- Culverts will not filter sediment.
- Culverts are easily crushed if not properly designed.

Design Criteria
Pipe size can be determined using general design criteria, such as in Table C-1, but it is ideally based upon site-specific hydrologic analysis.

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 to road use and erosion.

Headwalls

Use headwalls on culvert pipes as often as possible (see RETAINING WALL [RW]). The advantages of headwalls include preventing large pipes from floating out of the ground when plugged; reducing the length of the pipe capacity; allowing debris to funnel through the pipe; retaining the backfill material; and reducing the chances of culvert failure if it is overtopped.

Construction Specifications

Drainage crossing culverts

- Make road crossings of natural drainages perpendicular to the drainage to minimize pipe length and area of disturbance (Figure C-1).
- 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-lined corrugated metal pipe made of steel or aluminum, or properly bedded and backfilled corrugated plastic pipe.
- Align culverts in the bottom and middle of the natural channel flowline so the installation causes no change in the stream alignment or stream bottom elevation. Culverts should not cause damming or pooling or increase stream velocities significantly.
- Extend the outlet of the culvert at least one 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.
- It may be necessary to install rip rap, erosion control blanketing, or a combination of both or other energy-dissipater device at the outlet end of the culvert to reduce soil erosion or to trap sediment (see CULVERT PROTECTION [CP]).
- It may be desirable to construct pull offs/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 See Figure C-2 for installation details.

- Ditch relief culverts can provide better flow when skewed 0 to 30 degrees perpendicular to the road.
- 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.
- Discharge the culvert at the natural ground level where possible (see Figure C-3, type A), on firm, non-erosive soil or in rocky or bushy areas. If discharging on fill slopes, and armor outlets with riprap or logging slash (see Figure C-3, type B), or use down-drain structures (see Figure C-3, type C and SLOPE DRAIN [SD]).

- Extend the inlet of the culvert at least one foot beyond the flowline of the roadside ditch. Extend the outlet of the culvert at least one foot beyond the toe slopes to prevent erosion of the fill material.
- 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 (see CULVERT PROTECTION [CP]).
- Spacing of culverts is dependent on the road gradient, soil types, and runoff characteristics according to the table below.
- It may be desirable to construct pull offs/turnouts for vehicle on one or both sides of narrow culvert crossings. This will help avoid culvert crushing as well as disturbance to roadside ditches and berms.

	Road Grade		
Soil Type	**3-4%**	**5-8%**	**9-12%**
Highly Corrosive Granitic or Sandy	240'	180'	140'
Intermediate Erosive Clay or Load	310'	260'	200'
Low Erosive Shale or Gravel	400'	325'	250'

Backfill and compaction

- 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.
- Cover the top of the metal and plastic culvert pipes with fill to a depth of at least one foot to prevent 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.
- Mound fill materials over the top of culvert pipes so the road is slightly raised at the 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 being crushed.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). If any damage to culvert or inlet/outlet protection is noted or if there is any evidence of scour, repairs should be made immediately. Any debris that may be blocking the culvert inlet or outlet should be removed.

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), 2003. http://www.blm.gov/bmp/field%20guide.htm

United States Department of the Interior, Bureau of Land Management (BLM), *Surface Operating Standards for Oil and Gas Exploration and Development "Gold Book"*. Fourth Edition, 2007.
http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

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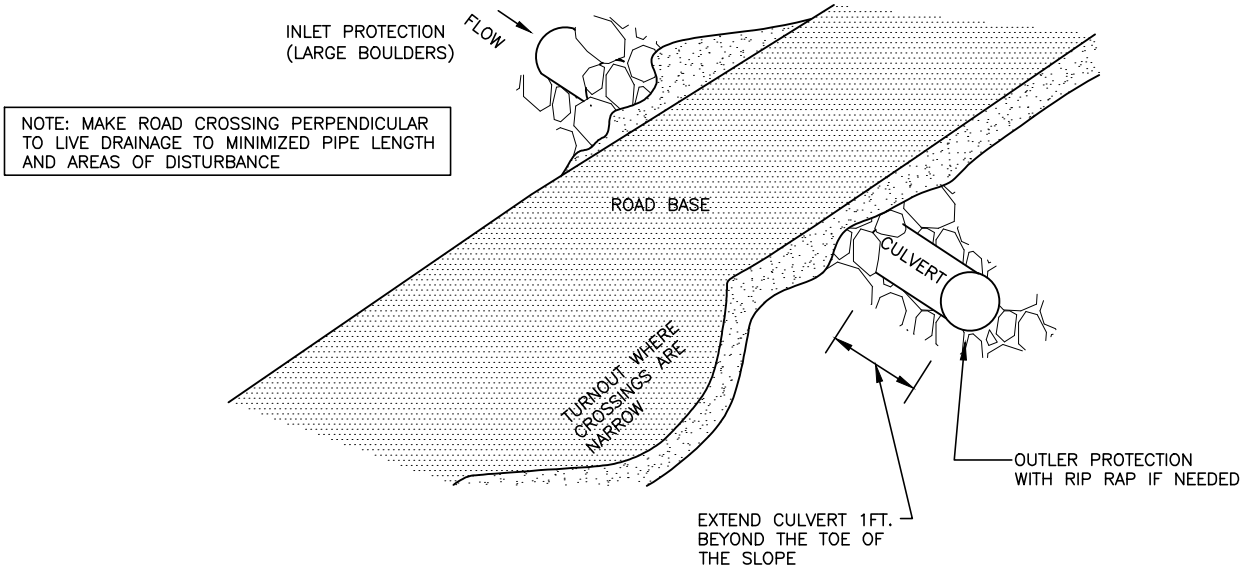
TABLE C-1
Culvert Sizing

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

FIGURE C-1
Drainage Crossing Culvert Alignment &
Overflow Dip



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Culvert Protection (CP)

Description

Culvert protection may be required at the inlet (upstream side) of the culvert and/or the outlet (downstream side) of the culvert.

Culvert inlet protection involves placing boulders, riprap, gabions, rock retaining walls, slash, and/or any other protection at the inlet 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 the pipes. Lined aprons or other appropriate energy-dissipating devices will reduce the velocity of stormwater flows and thereby prevent scour at stormwater outlets, protect the outlet structure, and minimize potential for erosion downstream.

Applicability

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

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

Limitations

Rock aprons at the culvert outlets should not be placed on slopes steeper than 10 %. Runoff from pipe outlets at the top of cut/fills or on slopes steeper than 10% should be routed using slope drains or riprap chutes to a rock apron at the toe of the slope. Otherwise, the flow will re-concentrate and gain velocity as the flow leaves the apron.

Design Criteria

Culvert inlet protection

Riprap, gabions, or rock retaining walls at culvert inlets shall be designed according to RIPRAP (R) or RETAINING WALL (RW).

Culvert outlet protection

Gabions or rock retaining walls at culvert outlets shall be designed according to RETAINING WALL (RW). No formal design is required for plunge pools at outlets. Riprap aprons at culvert outlets shall be designed as follows.

Tail-water depth: The depth of tail-water immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tail-water 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 tail-water condition. If the tail-water 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 tail-water condition. Pipes out-letting onto flat areas with no defined channel may be assumed to have a minimum tail-water condition.

Riprap apron size and D50 size: The apron length (L_A) and the D_{50} size of the riprap will be determined using Table CP-1 according to the design flow and weather there is a minimum or maximum tail-water condition. The apron width (W) shall then be determined as ($W=d+0.4L_A$) 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 one foot above the maximum tail-water 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 of two times the diameter of the outlet pipe.

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 such that 50% of the pieces, by weight, shall be larger than the D_{50} size determined from Table CP-1. 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 D_{50} size. All grout for grouted riprap must be 1-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 a D_{50} of 15 inches or less and 1.2 times the maximum stone size for a D_{50} greater than 15 inches.

Riprap stone quality: Stone for riprap shall consist of field stone or rough un-hewn angular stone. The stone shall be hard and angular and of a quality that will not disintegrate with exposure to water or weathering. The specific gravity of the individual stone shall be at least 2.5. Site rock or site boulders may be used providing 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

- Riprap, gabions, or rock retaining walls at culvert inlets shall be constructed in accordance to RIPRAP (R) or RETAINING WALL (RW).
- 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.
- Boulders should be dry-stacked around the culvert inlet and up the slope to the edge of the road.

Culvert outlet protection

Gabions or rock retaining walls at culvert outlets shall be designed according to RETAINING WALL (RW). Riprap aprons at culvert outlets shall be constructed according to CP-2 and the following.

- 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.
- If a pipe discharges into a well-defined channel, the channel's side slopes may not be steeper than 2:1.
- Construct the apron to the design length and width with no slope (Figure CP-2). The invert elevations must be equal at the receiving channel and the apron's downstream end. No over-fall at the end of the apron is allowed. The elevation of the downstream culvert outlet and of the apron shall be equal to the elevation of the receiving channel or adjacent ground. The outlet protection apron shall be located so there are no bends in the horizontal alignment.
- Line the apron with riprap, grouted riprap, or concrete. Riprap should be the appropriate size thickness and design. See RIPRAP (R) for the placement of riprap.
- If a culvert outlet discharges at the top of cut/fills or on slopes steeper than 10%, one of the following options is suggested.

1. Transition the culvert to a slope drain according to SLOPE DRAIN (SD). The slope drain shall convey stormwater to the bottom of the slope where the riprap apron, as designed above, shall prevent erosion at the slope drain outlet.
2. Line the slope below the 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) construction specification based on depth of flow and slope. The riprap channel shall dip into the slope such 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 Stormwater Management Plan (SWMP). Inspect for debris at the entrance to culverts and within culverts. Inspect riprap at culvert inlets for damage and dislodged stones. The maintenance needs are usually very low for properly installed riprap aprons at culvert outlets. However, inspect for evidence of scour beneath riprap at outlet aprons or for dislodged stones. Anything found to reduce the effectiveness of the culvert or culvert outlet protection should be repaired immediately.

References

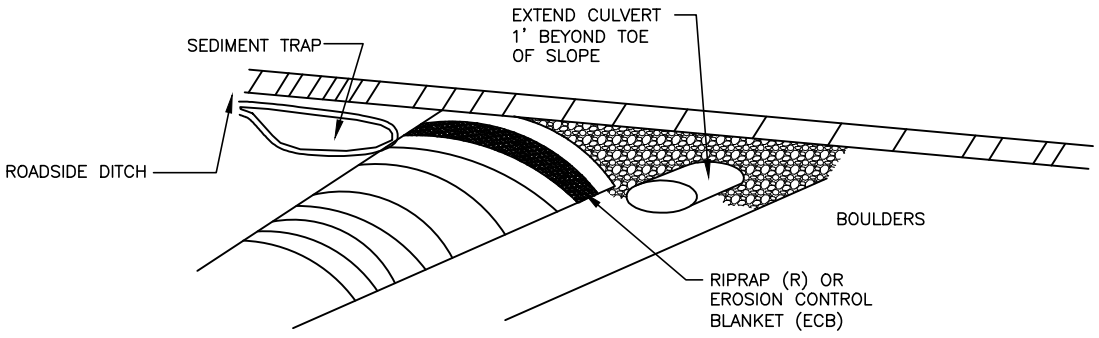
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2003. http://www.blm.gov/bmp/field%20guide.htm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

TABLE CP-1
Outlet Protection Design

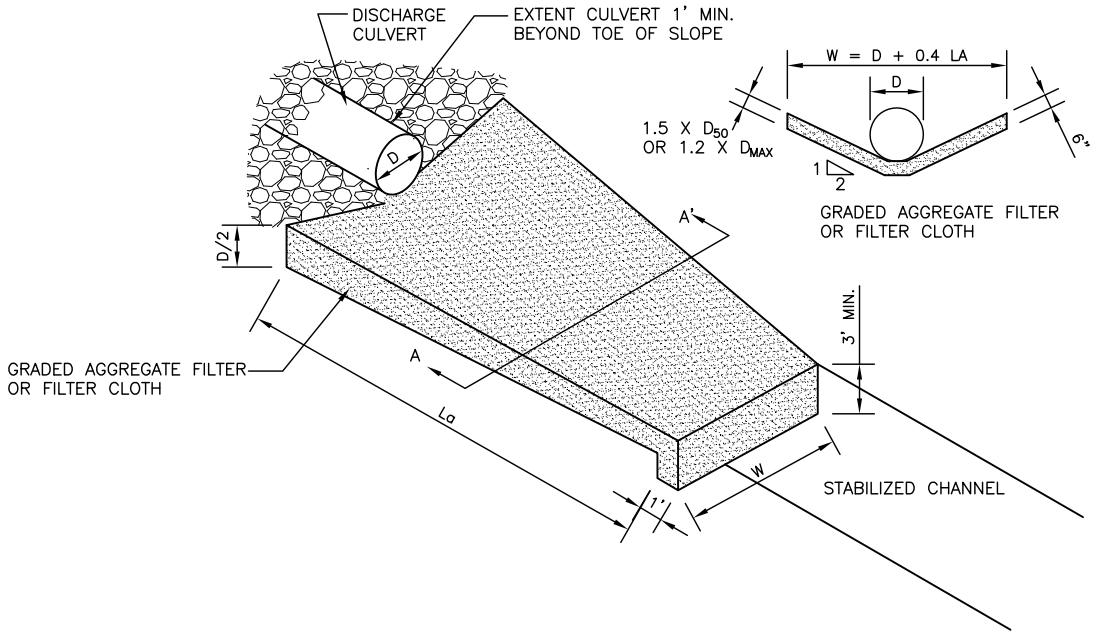
Riprap Aprons for Low Tailwater (downstream flow depth <0.5 X pipe diameter)															
Culvert Diameter	Lowest Value			Intermediate values to interpolate from									Highest value		
	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}	Q	L_A	D_{50}
	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	In	Cfs	Ft	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	18	2.5	100	60	7	140	85	13	180	104	18	220	120	23
42"	82	15	2.5	120	50	60	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 CP-1
Typical Inlet Protection



SCALE: NOT TO SCALE

FIGURE CP-2
Typical Outlet Protection



SCALE: NOT TO SCALE

Ditch (D)

Description
A ditch consists of a channel constructed across a slope to collect and divert runoff. The earthen channel may remain bare, or when necessary to protect it from erosion, it may be vegetated. The purpose of this practice is to divert surface water from one area to other areas for use or safe disposal.

Applicability
Ditches are usually appropriate where runoff can be diverted and disposed of safely to prevent flood damage, erosion, or sedimentation damage.

Specific locations and conditions include:

- Above steep slopes to limit surface runoff onto the slope;
- Across long slopes to reduce slope length to prevent erosion;
- Below steep grades where flooding, seepage, or sediment depositions may occur; and
- Around buildings or areas that are subject to damage from runoff.

Limitations
A ditch is an effective means of diverting sediment laden runoff around a disturbed area. A ditch can sometimes, if not properly constructed, concentrate runoff in the ditch and increase the erosion potential. The effectiveness of a ditch can be greatly reduced if the ditch crosses a vehicle roadway or entrance. It is recommended that a ditch be coupled with a sediment trapping device at the outfall of the ditch.

Design Criteria
A ditch shall have enough capacity to carry peak runoff. The ditch may be parabolic, V-shaped, or trapezoidal in shape. A ditch may be designed to deliver runoff to a stable outlet at a point where the outflow will not cause damage.

Construction Specifications

- 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 ditch.
- All ditches shall have uninterrupted positive grade to an outlet.
- Diverted runoff from a disturbed or undisturbed area shall outlet to a sediment trapping device or into an undisturbed stabilized area at non-erosive velocities. Vegetative outlets shall be installed before ditch construction, if needed, to ensure establishment of vegetative cover in the outlet channel.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Ditches should be cleared of any sediment and repairs completed when necessary. Maintenance efforts should be adequate to preserve ditch capacity.

