Texas American Resources Company
Best Management Practices (BMP's) Manual

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BEST MANAGEMENT PRACTICES (BMPs)

1.0 INTRODUCTION

In order to address the requirements of storm water pollution at construction sites, a variety of techniques should be employed to reduce soil erosion, site sediment loss, and manage construction-generated waste. This section provides design criteria for a variety of techniques to address these issues. These techniques, or best management practices (BMPs), consist of both temporary and permanent solutions to reduce pollution from a construction site.

Many BMPs address onsite soil losses. For construction sites, soil loss, in the form of erosion and sedimentation, as a result of storm events and wind, constitute the majority of pollution generated from a construction site. BMPs which address erosion and sediment control are much more site specific than waste management techniques. Erosion and sediment control BMPs are dependent upon site slopes, drainage patterns and quantities, and other site-specific conditions. Waste management consists of "good housekeeping" practices, which are dependent upon the type of construction and the quantity and type of building materials.

The following provides a method of selecting BMPs applicable to construction sites along with design criteria for each BMP. BMPs will be applied on a site specific basis and not all BMPs will be used at each construction site.

The designer must first use the BMP selection guide to determine BMPs applicable to the site. The fact sheets following the selection guide detail the design and maintenance requirements, limitations, and purpose of each design and the techniques. These provide the tools for the designer to select the appropriate BMPs and locate them onsite to effectively reduce sediment loss and erosion.

Information is also provided on maintenance of the control devices, as well as what should be checked during requirement inspections.

2.0 GENERAL CONSTRUCTION BMPS

BMPs are not a substitute for proper planning and construction techniques. The following BMPs are typical construction practices that are implemented by Texas American Resources Company.

SELECTION GUIDE:
BMPs FOR GENERAL CONSTRUCTION

BMP Name	Primary Purpose	Rating
Well Site Construction	Minimize surface disturbance and effects on other resources, and maintain reclamation potential of the site.	Very Effective
Road and Access Way Construction	Minimize surface disturbance and effects on other resources, and maintain reclamation potential of the site.	Very Effective
Pipelines and Flowlines	Minimize surface disturbance and effects on other resources, and maintain reclamation potential of the site.	Very Effective
Drainage and Drainage Structures	Ensure long-term success of the structure and minimize adverse environmental effects, such as erosion and sediment production.	Very Effective

2.1 Well Site Construction

General Construction BMP: Well Sites	
Description	To the extent permitted by the geologic target, the locations selected for well sites, tank batteries, pits, and pumping stations, etc. should be planned so as to minimize long-term disruption of the surface resources. Design and construction techniques and other practices should be employed that would minimize surface disturbance and effects on other resources, and maintain reclamation potential of the site. The following guidelines can be used to assist in meeting these objectives and reduce the overall impacts from well sites and other construction areas.
Location	Well sites should be located on the most level location available that will accommodate the intended use. The site layout should be oriented to conform to the best topographic situation given the geologic target and any safety considerations. Steeply sloping locations, which require deep nearly vertical cuts, and steep fill slopes should be avoided or appropriately mitigated. The location of the well site should also be reviewed to determine its effects upon the location of the access road.
Construction	Construction procedures must conform to the approved surface use plan of operations. Generally, all surface soil materials shall be removed and stockpiled. The depth of the topsoil to be removed and stockpiled should be determined at the predrill inspection and should be located to avoid mixing with subsurface materials during construction and reclamation. Stockpiles should be located so wind and water erosion are minimized and reclamation potential is maximized. Fills should be compacted to minimize the chance of slope failure. If appropriate, terraces may be used on cut and fill slopes to reduce land impacts, such as length of slope, to prevent excessive water accumulation and erosion. If excess cut material exists after fill areas have been brought to grade, the excess material will be disposed of or stockpiled at approved locations. Snow and frozen soil material will not be used in the construction of fill areas and pits. Run off water from off site areas should be diverted away form well site by ditches, waterbars, or terraces above and below the cut slopes. The reserve pit should be located in cut material. If this is not possible, at least 50 percent of the reserve pit should be constructed below original ground level to prevent failure of the pit dike. Fill dikes should be properly compacted in lifts (i.e. by rubber-tired construction equipment, sheeps foot roller, etc.). The necessary degree of compaction depends on soil texture and moisture content. Pits improperly constructed on slopes may leak along the plane between the natural ground level and the fill. There is a significant potential for pit failure in these situations. When constructing impoundments by fill embankment, a keyway or core trench 10- to 12-feet wide should be excavated to a minimum depth of 2- or 3-feet below the original ground level. The core of the embankment is then constructed with water impervious-material. It may be necessary to line reserve pits to prevent contamination of ground water and soil. Bentonite, plastic, or other synthetic liners are most commonly used. In some environmentally sensitive areas, self-contained mud systems may be required with the drilling fluids, mud and cuttings being transported to approved offsite disposal areas.
Maintenance	Maintenance activities normally include: blading, surface replacement, spot repairs, slide removal, brush removal, litter cleanup, weed control, and snow removal.