Removal

The ditch shall remain in place only until the disturbed areas are re-graded and prepared for permanent stabilization.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February, 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

FIGURE D-1
Parabolic Ditch

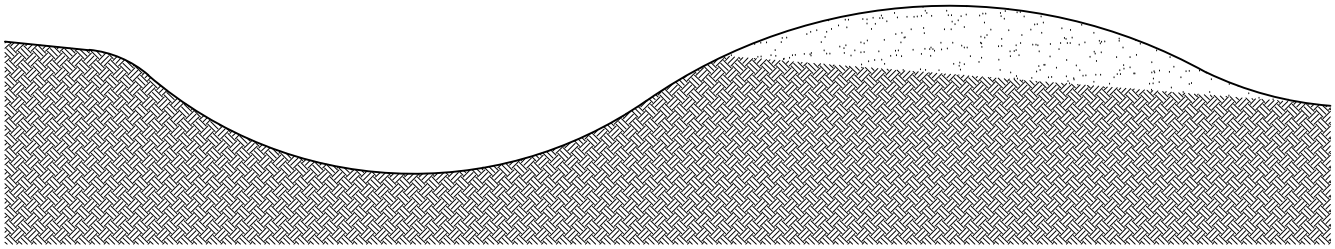
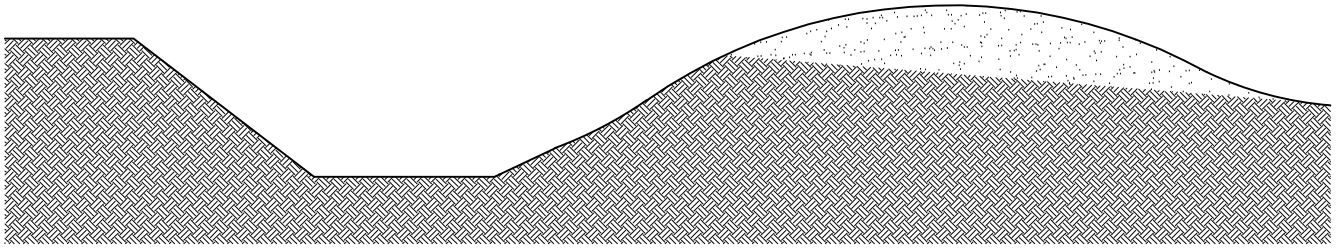


FIGURE D-2
Trapezoidal Ditch



SCALE: NOT TO SCALE

Ditch and Berm (DB)

Definition

A ditch and berm is a drainage with a parabolic or trapezoidal cross-section and a supporting ridge on the lower side that is constructed across the slope. The purpose of a ditch and berm is to prevent off-site stormwater runoff 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

Ditch and berms may be designed for temporary or permanent use. The maximum drainage area for a temporary, un-compacted ditch and berm is two acres. For drainage areas larger than two acres but less than ten acres, the ditch and berm should be compacted. For undisturbed drainage areas larger than ten acres, a permanent ditch and berm may be designed to handle larger flows. Ditch and berms may be used for:

- The up slope of cut or fill slopes to convey or divert flows away from disturbed areas;
- The down slope of cut or fill slopes to divert on-site runoff to a stabilized outlet or sediment trapping device;
- 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;
- Where runoff from higher areas has potential for causing erosions, or interfering with, or preventing the establishment of vegetation on lower areas;
- Where the length of slopes need to be reduced so soil loss will be kept to a minimum; and
- At the perimeter of a site or disturbed area.

Limitations

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

Design Criteria

For a temporary ditch and berm (drainage less than 10 acres), no formal design is necessary. For permanent ditch and berms (drainage area larger than 10 acres), the following guidelines apply.

Location

Ditch and berms are usually located above or below cut or fill slopes. Exact ditch and berm location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope, and the development layout. Where possible on shallow slopes, a vegetative buffer strip should be left between the edge of the cut or fill slope and the ditch and berm. See VEGETATIVE BUFFER (VB).

Capacity

The constructed ditch and berm shall have the capacity to carry, as a minimum, the peak discharge from a 10-year frequency rainfall event with the freeboard of not less than 0.3 feet.

Cross section See Figure DB-2 for details.

The ditch and berm shall be parabolic or trapezoidal in shape, if possible. The ditch and berm 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 ditch and berm. 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 channels is 3 feet per second, and 5 feet per second for clay vegetated channels. Ditch and berms are usually not 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 ditch and berm.

Construction Specifications

General

- 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 ditch and berm.
- All ditch and berms shall have uninterrupted positive grade to an outlet.
- 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. Vegetative outlets shall be installed before ditch and berm construction, if needed, to ensure establishment of vegetative cover in the outlet channel.

Temporary ditch and berm (drainage area < 10 acres)

- The ditch and berm shall be excavated or shaped to line, grade, and cross section as required to meet the specific criteria. The ditch and berm does not need to be compacted if the contributing drainage area is less than 2 acres.
- Stabilization with vegetation is not required as long as sediment traps (see SEDIMENT TRAPS [ST]) or other sediment control devices are provided.

Permanent ditch and berm (drainage area > 10 acres) See Figure D-2 for details.

- The ditch and berm shall be excavated or shaped to line, grade, and cross section as required to meet the specific criteria specified herein, and be free of bank projection or other irregularities that will impede normal flow.
- 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 and have a riprap center or provides other methods of controlling the meandering of low flows.
- 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.
- Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the completed ditch and berm.
- All earth that is removed and not needed in the construction shall be spread or disposed of on the well pad side so it will not interfere with the functioning of the ditch and berm.
- Immediately after the ridge and channel are constructed, they must be seeded or hydro-seeded and mulched or covered with erosion control blanketing according to SEEDING (S) and MULCHING (M) or EROSION CONTROL BLANKET (ECB) along with any disturbed areas that drain into the ditch and berm.
- For design velocities less than 3.5 feet per second, seeding and mulching may be used for establishing vegetation. It is recommended that, when conditions permit, temporary ditch and berms or other means should be used to prevent water from entering during the establishment of vegetation.
- For design velocities more than 3.5 feet per second, the ditch and berm shall be stabilized with seeding protected by jute or matting or with seeding and mulching, including temporary ditch and berms, until the vegetation is established.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Channels should be cleared of sediment and repairs made when necessary. Maintain ditch and berm capacity, ridge height, especially if high-sediment yielding areas are in the drainage area above the ditch and berm. Redistribute the sediment as necessary to maintain the capacity of the ditch and berm.

Removal

Temporary and un-compacted ditch and berms shall remain in place only until the disturbed areas are re-graded and prepared for permanent stabilization. Permanent ditch and berms shell remain in place until final reclamation.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February, 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

United States Department of Agriculture (USDA), Natural Resources Conservation Services (NRCS), *Field Office Technical Guide.* 2002. http://www.nrcs.usda.gov/technical/efotg/

FIGURE DB-1
Temporary Ditch and Berm Insallation

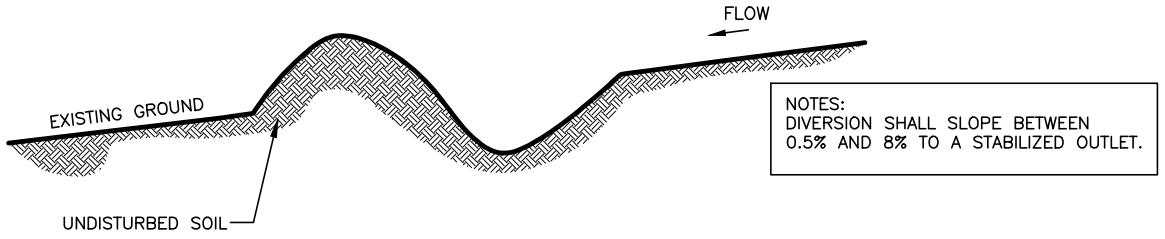
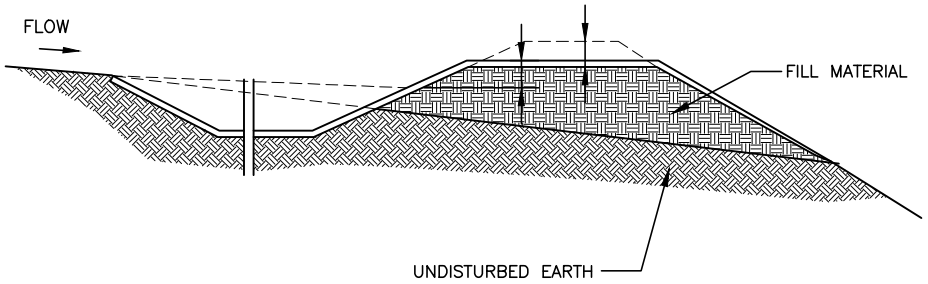


FIGURE DB-2
Permanent Ditch and Berm Insallation



SCALE: NOT TO SCALE

Drainage Dip (DD)

Description

Drainage dips intercept and remove surface water from roads 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.

Applicability

Drainage dips may be used:

- To remove water from the road surface efficiently and economically;
- In place of a culvert which can be costly and susceptible to plugging or failure; and
- 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 filter at discharge point.

Design Criteria

No formal design required.

Construction Specifications

See Figure DD-1 for details.

- Construct rolling dips deep enough to provide adequate drainage, angled 0 to 25 degrees perpendicular to the road, with a 3 to 5% out slope, and long enough (50 to 200 feet) to pass vehicles and equipment.
- In soft soils, armor the mound and dip with gravel or rock, as well as the outlet of the dip.
- 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.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). 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, Gordan, 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:www.blm.gov/bmp/field%20guide.htm

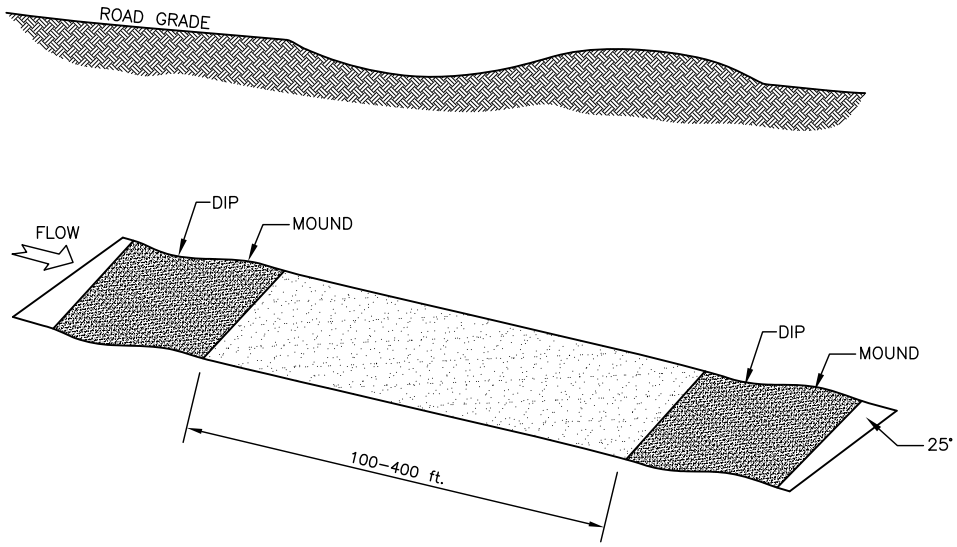
Maine Department of Conservation, *Best Management Practices for Forestry: Protecting Maine's Water Quality.* Maine Forest Service, Forest Policy and Management Division. Augusta, Maine. 2004. http://www.maine.gov/doc/mfs/pubs/bmp_manual.htm

United States Department of the Interior, Bureau of Land Management (BLM), *Surface Operating Standards for Oil and Gas Exploration and Development "Gold Book"*. Fourth Edition, 2007. http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

TALE 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	150
7 - 9	250	130
10 - 12	200	110
12+	160	100

FIGURE DD-1
Typical Drainage Dip



SCALE: NOT TO SCALE

Erosion Control Blanket (ECB)

Description

Erosion control blankets, also called turf reinforcement mats (TRM), 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:

- 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; and
- May be used on slopes as steep as 1:1.

Limitations

- Blankets used on slopes should be 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. The manufacturer 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 material and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material. Table ECB-1 indicates some recommended criteria for the selection of erosion control blankets.

Construction Specifications

- Smooth soil prior to installation and apply seed prior to fabric installation for stabilization of construction sites.
- Select the appropriate fabric type using the guidelines from Table ECB-1.
- Installation of the blankets shall be in accordance with the manufacturer's recommendations and 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 the exposed soil.
- Pins or staples shall be made of wire 0.162 inches or larger in diameter. "U" shaped staples shall have legs 8" long and a 1" crown. The bar of the "T" shall be at least 4" long. Triangular survey stakes can also be used.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Inspections should determine if cracks, tears, or breaches have formed in the fabric. If the effectiveness of the erosion control blanket has been reduced, the fabric should be repaired or replaced immediately. Re-anchor loosened matting and replace missing matting and staple as required. It is necessary to maintain contact between the ground and the blanket at all times. Trapped sediment should be removed after each storm event, where feasible without damaging existing BMPs.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.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), 2003. http://www.blm.gov/bmp/field%20guide.htm

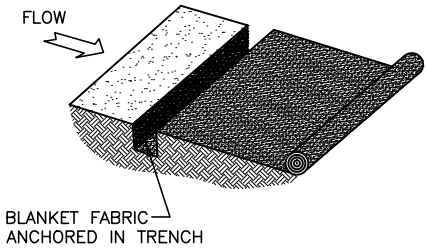
North American Green, 2004. http://www.nagreen.com

Table ECB-1
Suggested Blanket Types

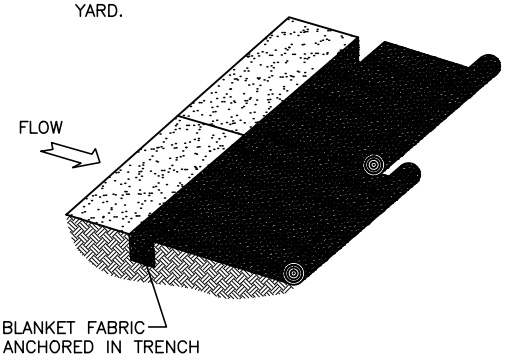
Description	Longevity	Applications	Max. Flow Velocity
Single Net Straw Blanket	12 Months	4:1 - 3:1 Slopes Low Flow Channels	5
Rapid Degrading Net	45-60 Days	4:1 - 3:1 Slopes Low Flow Channels	5
Double Net Straw Blanket	12 Months	3:1 - 2:1 Slopes Moderate Flow	6
Rapid Degrading Nets	45-60 Days	3:1 - 2:1 Slopes Moderate Flow	6
Double Net Blanket 70% Straw/30% Coconut	24 Months	2:1 - 1:1 Slopes Medium Flow Channels	8
Double Net Blanket 100% Cconut	36 Months	1:1 & Greater Slopes High Flow Channels	10
Double Net Blanket Polypropylene Fiber		1:1 & Slopes Extended Flow Areas High Flow	9 (unveg.) 16 (veg)
Organic Net	12 Months	4:1 - 3:1 Slopes Low Flow Channels	5
Organic Nets	12 Months	3:1 - 2:1 Slopes Moderate Flow	6
	18 Months	2:1 - 1:1 Slopes Medium Flow Channels	8
	24 Months	1:1 & Greater Slopes High Flow Channels	10

FIGURE ECB-1
Erosion Control Blanket Installation

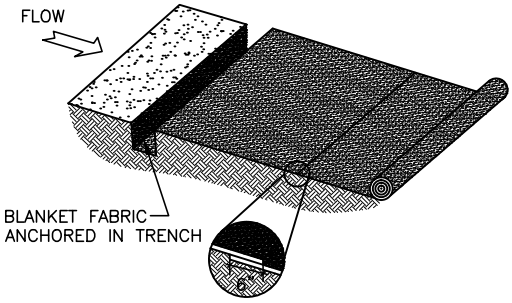
1. BURY UPSLOPE END BLANKET IN TRENCH 6" DEEP BY 6" WIDE



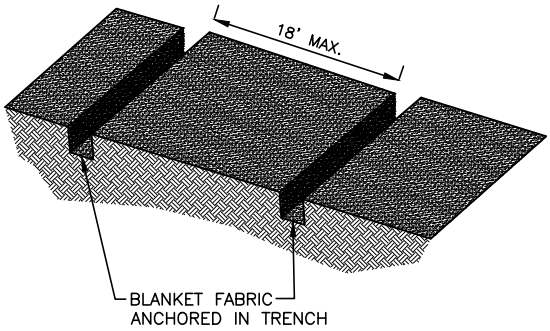
2. USE A 4" MIN. OVERLAY WHENEVER TWO WIDTHS OF BLANKET ARE APPLIED SIDE BY SIDE,
STAPLE PATTERN: MINIMUM 3 PER SQUARE YARD.



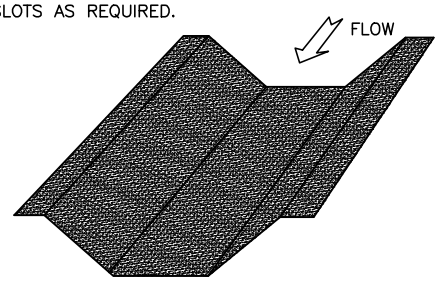
3. USE A 6" OVERLAP WHENEVER ONE ROLL OF BLANKET ENDS AND ANOTHER BEGINS

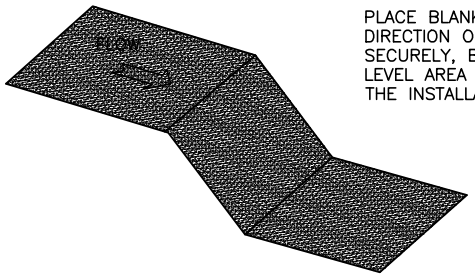


4. CHECK SLOTS SHOULD BE MADE EVERY 18'. INSERT A FOLD OF THE BLANKET INTO A TRENCH 6" WIDE BY 6" DEEP AND TAMP FIRMLY. LAY THE BLANKET SMOOTHLY OR THE SURFACE OF THE SOIL. DO NOT STRETCH THE BLANKET, AND DO NOT ALLOW WRINKLES. INSTALL STAPLE 20" ON CENTER IN TRENCH



IF POSSIBLE, PURCHASE BLANKET WITH A WIDTH THAT IS WIDE ENOUGH TO REACH ALL THE WAY ACROSS THE CHANNEL. PLACE BLANKET PARALLEL TO THE DIRECTION OF FLOW. DO NOT JOIN STRIPS IN THE CENTER OF DITCH. USE CHECK SLOTS AS REQUIRED.





PLACE BLANKET PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY, BRING BLANKET TO A LEVEL AREA BEFORE TERMINATING THE INSTALLATION

SCALE: NOT TO SCALE

Filter Berm (FB)

Description

A filter berm is a temporary ridge made up of natural materials that already occur on the project site such. Brush filter berms use small tree ranches, root mats, grass, leaves, stone, or other debris or material naturally available or left over from site clearing and grubbing (slash). 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.

- Five to 7 feet beyond the tow 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.
- Brush 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 brush 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 in required.

Construction Specifications

Brush (Slash) Filter Berms

- Place material cleared form the site across the slope or swale. Material with a diameter larger than six inches should not be used.
- Cut up brush if necessary and compact to avoid large voids within the barrier.
- The barrier mound should be at least three feet high and five feet wide at its base.
- 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 four inches deep and six inches wide on the drainage side of the barrier. This is done to secure the fabric and create a barrier to sediment while allowing storm water 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

- 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.
- 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.
- Trenching is not required.
- 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 Storm Water Management Plan (SWMP). 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

Remove filter berms after uphill drainage areas are stabilized. Rock and brush may 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/ndpes/stormwater/menufbmps/con_site.cfm

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

Hydro-mulch (HM)

Hydro-mulch is a soil binder that provides temporary soil stabilization. The stabilizer is sprayed onto the surface of exposed soil to hold the soil in place and minimize erosion from runoff and wind. These materials are easily applied to the surface of the soil, can stabilize areas where vegetation cannot be established, and provide immediate protection. Soil binders are typically applied to disturbed areas requiring short-term temporary protection. Because soil binders can often be incorporated into the work, they may be a good choice for areas where grading activities will soon resume. Applications can be applied to stockpiles to prevent water and wind erosion.

Applicability

Use hydro-mulch alone in areas where other methods of stabilization are not effective because of environmental constraints, or use them in combination with vegetative or perimeter practices to enhance erosion and sediment control.

Limitations

- Soil binders are temporary in nature and may need reapplication.
- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer, which may be 24 hours or longer. Soil binders may need reapplication after a storm event.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.
- Soil binders do not hold up to pedestrian or vehicular traffic across treated areas.
- Soil binders may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.
- May not cure if low temperatures occur within 24 hours of application.

Design Criteria

Closely follow the manufacturer's recommended application procedures to prevent the products from pooling and creating impervious areas where stormwater cannot infiltrate.

Maintenance Considerations

Inspect chemically stabilized areas regularly for signs of erosion, and if necessary, reapply the stabilizer.

References

California Department of Transportation (CDOT), *Construction Site Best Management Practices Manual.* CA., March 1, 2003. http://www.dot.ca.gov/hq/construc/stormwater

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Land Grading (LG)

Description

Grading involves reshaping the ground surface to planned grades. Grading provides more suitable topography for well pads and pipelines and helps to control runoff, soil erosion, and sediment during and after construction in these areas. Land grading includes the following.

- Proper cut and fill techniques to ensure roads and well pads remain stable over time.
- Road crowning or sloping to properly route stormwater off of the roadway.
- Surfacing of roads or well pads with gravel to avoid mud, rutting, and large quantities of sediment that will wash away during storms.

Applicability

- The construction and maintenance of any road or well pad, but particularly those located on steep topography or easily erodible soils.
- Surface gravel areas with “soft” soils sections, steep grades, highly erosive soils, or 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

- 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.
- Rutting and wash boarding may develop if surface gravel is not designed properly or if road or well pad is not sloped properly.
- Flat-blading to maintain the roadway must be done properly to avoid changes in gravel thickness, road slope, and road grade.

Design Criteria

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 activity 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 cuts and fills can be a major source of sediment. Slope failures can close the roads or require major repairs and can greatly increase 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 failure does 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 geologist. Failures that occur typically impact 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 for details.

All roads should be designed with one of the following three slope types.

1. Out-sloped 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. Out-sloped roads with clay rich, slippery road surface materials often require surface stabilization with gravel or limited use during rainy periods to assure traffic safety. Roads with over 10% to 12% grades and on steep hill slope areas, out-sloped roads are difficult to drain and can feel unsafe.
2. In-sloped roads are the best method to control surface water. However, in-sloped roads also concentrate water and require a system of ditches and turnouts or cross draining culverts.
3. 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 in-sloped or out-sloped road drainage is more effective.

Construction Specifications

Cut and fill slopes

- 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.
- Fill material shall be free of brush, logs, stumps, roots, or other objectionable material that would interfere with, or prevent construction or satisfactory fills. This material can be set aside and later used at the toe of fill slopes as filter berms.
- Table LG-1 presents a range of commonly used cut and fill slope ratios appropriate for the soil and rock types described. 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.
- All fills shall be compacted as required to reduce erosion, slippage, settlement, subsidence, or other related problems.
- 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 top soiled shall be scarified to a minimum depth of 4 inches prior to placement of topsoil.

Road slope See Figure LG-1.

- Compact soil or road base material to direct runoff.
- 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.
- If using an in-slope design, runoff will be directed toward the hillside and requires a roadside ditch with periodic turnouts or cross drain culvert installation.
- If using an out-slope design, ensure a moderate road slope with dense vegetative cover.

Surface gravel

- 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; (3) contains 5-15% clayey binder to prevent raveling; and (4) has a plasticity index of 2 to 10.
- Gravel thickness should be at least twice the diameter of the largest stone with a minimum thickness of 4 inches. Gravel thickness can be reduced with the use of geotextile or geo-grid sub-grade reinforcement when gravel is placed over very weak soils. Also, geotextile layers are useful over soft soils to separate the gravel from the soil, keep it uncontaminated, and extend the useful life of the gravel.
- Compact the aggregate during construction and maintenance to achieve a dense, smooth surface and thus reduce the amount of water that can soak into the road or well pad.
- "Spot" stabilize local wet areas and soft areas with 4 to 6 inches of coarse rocky material, add more as needed.
- Blend coarse aggregate and fine clay-rich soil (when available) with 5% to 15% fines for binder to produce a desirable composite roadway material that is coarse yet well graded.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Inspect cut and fill slopes for rills or other indications of erosion. Maintain all crowns, out slopes, in slopes, and surface gravel.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

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

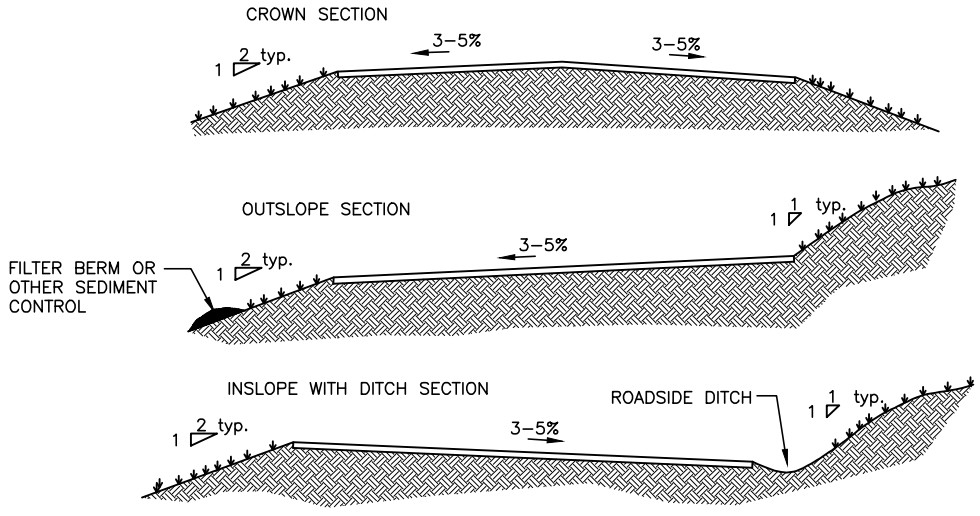
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency of International Development (USAID), 2003. http://www.blm.gov/bmp/field%20guide.htm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

TABLE LG-1
Stable Slope Ratios for Various Conditions

Soil/Rock Condition	Slope Ratio (Hor:Vert)
Most rock	1/4: 1 to 1/2: 1
Very well cemented soils	1/4: 1 to 1/2: 1
Most in-place soils	3/4: 1 to 1: 1
Very fractured rock	1: 1 to 1 1/2: 1
Loose coarse granular soils	1 1/2: 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 1/2: 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



SCALE: NOT TO SCALE

Level Spreader (LS)

Description

A level spreader is a device used to prevent erosion and to improve infiltration by spreading concentrated storm water runoff evenly over the round as shallow flow instead of through channels. It usually involves a depression in the soil surface that disperses flow onto a flatter area across a slight slope and then releases the flow onto level vegetated areas. This reduces flow speed and increases infiltration.

Applicability

A level spreader is most effective for a contributing area less than five acres in size and slopes no steeper than 2:1. Level spreaders may be used where:

- Sediment-free storm runoff can be released in sheet flow down a stabilized slope without causing erosion;
- A level lip can be constructed without filling;
- The area below the level lip is uniform with a slope of 10% or less and the runoff will not re-concentrate after release; and
- No traffic will be allowed over the spreader.

Limitations

This practice applies only in those situations where the spreader can be constructed on undisturbed soil and the area below the level lip is uniform with a slope of 10% or less and is stabilized by natural vegetation. The runoff water should not be allowed to reconcentrate after release unless it occurs during interception by another measure (such as a detention basin) located below the level spreader.

Design Criteria

Capacity

The design capacity shall be determined by estimating the peak flow from the 10-year storm. The drainage area shall be restricted to limit the maximum flows into the spreader to 30 cfs.

Construction Specifications

- A transition section will be constructed from the diversion channel to the spreader to smoothly blend the different dimension and grades.
- The level lip will be constructed in undisturbed soil to a uniform height and zero grade over the length of the spreader. For design flows less than 5 cfs, a vegetated level lip may be constructed with an erosion=resistant material, such as jute or excelsior blankets, to inhibit erosion and allow vegetation to become established. The matting should be a minimum of 4 ft. wide extending 6 inches over the lip and buried 6 inches deep in a vertical trench on the lower edge.
- For design flows higher than 5 cfs and permanent installations, a rigid level lip of non-erodible material, such as site rock and gravel, should be used.
- The runoff discharge will be outleted onto a stabilized and generally smooth vegetated sloped not exceeding 10%.
- Seed and mulch the disturbed area immediately after construction.
- Heavy equipment and traffic should not be allowed on the level spreader, as they can cause compaction of soil and disturbance of the slope grade.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). The spreader should be regarded if ponding or erosion channels develop. Dense vegetation should be sustained and damaged areas reseeded when necessary.

Removal

Level spreaders may be left in place or removed upon final site reclamation.

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/ndpes/stormwater/menufbmps/con_site.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Urban Erosion and Sediment Control.* New York. Fourth Edition, 1997. http://www.dec.state.ny.us/website/dow/toolbox/ecstandards

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. http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep1110-1-16/

Low Water Crossing (LWC)

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 stream bank 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, riprap, 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 broad crested weir in order to pass larger flow.
- Fords can, by “forgiving” and accommodating 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.
- 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 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 floodplain 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) the channel is too wide for normal bridge construction, b) anticipated loading may prove unsafe for single span bridges, or c) access is not needed from bank to bank. Culverts are normally preferred over a ford-type 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.

- Clearing and excavation of the stream banks and bed should be kept to a minimum.
- A temporary bridge structure shall be constructed at or above bank elevation to prevent the entrapment of floating materials and debris.
- Abutments should be parallel to the stream and on stable banks.
- 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.
- Stringers shall either be logs, saw timber, pre-stressed concrete beams, metal beams, or other approved materials.
- 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.
- 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.
- Curbs or fenders may be installed along the outer sides of the deck. Curbs or fenders are an option, which will provide additional safety.
- 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.
- All areas disturbed during installation shall be stabilized in accordance with SEEDING (S).

Culverts

See CULVERTS (C).

Fords See Figure LWC-2 for details.

- Locate fords where stream banks are low and where the channel is well confined.
- Clearing and excavation of the stream shores and bed should be kept to a minimum.
- Excavate streambed as necessary and place an 18-inch thick layer of 4-inch to 8-inch riprap. Cover this layer of riprap with a 6-inch thick layer of 2-inch to 4-inch crushed aggregate. The total thickness of riprap/aggregate should be a minimum of 24 inches thick. This type of simple low water crossing is ideal for ephemeral drainages.
- For all 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.
- Use an adequately long aggregate surface to protect the “wetted perimeter” of the natural flow channel. Add protection above the expected level of the highest flowline. 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.
- The downstream edge of a ford is a particularly critical location for scour and may need energy dissipaters or riprap protection.
- Use well-placed, sturdy depth markers at fords to advise traffic of dangerous water depths.
- All areas disturbed during ford installation shall be stabilized in accordance with SEEDING (S).

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP).

Bridges

Inspection will ensure that the bridge, streambed, and stream banks 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 stream bank erosion should be repaired immediately. Any trapped sediment or debris will be removed and disposal of outside of the floodplain and stabilized.

Culverts

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

Fords

Inspections will 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

All low water crossings will be removed when the structure in no longer needed.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Keller, Gordan, 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), 2003. http:www.blm.gov/bmp/field%20guide.htm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

United States Department of the Interior, Bureau of Land Management (BLM), *Surface Operating Standards for Oil and Gas Exploration and Development "Gold Book"*. Fourth Edition, 2007. http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

FIGURE LWC-1
Bridge Installation

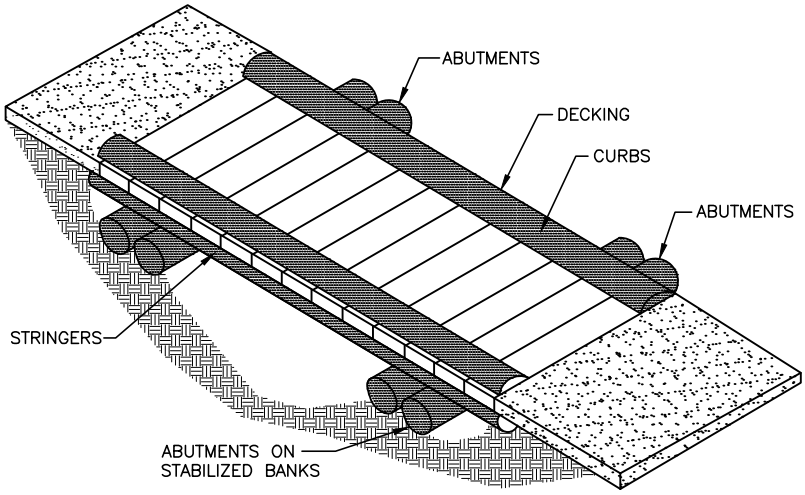
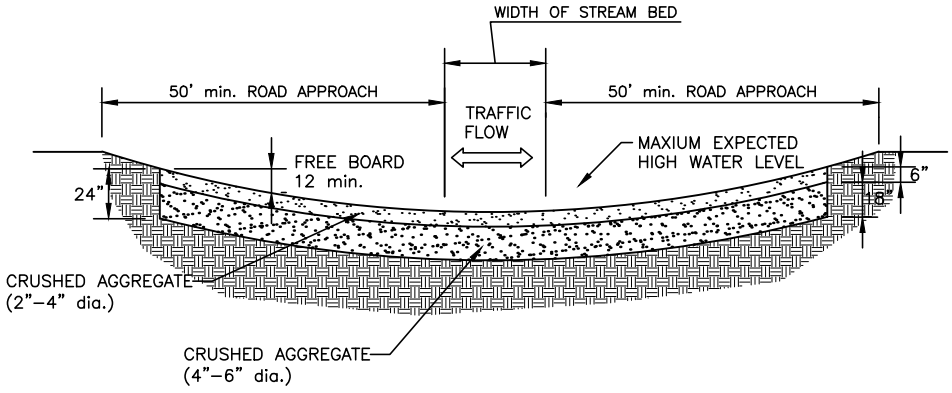


FIGURE LWC-2
Ford Installation



SCALE: NOT TO SCALE

Mulching (M)

Description

Mulching is a temporary erosion control practice in which materials such as grass, hay, wood chips, wood fibers, straw, or gravel are placed on exposed or recently planted soil surfaces. Mulching stabilizes soils by minimizing rainfall impact and reduces 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 matting is 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 mulch.

Applicability

Mulching is often used after (or in combination with) seeding to help aid in the establishment of vegetation. Hydraulic application of mulch is often used in steep areas (up to 1:1) where regular mulching is difficult because of environmental constraints. Mulch matting, with net or anchoring to hold it in place, can also be used on steep slopes or in critical areas such as waterways. Mulch can last for one to two years and is most effective when used on an area less than two acres in size.

Limitations

- Mulching, matting, and netting might delay seed germination because the cover changes soil surface temperatures.
- The mulches are subject to erosion and may be washed away in a large storm.
- Maintenance is necessary to ensure that mulches provide effective erosion control.

Design Criteria

No formal design is required.

Construction Specifications

Site preparation

- Prior to mulching, install the necessary temporary or permanent erosion control practices and drainage system within or adjacent to the area to be mulched.
- Slope, grade, and smooth the side to fit the needs of the selected mulch products.
- Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

Mulching and anchoring

- 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 establishment. See Table M-1 for suggested materials and application rates. Other materials include hydraulic mulch products with 100% post-consumer paper content and yard trimming composts. All materials should be free of seed.
- Apply mulch after soil amendments and planting is accomplished or simultaneously if hydro-seeding is used. See Table M-1 for installation guidelines.
- Use a mulch crimper to apply and anchor mulch. A crimper should have approximately 6-inch cleats with perpendicular, dull, disc blades. If a crimper is unavailable the Contractor shall apply the 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 the 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.

Hydraulic mulching

- For steep slopes or other areas where hydraulic application of mulch is desired, a high-quality type of hydraulic matrix known as a Bonded Fiber Matrix (BFM) 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 typical construction specification for wood fiber mulch (hydro-mulch) is as follows: Biodegradable green–dyed wood-cellulose-fiber mulch, which is non toxic, free of plant growth- or germination-inhibitors, with maximum moisture content of 15% and a pH range of 4.5 to 6.5.
- A typical construction specification for weed-free-straw non-asphaltic tackifier is as follows: Organic derivative vegetative gum tackifier recommended by fiber-mulch manufacturer for a slurry application, which is nontoxic and free of plant growth-or germination-inhibitor.

- Hydraulic application of BFM must be done when no rainfall in expected, preferably within a 24-hour time period. Mix BFM in a hydraulic application machine (such as a hydro-seeder or a mulch blower) and then apply to the slope as a liquid slurry. The slurry must be constantly agitated to keep the proper application rate and achieve uniform effective coverage. The minimum application rate shall be 2,000 pounds per acre with a typical application rate between 3,000 and 4,000 pounds per acre.

Maintenance Considerations

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

Removal

Anchor netting and any other artificial mulch material should be removed when protection is no longer needed and then disposed of in a landfill.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

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

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	1/2 - 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 manuracturer'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 adheisive 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 120lbs./ac. In 480 gal. of water (#156/sec.) or Aerospray 70 (60gal./ac.) according to manufacturer's instructions. Avoid application during rain. A 24-hour curing period and a soil temperatire higher than 45 deg. Ferhenheit are required.

Retaining Wall (RW)

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.

Several different retaining wall types are:

- **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 weight and structural resistance, and are generally used for permanent applications.
- **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.
- **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.
- **Gabions:** These 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.

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 re-grading, to be ineffective. The preconstruction drainage patter 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 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; and
- 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 the manufacturer's standards and specifications and must be able to handle expected storm and flood conditions. At a minimum, they should be constructed of a hexagonal triple twist mesh of heavily galvanized steel wire (galvanized wire may also receive a polyvinyl chloride coating). The maximum linear dimension of the mesh opening shall not exceed 4.5 inches and the area of the mesh opening shall not exceed 10 square inches.

The design water velocity for channels utilizing gabions should not exceed the following.

Gabion Thickness (feet)	Maximum Velocity (feet per second)
0.5	6
0.75	11
1	14

Construction Specifications

Rock retaining wall See Figure RW-1 for details.

- Excavate a footing trench at the location of the proposed wall.
- Place the largest rocks in the footing trench with their longitudinal axis normal to the wall face. Arrange subsequent rock layers so each rock above the foundation course has a firm seating on the underlying rocks.
- The batter of the wall face shall be between ½:1 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.
- Place fill material behind the rock wall. Slope above the wall should be maintained at 2:1 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.
- Re-vegetate the stabilized slope with a method applicable to the particular site.

Gabion retaining wall See Figure RW-2 for details.

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 to the manufacturer's recommendations. General specifications are listed below.

- Clear and grade the area of trees, brush, vegetation, and unsuitable soils. Compact the sub-grade firmly to prevent slumping or undercutting.
- Install a filter fabric or granular filter according to RIPRAP (R) to maintain separation of rock material with the underlying soil, if required.
- Place empty gabion baskets such that each row, tier, or layer of baskets shall be reasonably straight and 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. 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.
- 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.
- Before filling each gabion with rock, all kinks and holds 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.
- The gabion cells should be carefully filled with 4-inch to 8-inch 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. Rocks should be sound, durable, and well graded. All exposed rock surfaces should have a reasonably smooth and neat appearance. No sharp rock edges should project through the wire mesh.
- The gabion cells in any row or layer should be filled in stages so local deformations may be avoided.

- At no time should any cell be filled to a depth exceeding 12 inches more than any adjacent cell.
- The layer of rock should completely fill the gabion basket so 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 no more than a 1-inch gap remains at any connection.
- 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.
- 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 Stormwater Management Plan (SWMP). 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 war. 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

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

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New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

FIGURE RW-1
Construction of Rock Retaining Structures

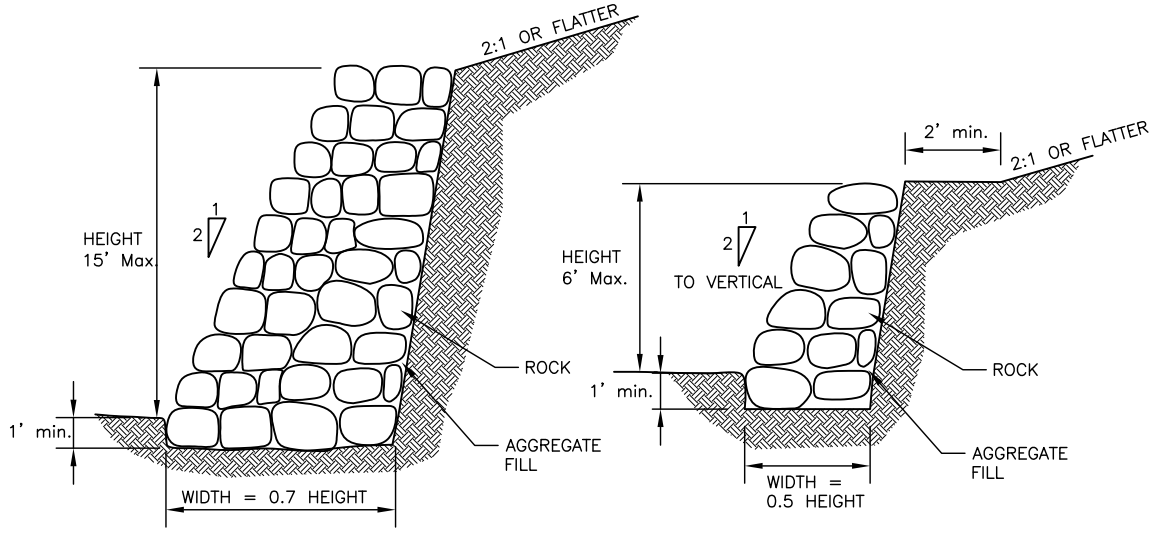


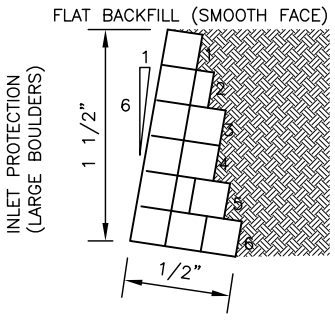
FIGURE RW-2
Grabion Design

NOTE:
LOADING CONDITIONS ARE FOR SILTY SAND TO SAND AND GRAVEL BACKFILL. FOR FINE OR CLAY RICH SOILS, EARTH PRESSURE ON THE WALL WILL INCREASE FOR EACH HEIGHT. BACKFILL WEIGHT = 110 pcf.

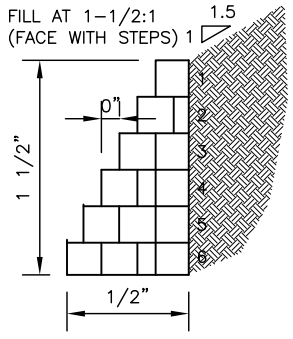
–SAFE AGAINST OVERTURNING FOR SOILS WITH A MINIMUM BEARING CAPACITY OF 2 TONS/ft²

–FOR FLAT OR SLOPING BACKFILLS, EITHER A FLAT OR STEPPED FACE BE USED.

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



SCALE: NOT TO SCALE

Ripping (RP)

Description
Ripping is a series of infiltration trenches, with no outlet, that receives stormwater runoff. Runoff is stored in the void space within these trenches and infiltrates through the bottom and into the soil matrix. The primary pollutant removal mechanism of this practice is filtering through the soil. Ripping increases soil drainage by opening up the soil which allows stormwater to infiltrate at a faster rate and reducing erosion by promoting infiltration.

Applicability
Ripping can be applied in most regions of the country and is most effective in areas that do not have steep slopes or in soils with a high concentration of clay that may prevent infiltration of stormwater. Ripping is best used in areas where sheet flow of stormwater occurs.

Limitations
Depending on the surface and/or soil makeup, some areas might not be suitable for all ripping techniques, for example rock formations.

Design Criteria
Ripping should be completed by going against the natural contours to slow down stormwater velocity.

Construction Specifications
Ripping should be done with a tool bar attached to a back hoe or land grader equipment. The tool bar should have a minimum of three mounted rippers. Ripped depths should be at least 10 inches in depth and not to exceed 18 inches. The distance between contours is modified as the slope becomes steeper.

Maintenance Considerations
The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP).

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

United States Fish and Wildlife Service, *Contour Tilling/Ripping*, January 2009. http://www.fws.gov/fire/ifcc/esr/Treatments/contour-tillingi.htm

FIGURE RP-1
Ripping (elevation view)

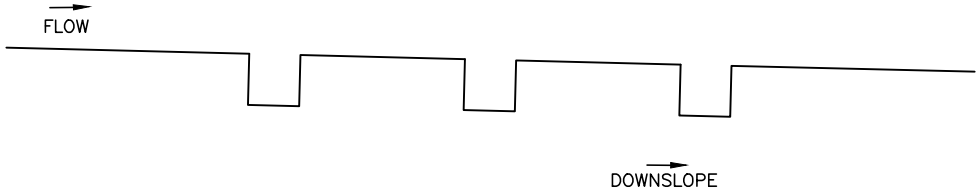
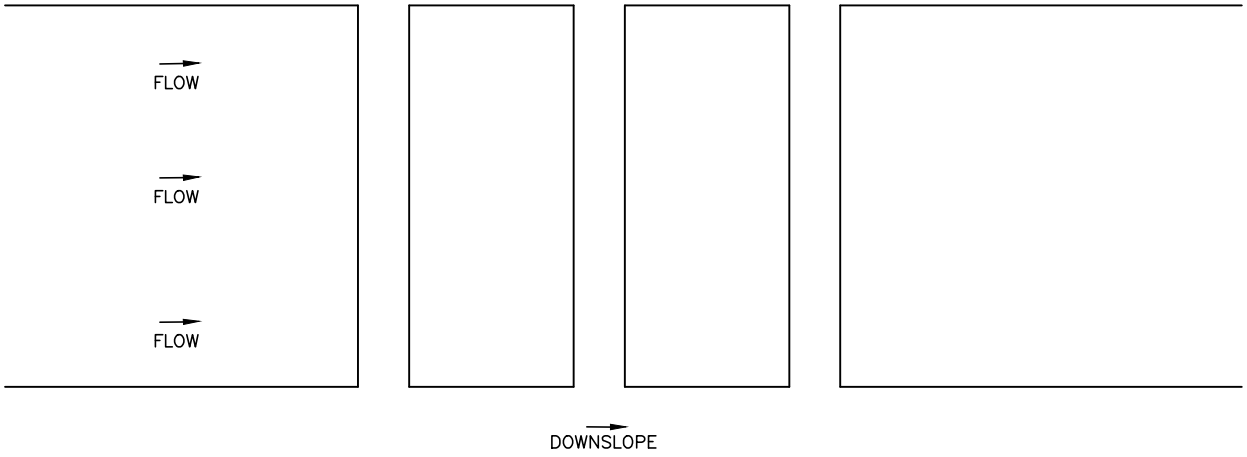


FIGURE RP-2
Ripping (plan view)



SCALE: NOT TO SCALE

Riprap (R)

Description
Riprap is a permanent, erosion resistant layer made of stones or boulders. 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 re-vegetation or where flow velocities exceed 5 feet per second. Riprap can be used in:

- Cut and fill slopes;
- Chanel side slopes and/or bottoms;
- Inlets and outlets to culverts, slope drains, and sediment traps; and
- Roadside ditches.

Limitations
Riprap is limited by steepness of slope, because slopes that are 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 temporary 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). Fifty percent 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 one 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 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.

Size

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

- **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 the repose of the stone selected. Angles of the repose of riprap stones may be estimated using 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.
- **Outlet Protection:** Design criteria for sizing stone and determining dimensions of riprap aprons are presented in CULVERT PROTECTION (CP).
- **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.

The design of a sand/gravel filter blanket is based on the ratio of particle size in the overlying filter material to that of the base material in accordance with the criteria below. Multiple layers (each a minimum of 6-inches thick) may be designed to affect a proper filter if necessary. A sand/gravel filter blanket should have the following relationship for a stable design.

The design of a synthetic filter fabric, which may be used with or in place of gravel filters, is:

- Filter fabric covering a base containing 50 percent or less by weight of fine particles (#200 sieve size);
- Total open area of filter fabric should not exceed 36%;
- Filter fabric covering other soils;
- Equivalent opening size (EOS) is no larger than 0.21 mm (#70 sieve size);
- Total open area of filter fabric should not exceed 10%; and
- *EOS- Equivalent opening size compared to a U.S. standard sieve size.

No filter fabric should have less than 4% open area or an EOS less than U.S. Standard Sieve #100 (0.15 mm). The permeability of the fabric must be greater than that of the soil. The fabric may be made of woven or non-woven monofilament yarns and should meet the following minimum requirements.

- Thickness 20-60 mils
- Grab strength 90-120 lbs
- Conform to ASTM D-1682 or ASTM D=177

Construction Specifications

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. For culvert outlet protection, construct according to CULVERT PROTECTION (CP).

Sub-grade Preparation

Prepare the sub-grade for riprap to the required lines and grades. Compact any fill required in the sub-grade to a density approximating that of the undisturbed material or overfill depressions with riprap. Remove brush, trees, stumps, and other objectionable material. Cut the sub-grade sufficiently deep so 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.

Sand/Gravel filter basket

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.

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 2:1.

Stone placement

Place riprap so it forms a 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 the final placement. Place riprap though chutes or other methods that cause segregation of stone sizes. If a filter is used, be careful not to lodge the underlying base filter or damage the filter cloth when placing the stones. If damage occurs, remove the riprap and repair the filter.

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 stones 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 Stormwater Management Plan (SWMP). 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

Riprap is generally not removed.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

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

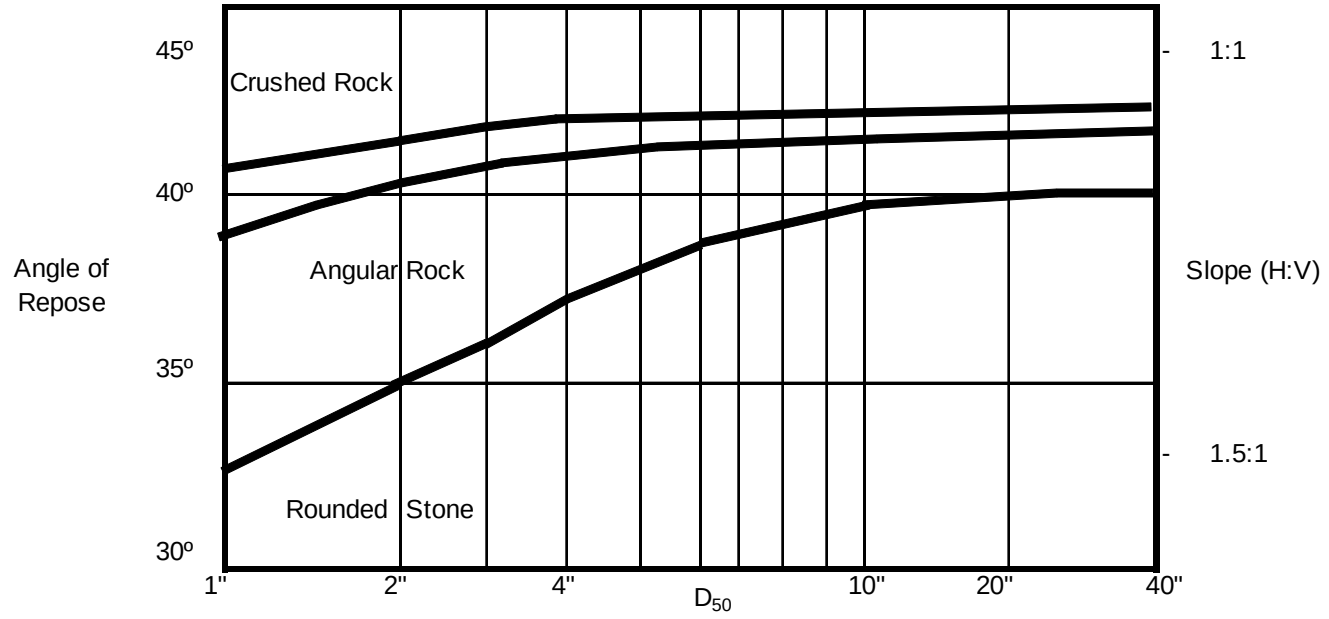


FIGURE R-2
Typical Riprap Slope Protection Detail

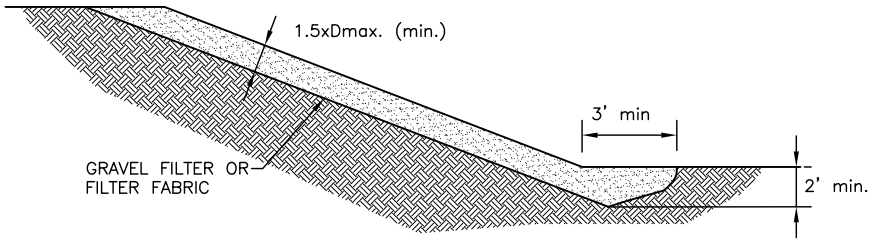
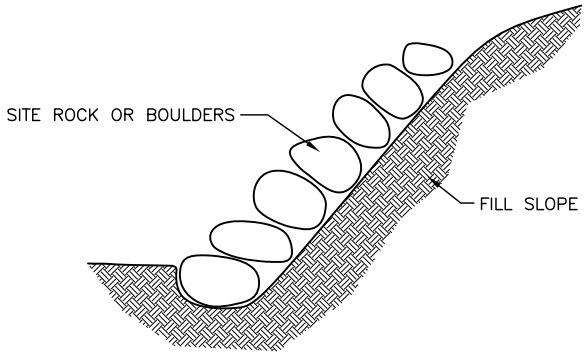


FIGURE R-3
Typical Boulder Drystack Detail



SCALE: NOT TO SCALE

Roadside Ditches (RSD) and Turnouts (TO)

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. Turnouts (also called wing ditches) are extensions of roadside ditches. Turnouts effectively remove run-off water from the roadside ditch into well-stabilized areas before it reaches a waterway.

Applicability

- Roadside ditches should be used for all roads built on sloping topography and with either an in-slope or a crowned design.
- Ditch turnouts should be used as much as possible but their best use may be on slopes longer than 150 feet or greater than 5%, as conditions allow.
- Turnouts are applicable where fairly flat naturally vegetative areas exist at intervals by the roadside.

Limitations

- If these structures are not installed correctly, they may become a source of erosion.
- Roadside ditches do not necessarily filter sediment from runoff.
- Turnouts should be on gradual slopes only.
- Turnouts require vegetative cover or other filter at the discharge point.
- Turnouts only work well if small volumes of runoff drain into the turnout.
- Turnouts should only receive runoff from the road and ditch surface, not from large, uphill watersheds.

Design Criteria

No formal design required.

Construction Specifications

Roadside ditches

- Roadside ditches should be constructed with no projections of roots, stumps, rocks, or similar debris.
- Excavate ditches along roadside to a width and depth that can handle expected flow according to Figure RSD-1.
- All ditches shall have uninterrupted positive grade to an outlet. Slope ditch so water velocities do not cause excessive erosion, but no less than 0.5%. If steep slopes and high velocities exist, use a CHECK DAM (CD) to slow runoff and catch sediment.
- To control erosion and collect sediment, construct aggregate check dams according to Figure CD-1 of CHECK DAM (CD).
- 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.
- If necessary, stabilize ditches with RIPRAP (R) or EROSION CONTROL BLANKET (ECB).

Turnouts

- Use turnouts wherever possible and on undisturbed soil.
- Turnouts should be on gradual slopes only and should slope gradually down from the bottom of the roadside ditch.
- Angle turnouts at approximately 30 degrees to the roadside ditch.
- Discharge the turnout into a 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 outlets areas are not available, use culverts or other controls to direct runoff to a stabilized area.
- Space turnouts according to the slope as indicated on Figure TO-1.
- Turnouts only work well if small volumes of runoff drain into the turnouts. Turnouts should only receive runoff from the road and ditch surface, not from large, uphill watersheds.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Road ditches and turnouts should be inspected for any signs of channelization and repaired as necessary. Structures will fail if water exists in channelized flow. Also inspect for sediment buildup at the outlet 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.

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http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/gold_book.html

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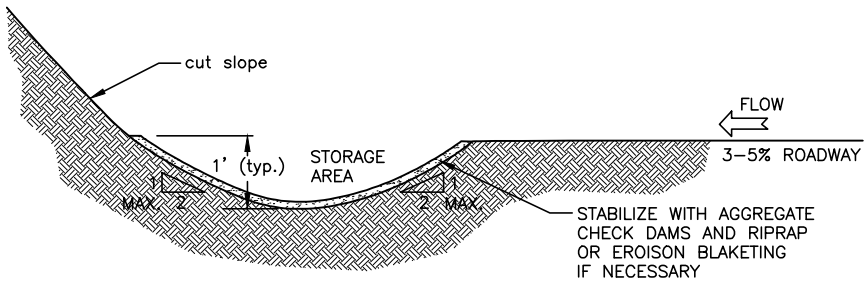
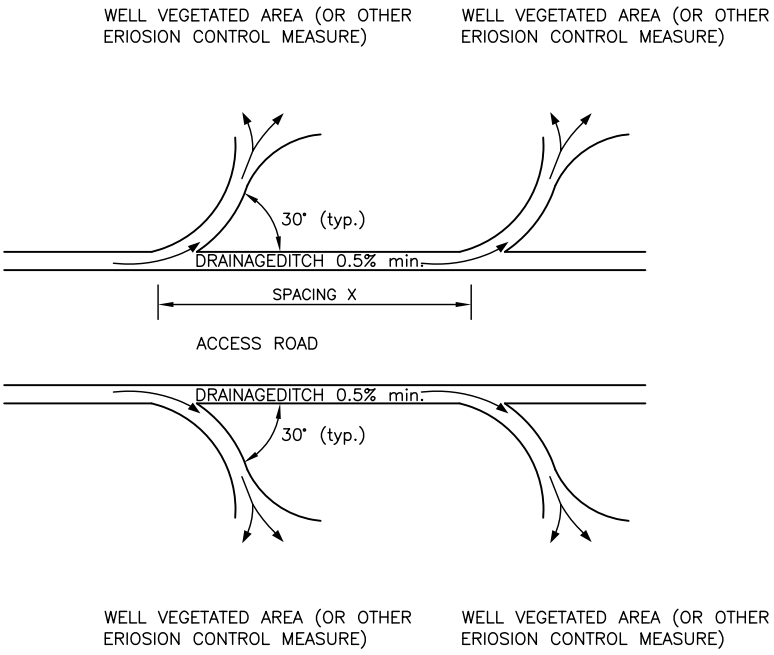
FIGURE RSD-1
Roadside Ditch Insallation



NOTE:
SLOPE DITCH 0.5% TO 20% TO STABILIZED OUTLET

SCALE: NOT TO SCALE

FIGURE TO-1
Turnout Layout



Road Slopes	Turnout Spacing X
<2%	<5000 ft
2-5%	200ft
5-10%	100ft
>10%	75ft

SCALE: NOT TO SCALE

Sediment Pond (SP)

Description

Sediment ponds can be used to capture sediment from stormwater runoff before it leaves a construction site. Sediment pond structures allow a pool to form in an excavated or natural depression, where sediment can settle. The pool is dewatered through a single riser and drainage hole leading to a suitable outlet on the downstream side of the embankment or through the gravel of a rock dam. The water is released more slowly than it would be without the control structure.

Applicability

Sediment ponds are usually used for drainage areas of 5 to 100 acres. They can be temporary or permanent. Sediment ponds designed to be used for up to 3 years are usually described as temporary. Those designed for longer service are considered permanent. Temporary sediment basins can be converted into permanent stormwater runoff management ponds, but they must meet all regulatory requirements for wet ponds.

Sediment ponds are applicable in drainage areas where it is expected that other erosion controls, such as sediment traps, will not adequately prevent off-site transport of sediment.

Limitations

Do not use a sediment pond with an earthen embankment or a rock dam in an area of continuously running water (live streams). Do not use a sediment pond in an area where failure of the earthen or rock dam will result in loss of life or damage to homes or other buildings. Do not use sediment basins in areas where failure will prevent the use of public roads or utilities.

Design Criteria

Investigate potential sites for sediment ponds during the initial site evaluation. Construct the ponds before any grading takes place in the drainage area. For permanent structures, a qualified professional engineer experienced in designing dams should complete the basin design.

Construction Specifications

A sediment pond is constructed by excavation or by erecting an earthen embankment across a low area or drainage swale. Some sediment ponds are designed to drain completely during dry periods. Others are constructed so a shallow pool of water remains between storm events.

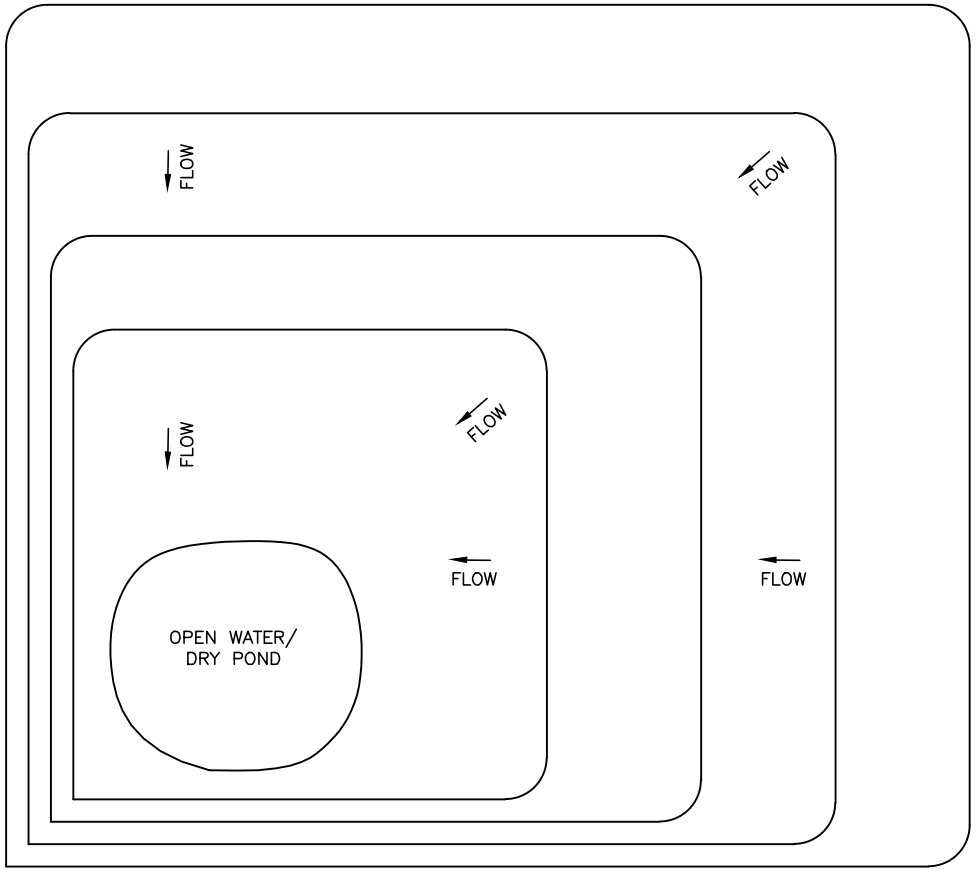
Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP) to ensure proper drainage from the collection pool and determine the need for structural repairs. Replace material eroded from earthen embankments or stones moved from rock dams immediately. Locate sediment basins in an area that is easily accessible to maintenance crews for removal of accumulated sediment. Remove sediment from the basin when the storage capacity has reached approximately 50%. Remove trash and debris from around dewatering devices promptly after rainfall events.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

FIGURE SP-1
Sediment Pond



NOTE:
PUT SEDIMENT POND AT LOWEST LAYING AREA ON SITE.

SCALE: NOT TO SCALE

Sediment Trap (ST)

Description

Sediment traps are small collection areas that allow sediment to settle out of stormwater runoff. They are usually installed 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.

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 five acres. The effective life span of these temporary structures is usually limited to 24 months. Traps may be located in a 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 eroded soils to settle, due to the short detention periods for stormwater, traps typically do not remove fine particles such as silts and clays.
- Water may remain in sediment traps for extended periods causing mosquitoes and other insects to gather. Locate the trap in a sunny spot if possible.
- Never construct a sediment trap on a live flow stream or in wetlands.

Design Criteria

Location

Traps 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. 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 approximate storage capacity of each trap should be 3,600 ft^3 per acre of contributing drainage area. Half of this volume may be in the form of wet storage (a permanent pool) and the other half may be in the form of dry storage. When possible, the wet storage volume should be contained within the excavated portion of the trap. The following formula may be used, as a reference, to estimate the volume of a sedimentation trap.

Volume (ft^3) = 0.4 x surface area (ft^2) x maximum pool depth (ft)

Construction Specifications

See Figure ST-1 for installation details.

- If possible, sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.
- Traps should be located above the floodplain, where possible. If there are space constraints, several small sediment traps may be constructed in series.
- Area under embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. The pool area shall be cleared.
- 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.
- The spillway may consist of a stone section in the embankment formed by a combination coarse aggregate/riprap to provide for filtering/detention capability. Riprap shall be 4-inch to 8-inch rock, while the coarse aggregate shall be ½ to ¾ inches. A Geotextile may be placed at the stone-soil interface to act as a separator.
- Another option for the spillway is to use straw bales or wattles at the overflow point in the trap and line the rest of the spillway with an erosion control blanket (see EROSION CONTROL BLANKET [ECB]).

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). 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% 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 1.5 feet below the low point of the trap embankment.

Removal

The structure shall be removed and the area stabilized when the drainage area has been properly stabilized.

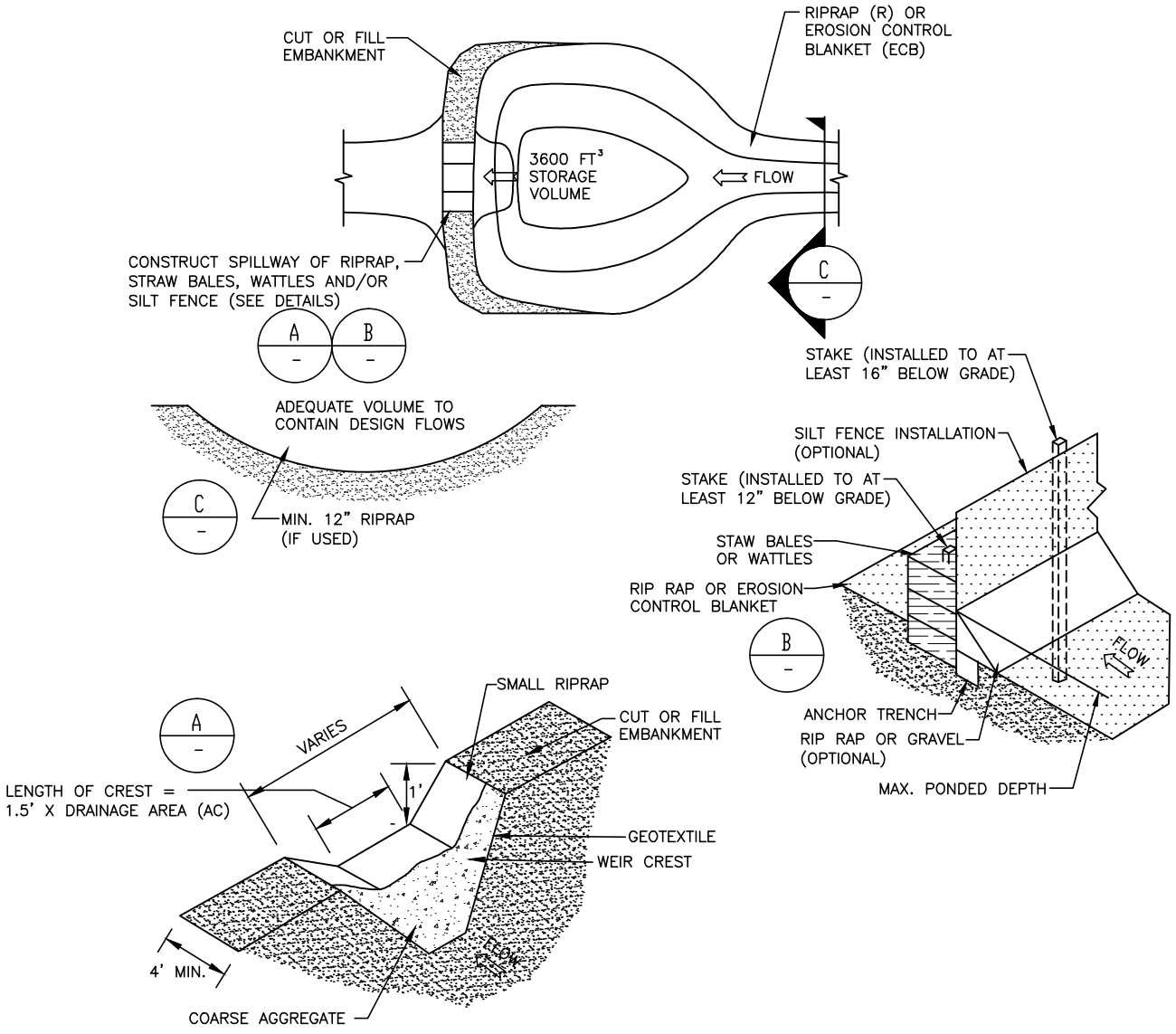
References

Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide.* 2002. http://www.coloradodot.info/programs/environmental/water-quality/documents/erosion-storm-quality

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.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



SCALE: NOT TO SCALE

Seeding (S)

Description

Seeding involves planting seed to establish a vegetative cover in disturbed areas. Seeding establishes vegetation that reduces erosion and sediment displacement by stabilizing disturbed areas in a manner that is economical, adaptable to site conditions, and allows selection of the most appropriate plant material. Seeding 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; and
- Enhances natural beauty.

Applicability

Seeding is most effective on slopes no steeper than 2:1. Seeding may be used as a permanent control or a temporary control in areas where exposed soil surfaces are not to be re-graded for periods longer than 30 days. Such areas include denuded areas, soil stockpiles, berms, temporary road banks, etc.

Limitations

The effectiveness of seeding can be limited by:

- High erosion potential during establishment;
- The need for stable soil temperature and soil moisture content during germination and early growth;
- The need to re-seed areas that fail to establish; and
- Limited seeding times depending on the season.

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.

When to seed

Areas to be stabilized with vegetation must be seeded or planted one to four months after grading is completed unless temporary stabilization measures are in place. Temporary stabilization measures should be installed through “no growth” periods during winter months until the weather can support seed growth.

Seed mix

Climate, soils, and topography are major factors that dictate the suitability of plants for a particular site. Vegetation that has adapted to the site, has strong roots, and provides good ground cover should be used. Although a native seed mix is best, some grasses such as Vetiver have been used extensively worldwide because of their strong deep roots, adaptability, and non-invasive properties.

Construction Specifications

- Seeding does not immediately stabilize soils. Temporary erosion and sediment control measures should be in place to prevent off-site transport of sediments from disturbed areas until vegetation is established.
- Vegetation should not be established on slopes that are unsuitable due to inappropriate soil texture, poor internal structure or internal drainage, volume of overland flow, or excessive steepness, until measures have been taken to correct these problems.
- If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted, or hardened, the soil surface shall be loosened by disking, raking, harrowing, or other acceptable means to ensure good water infiltration and root penetration (see SOIL ROUGHENING [SR]).
- The soil on a disturbed site may need to be modified to provide an optimum environment for seed germination and seedling growth. To maintain a good stand of vegetation, the soil must meet certain minimum requirements as a growth medium. If any of the below criteria cannot be met then topsoil shall be applied. The existing soil must have these characteristics:
    1. Enough fine-grained material to maintain adequate moisture and nutrient supply.
    2. Sufficient depth of soil to provide an adequate root zone. The depth to rock or impermeable layers such as hardpans shall be 12 inches or more, except on slopes steeper than 2:1 where the addition of soil is not feasible.
    3. A favorable pH range for plant growth. If the soil is so acidic that a pH range of 6.0 to7.0 cannot be attained by addition of pH-modifying materials, then the soil is considered an unsuitable environment for plant roots and further soil modification would be required.
    4. Freedom from toxic amounts of materials harmful to plant growth.

5. Freedom from excessive quantities of roots, branches, large stones and clods of earth, or trash of any kind. Clods and stones may be left on slopes steeper than 3:1 if they do not significantly impede good seed soil contact.

- Add fertilizer and/or lime, if necessary. Lime and fertilizer may be incorporated into the top 2 to 4 inches of the soil if possible. The addition of lime is equally as important as applying fertilizer. Lime will modify the pH and supply calcium and magnesium. Its effect on pH makes other nutrients more available to the plant.
- The appropriate seed shall be evenly applied with a broadcast seeder, drill, cultipacker or hydro-seeder. Seeding depth should be ¼ to ½ inch.
- If necessary, apply mulch according to MULCHING (M). The mulch will hold moisture and modify temperature extremes and prevent erosion while seedlings are growing.

Maintenance Considerations

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

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.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), 2003. http://www.blm.gov/bmp/field%20guide.htm

Silt Fence (SF)

Description

Silt fences are used as temporary perimeter control around sites where there will be soil disturbance due to construction activities. They consist of a length of filter fabric stretched between anchoring posts 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 0.5cfs. 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.

Limitations

- Silt fence 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 to occur.
- 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 the fence. Location 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

The fence should be designed to withstand the runoff from a 10-year storm event.

Construction Specifications

- Erect silt fence according to Figure SF-1.
- If standard strength fabric is used in combination with wire mesh, the support posts should be spaced no more than 10 feet apart. If extra-strength fabric is used without wire mesh reinforcement, the support posts should be spaced no more than 6 feet apart.
- Stakes used to anchor the filter fabric should either be wooden or metal. Wooden stakes should be at least 3 feet tall and have a minimum diameter of 2 inches if a hardwood such as oak is used. Softer woods such as pine should be at least 4 inches in diameter. When using metal post in place of wooden stakes, they should have a minimum weight of 1 to 1.33pounds per linear foot. If metals post are used, attachment points are needed for fastening the filter fabric using wire ties. The height of the fence post should be between 16 to 34 inches above the original ground surface.
- Material for silt fences should be a pervious sheet of synthetic fiber such as polypropylene, nylon, polyester, or polyethylene yarn, chosen based on minimum synthetic fabric requirements, as shown in the following table.

Physical Property	Requirements
Filtering Efficiency	75-85% (minimum): Highly Dependent on local conditions
Tensile Strength at 20% (maximum) Elongation	Standard Strength: 30 lbs/linear inch (minimum) Extra Strength: 50 lbs/linear inch (minimum)
Ultraviolet Radiation	90% (minimum)
Slurry Flow Rate	0.3 gal/ft2/min (minimum)

- Use a continuous roll of fabric to eliminate unwanted gaps in the fence. If a continuous roll of fabric is not available, the fabric should overlap from both directions only at the stakes or posts with a minimum overlap of 6 inches.
- Extend silt fence across grade and up slope for a short distance.
- Compact backfill at the base of the fabric.
- Plow in or entrench 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.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). 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 that impact the effectiveness of the silt fence are discovered, they should be repaired or the fabric should be replaced immediately. Accumulated sediments should be removed from the fence base when the sediment reaches 1/3 to 1/2 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 due to a sudden storm event.

Removal

Remove silt fences and all accumulated sediment after uphill drainage areas are stabilized by vegetation or other means.

References

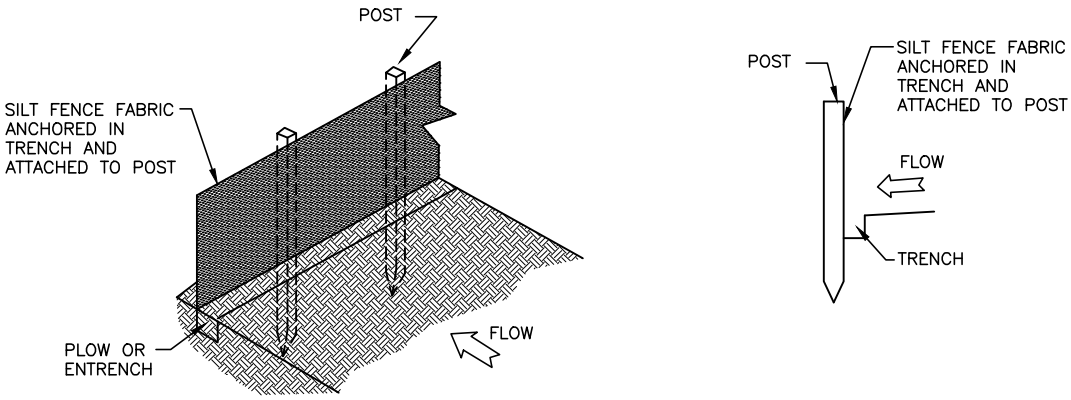
Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide*. 2002. http://www.coloradodot.info/programs/environmental/water-quality/documents/erosion-storm-quality

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.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), 2003. http://www.blm.gov/bmp/field%20guide.htm

FIGURE SF-1
Silt Fence Installation



SCALE: NOT TO SCALE

Slope Drain (SD)

Description
A slope drain is a conduit extending the length of a disturbed slope and serving as a temporary diversion outlet. 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 two 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 five 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.

- The slope drain shall have a slope of 3% or steeper.
- The top of the diversion berm over the inlet pipe, and those diversions carrying water to the pipe, shall be at least 6 inches higher at all points than the top of the inlet pipe.
- A flared end section of corrugated metal shall be attached to the inlet and of the pipe with a watertight connection. The corrugated metal pipe should have watertight joints at the ends.
- The drain should consist of heavy-duty material manufactured for the purpose and have grommets for anchoring at a spacing of 10 feet or less. The pipe is typically corrugated plastic or flexible tubing, although for flatter, shorter slopes, a polyethylene-lined channel is sometimes used. Where flexible tubing is used, it shall be the same diameter as the inlet pipe and shall be constructed of a durable material.
- The soil around and under the pipe and end section shall be hand tamped in 4-inch lifts to the top of the diversion berm.
- The slope drain shall outlet into a sediment trapping device when the drainage is disturbed. A riprap apron shall be installed below the pipe outlet where water is being discharged into a stabilized area.
- 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 Stormwater Management Plan (SWMP). Inspections should determine if the capacity or slope drain was exceeded or if blockages have occurred. Repairs should be made promptly. Construction equipment and vehicular traffic must be rerouted around slope drains.

Removal

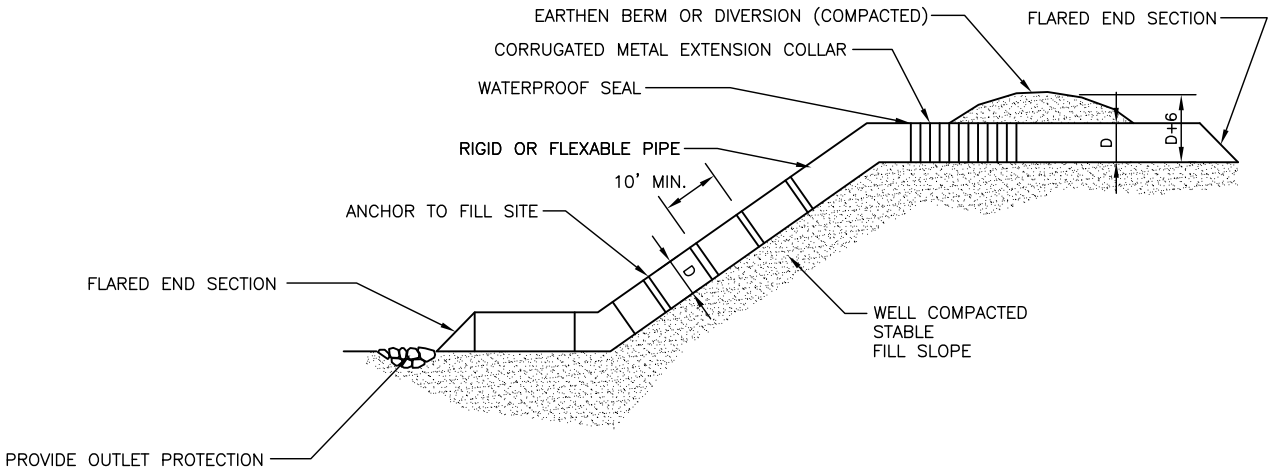
Remove slope drain on completion of construction and stabilization activities.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

FIGURE SD-1
Slope Drain Installation



Drainage Area (acres)	Pipe/Tubing Diameter (in) D
<0.5	12

SCALE: NOT TO SCALE

Straw Bale Barrier (SBB)

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. Straw bale barriers have an estimated design life of three months.

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 soil areas.
- Along streams and channels for both erosion and sediment control.
- As check dams across mildly sloped swales or construction roads (See CHECK DAM [CD]).

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 in the possibility of a washout.

Design Criteria

No formal design is required.

Construction Specifications

See Figure SBB-1 for installation details.

- 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.
- Allow sufficient space up slope from the barrier to allow ponding and to provide room for sediment storage.
- All bales shall be either wire bound or string tied. Straw bales shall be installed so bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings.
- 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 minimum 2 inch x 2 inch x 36 inch wood stakes or standard “T” or “U” steel posts (minimum weight of 1.33 pounds per linear foot).
- After the bales are staked and chinked (gaps filled by wedging), the excavated soil shall be back filled 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.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). 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

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 up-slope 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.

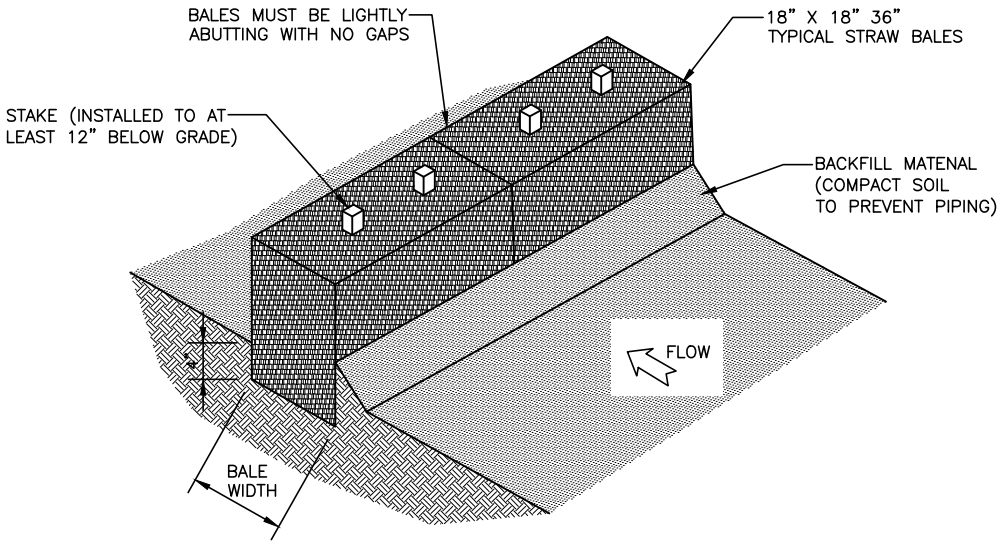
References

Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide.* 2002. http://www.coloradodot.info/programs/environmental/water-quality/documents/erosion-storm-quality

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 Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

FIGURE SBB-1
Straw Bale Installation



SCALE: NOT TO SCALE

Soil Roughening (SR)

Description

Soil (surface) roughening is an erosion control practice that involves tracking, scarifying, imprinting, or tilling a disturbed area to provide temporary stabilization of disturbed areas. Surface roughening creates variations in the soil surface that help to minimize wind and water erosion. Depending on the technique used, surface roughening may also help establish conditions favorable to establishment of vegetation.

Applicability

Soil roughening is most effective for areas of one 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.

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.

Design Criteria

No formal design is required. However, the selection of the appropriate method 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 (temporary or permanently) in an area.
- All cut and fill slopes should be roughened whenever possible.
- Do not blade or scrap the final fill slope face.
- Excessive compacting of the soil surface should be avoided during roughening, and areas should be seeded as soon as possible after roughening is completed.

Maintenance Considerations

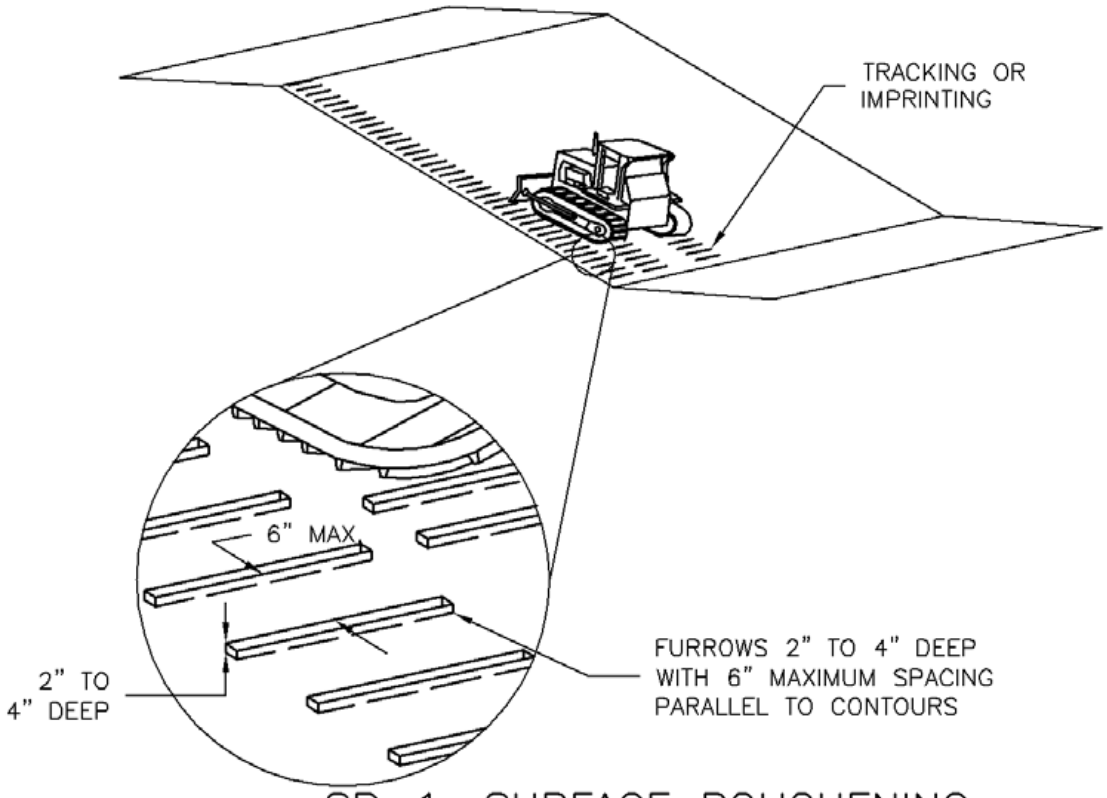
The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Roughening might need to be repeated after storm events.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

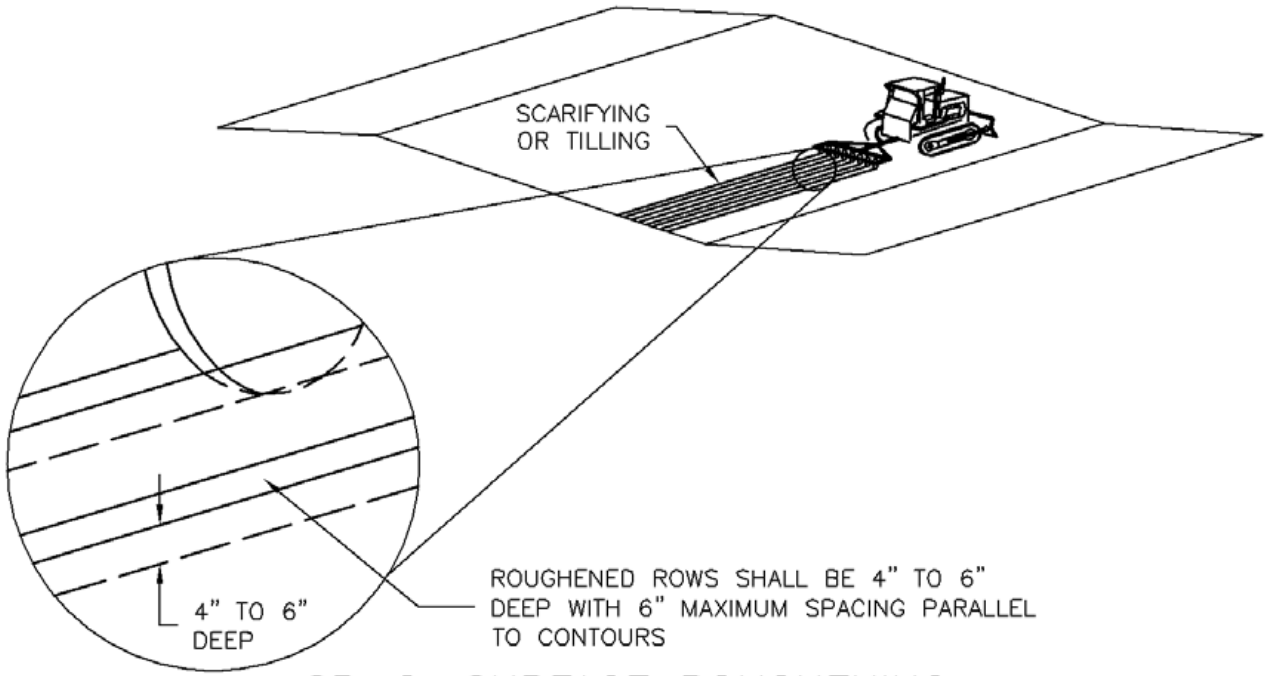
Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html



SR–1. SURFACE ROUGHENING

FOR STEEP SLOPES (3:1 OR STEEPER)



SR–2. SURFACE ROUGHENING

FOR LOW SLOPES (LESS THAN 3:1)

Terracing (T)

Description

Terraces (sometimes called reverse slope benches) are made of either earthen embankments or ridge and channel systems that are properly spaced along a fill slope. Terraces are constructed with an adequate grade to promote drainage to a stabilized outlet. They 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.

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.
- 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.

Limitations

- Terraces are not appropriate for use on sandy, extremely steep, 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

Terraces should be constructed according to Figure T-1 for cut slopes and Figure T-2 for fill slopes.

- Construct diversion ditches at the top of the slope if necessary to prevent or reduce surface water from running down the slope face.
- 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 a crimper has access for mulching.
- Terraces must drain to a stabilized outlet, such as a stabilized waterway, vegetated area, or other suitable outlet. Slope drains (SLOPE DRAIN [SD]) 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.
- 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.
- Stabilize or re-vegetate the slope with methods applicable to the particular site.

Maintenance Considerations

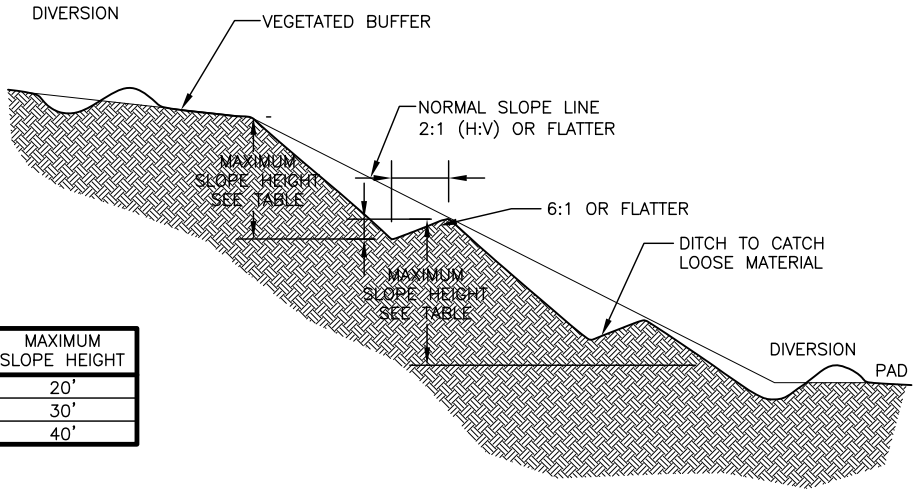
The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Maintain terrace ridge height and outlet elevations. Remove sediment that has accumulated on the terrace to maintain capacity and a positive channel grade. If excessive seepage or surface runoff is a problem, control the seepage/runoff with appropriate drainage facilities. Take prompt action as needed to ensure proper drainage and slope stability. Repair rills and re-seed 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

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

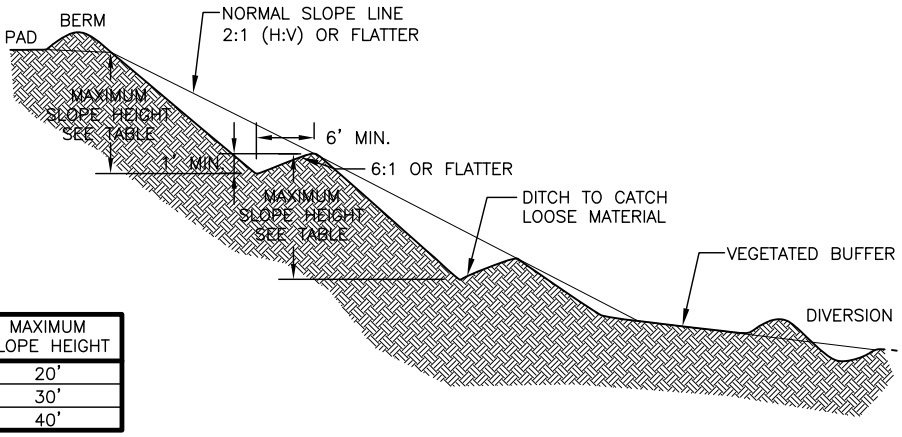
FIGURE T-1
Terracing - Cut Slope



SLOPE	MAXIMUM SLOPE HEIGHT
2:1	20'
3:1	30'
4:1	40'

1. TERRACES SHALL SLOPE BETWEEN 2% AND 3% TO A STABILIZED OUTLET.
2. FLOW LENGTH ALONG A TERRACE SHALL NOT EXCEED 800 FEET.

FIGURE T-2
Terracing - Fill Slope



SLOPE	MAXIMUM SLOPE HEIGHT
2:1	20'
3:1	30'
4:1	40'

1. TERRACES SHALL SLOPE BETWEEN 2% AND 3% TO A STABILIZED OUTLET.
2. FLOW LENGTH ALONG A TERRACE SHALL NOT EXCEED 800 FEET.

SCALE: NOT TO SCALE

Tracking Pad (TP)

Description

A stabilized construction entrance (i.e., tracking pad) is a pad of gravel where construction traffic leaves a site. The purpose of a stabilized access to a site is to minimize the amount of tracked mud that leaves a site. As a vehicle drives over the gravel tracking pad, mud and sediment are removed from the vehicle's wheels and off-site transport of soil is reduced. The gravel tracking pad also reduces erosion and rutting in the soil beneath the stabilized structure. The filter fabric 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 width of the tire.

Applicability

Typically, stabilized construction accesses are installed at locations where construction traffic leaves or enters an existing paved road. However, the applicability of the site access stabilization should be extended to any roadway or entrance where vehicles will enter or leave the site.

Limitations

- Although stabilizing construction access 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 stabilized site access is recommended.
- Site 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 TP-1 for installation details.

- If the pad is constructed on a crowned road, a roadside ditch with check dams or sediment traps may 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.
- Place a matrix of 2-inch to 4-inch washed stone, reclaimed or recycled concrete equivalent to a minimum of 12 feet wide and 20 feet in length.
- All surface water flowing or diverted toward the construction access shall be piped across the entrance. If piping is impractical, a mountable berm with 5:1 slope will be permitted.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Stabilization of site accesses 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 stabilized construction site access to keep the access effective. Soil that is tracked off site should be swept up immediately for proper disposal.

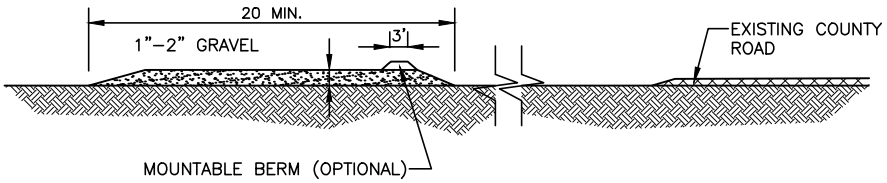
References

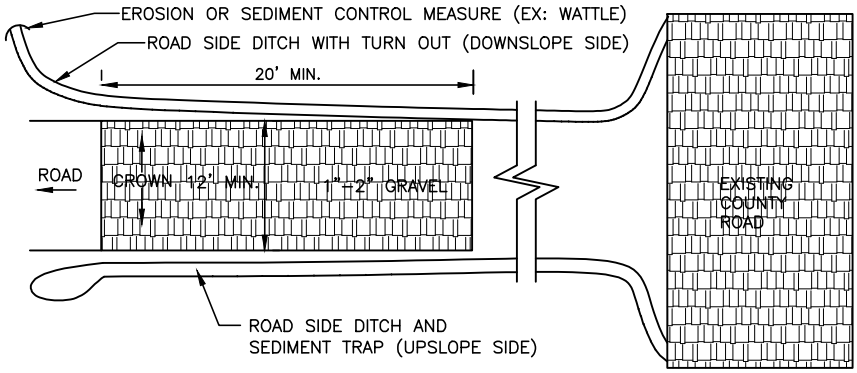
Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide*. 2002. http://www.coloradodot.info/programs/environmental/water-quality/documents/erosion-storm-quality

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

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

FIGURE TP-1
Tracking Pad





SCALE: NOT TO SCALE

Vegetative Buffer (VB)

Description

Vegetative buffers (also known as vegetative filter strips) are areas of either natural or established vegetation that are maintained to protect the water quality of neighboring areas. Vegetative buffers reduce the velocity of stormwater runoff, provide an area for the runoff to permeate the soil, contribute to ground water 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.

- It 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; and
- Provides a fully developed habitat for wildlife.

Applicability

Vegetative 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 stream banks, 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 pollution.

Limitations

- Vegetated buffers require plant growth before they can be effective and land on which to plant the vegetation must be available.
- Although vegetative 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 required.

Construction Specifications

- Buffer widths should be determine 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 the slope increases.
- Fertilizing seeded or planted ground may enhance growth and improve its effectiveness as a buffer.
- Direct sediment-laden water onto the naturally vegetated or stabilized planted ground.
- 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 Stormwater Management Plan (SWMP). 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 focus on encroachment, gully erosions, density of vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If there are more than 6 inches of sediment in one place, it should be removed.

Removal

Removal is not necessary.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Water Bar (WB)

Description
A water bar is an earthen ridge and channel constructed diagonally across a sloping road, trail, or disturbed area that is subject to erosion. Water bars are normally used for drainage and erosion protection of closed, blocked, or infrequently used roads to limit the accumulation of erosive volumes of water by diverting surface runoff at pre-designed intervals.

Applicability
Water bars are applicable where runoff protection is needed to prevent erosion on sloping access right-of-ways or long, narrow sloping areas generally less than 100 feet in width. This is a practice that is often used on limited-use roads, trails, and firebreaks. It is an excellent method of retiring roads and trails as well as abandoned roads where surface waters 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 the discharge point.

Design Criteria
No formal design is required.

Construction Specifications
See Figure WB-1

- Clear the base for the ridge before placing fill.
- Track the ridge to compact it to the design cross section.
- Install the water bar according to Figure WB-1 as soon as the base is cleared and graded. The positive grade shall not exceed 2%.
- Vehicle crossings shall be stabilized with gravel. Exposed areas shall be immediately seeded and mulched.
- Extend the water bar inlet and outlet one foot or more beyond the side of the road, trail or disturbed area to keep the diverted water from re-entering the area.
- Space the water bars according to Table WB-1.
- Locate the outlet on an undisturbed area. Field spacing shall be adjusted to use the most stable outlet areas. Outlet protection shall be provided when natural areas are not adequate.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Inspect water bars for erosion damage and sediment. Check outlet areas and make repairs as needed to restore operation.

Removal

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 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), 2003. http://www.blm.gov/bmp/field%20guide.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.dec.state.me.us/doc/mfs/pubs/pdf/bmp_manual/bmp_manual.pdf

New York State Department of Environmental Conservation, *New York Guidelines for Erosion and Sediment Control*. New York. August 2005. http://www.dec.ny.gov/chemical/29066.html

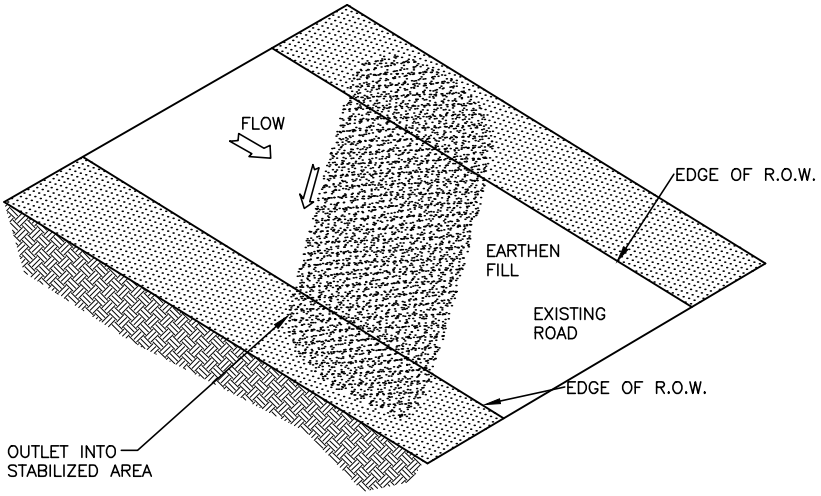
TABLE WB-1
Water Bar Spacing

Road/Trail Grade (%)	Low to Non Erosive Soils[1]	Erosive Soils[2]
0-5	245'	130'
6-10	200'	100'
11-15	150'	65'
16-20	115'	50'
21-30	100'	40'
31+	50'	30'

[1]Low Erosions=Coarse Rocky Soils, Gravel, and Some Clay

[2]High Erosion Soils=Fine, Friable Soils, Silt, Fine Sands

FIGURE WB-1
Water Bar Installation



SCALE: NOT TO SCALE

Wattles (W)

Description

A wattle consists of straw, flax, or other similar synthetic materials bound into a tight tubular roll. 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, wattles can also reduce erosion.

Applicability

Wattles may be suitable:

- Along the top, face, and at the grade breaks of exposed and erodible slopes to shorten slope length 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;.
- At the overflow location of sediment traps;
- As check dams in unlined ditches; and
- Around temporary stockpiles.

Limitations

- Wattles are not effective unless trenched.
- Wattles at the toe of the slope greater than 5:1 should be a minimum of 20-inch 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 in 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
Wattles should be either prefabricated rolls or rolled tubes of erosion control blankets. If using erosion control blankets, roll the length of erosion control blanket into a tube with a minimum of 8 inches in diameter and bind the roll at each end and every 4 feet along the length of the roll with jute-type twine.

See Figure W-1 for wattles used to control erosion along slopes.

Locate wattles on level contours spaced as follows.

- Slope inclination of 4:1 or flatter: Fiber rolls should be placed at a maximum interval of 20 feet.
- Slope inclination between 4:1 and 2:1: Fiber rolls should be placed at a maximum of 15 feet.
- Slope inclination 2:1 or greater: Fiber rolls should be placed at a maximum interval of 10 feet.
- Turn the ends of the wattles upslope to prevent runoff from going around the roll.
- Stake wattles into a 2 to 4 inch deep trench with a width equal to the diameter of the wattle. Drive stakes at the end of each wattle and space 4 feet maximum on center.
- If more than one wattle is placed in a row, the rolls should be overlapped, not abutted.

Maintenance Considerations
The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). 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 half the distance between the top of the wattle and the adjacent ground surface.

Removal
Wattles are typically left in place. 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 (CASQA). 2003. Stormwater Best Management *Practice Handbook: Construction.* https://www.casqa.org/store/products/tabid/154/p-167-construction-handbookportal-initial-subscription.aspx

FIGURE W-1
Wattles Ground Level

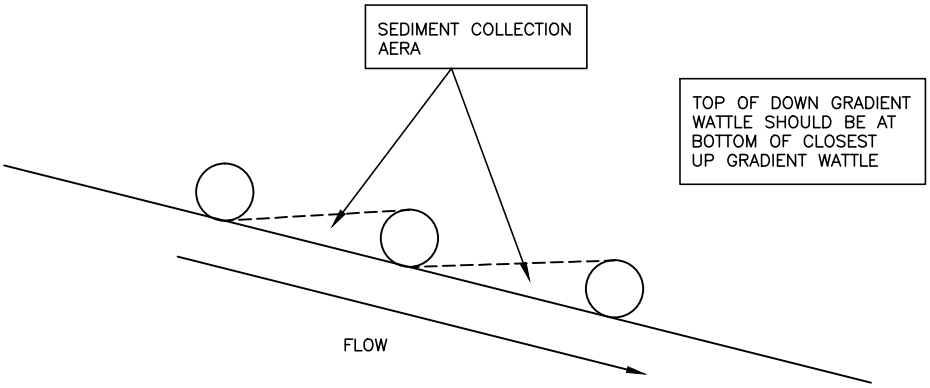


FIGURE W-2
Wattles (Tied In)

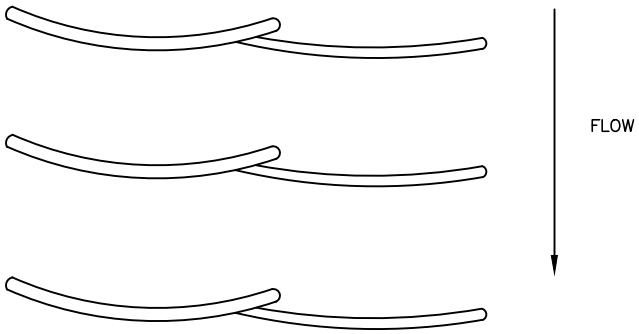
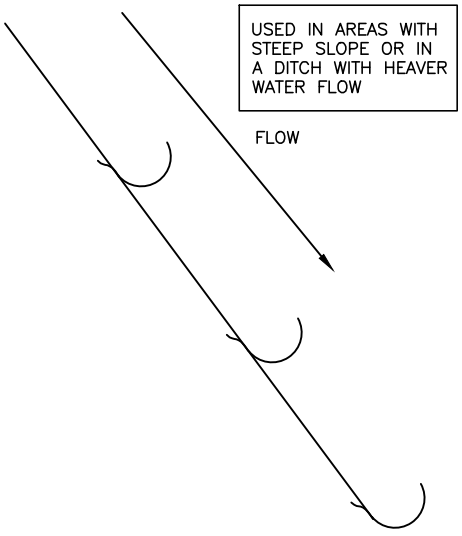


FIGURE W-3
Wattles With Check Dam Application



SCALE: NOT TO SCALE

Wind Fence (WF)

Description

Wind fences are barriers of small, evenly spaced wooden slats or fabric erected to reduce wind velocity and to trap blowing sediment. They can be used effectively as perimeter controls around open construction sites to reduce the off-site movement of fine sediments transported by wind. They also prevent off-site damage to roads, streams, and adjacent properties. The spaces between the fence slates allow wind and sediment to pass through but reduce the wind velocity, which causes sediment deposition along the fence.

Applicability

Wind fences are applicable to areas with a preponderance of loose, fine-textured soils that can be transported off site by high winds. They are especially advantageous for construction sites with large areas of cleared land or in arid regions where blowing sand and dust are especially problematic.

Limitations

- A wind fence does not control sediment carried in stormwater runoff.
- Wind fences should be installed in conjunction with other sediment and erosion control measures that capture sediment from runoff.

Design Criteria

No formal design is required.

Construction Specifications

- Erect the fence perpendicular or as close to perpendicular as possible to the prevailing wind.

- Erect multiple fences to increase sediment-trapping efficiency, depending on the degree of protection desired. Linear rows of fence 2 to 4 feet high and spaced 20 to 40 feet apart may be installed.

Maintenance Considerations

The frequency of inspections should be in accordance with the Stormwater Management Plan (SWMP). Inspection should ensure that there are no breaks or gaps in the fence. Repairs should be made immediately. Sand and sediment should be cleaned from the fence area periodically to prevent their mobilization by stormwater runoff.

Removal

Remove fence after construction activities are complete and the site is stabilized.

References

United States Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Stormwater Runoff Control.* Washington, D.C., February 2003. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

APPENDIX E

TRAINING LOGS