2.2 Road and Access Way Construction

General Construction BMP: Roads and Access Ways	
Rationale	Special concerns such as steep slopes, erosion hazards, visual resources and other concerns require special consideration when roads and access ways are involved. In areas of high environmental sensitivity, special road location, design and construction techniques may be required. Early contact with appropriate surface owner/manager will provide specific requirements and identify any special access needs.
Location	Road location is the most critical stage for the engineering and environmental success of a road construction project. The surface and subsurface conditions of a road location largely determine the cost to survey, design, construct, and maintain a road.
Design	Design Requirements (Bureau of Land Management and Forest Service Local Roads): a. Design speed 15-25 miles per hour b. Travelway width – minimum 12 feet with turnouts. c. Recommended minimum horizontal curve radius, 100 feet. Where terrain will not allow 100-foot curve radii, curve widening may be necessary. d. Normal road gradients of more than 8 percent should be avoided except for pitch grades (i.e. 300 feet or less in length). If terrain conditions cause grades greater than 8 percent to be required, the SMA should be contacted to obtained approval prior to construction. e. Turnouts should be designed into all single lane roads (travelways of 12-14 feet). f. Drainage control shall be ensured over the entire road through the use of drainage dips, insloping, natural rolling topography, ditch turnouts, or culverts. Culverts, drainage crossings, and other controls should be designed for a 10-year frequency or greater storm, with an allowable head of one foot at the pipe inlet. g. Roadbed culverts should be used to drain inside road ditches when drainage dips are not feasible. h. Vehicle tracking pads consisting of crushed rock should be utilized at all necessary entrance/exit points for the site. i. Road design should consider the potential for occasional access of oversized oilfield vehicles.
Construction	a. Construction (Bureau of Land Management and Forest Service Local Roads): b. Clearing and grubbing will normally be required on all sections of the road. Exceptions would be allowed in areas of sparse, non-woody vegetation. All clearing and grubbing should be confined to a specified clearing width, which is usually somewhat wider than the limits of actual construction (roadway). c. All soil material and fragmented rock removed in excavation should be used as part of the construction process. Excess cut material should not be wasted unless specified in an approved plan. d. Application of roadbed material should be avoided if the materials or the surface are frozen or too wet for satisfactory compaction. Equipment should be routed over the layers of roadbed material already in place to help avoid uneven compaction anywhere along the travel route. Borrow material should not be used until material from roadway excavation has been placed in the embankments, unless otherwise permitted. Borrow areas used by the operator must be approved prior to the start of excavation. Roadside ditches should conform to the slope, grade, and shape of the required cross-section without projections of roots, stumps, rocks, or similar debris. Side ditches should be excavated to a depth of one-foot minimum below finished road surface. Backslope on the road ditches should not be cut flatter than two to one. Drainage turnout spacing on these ditches should not exceed 500 feet; slopes greater than 5 percent would require closer spacing of turnout furrows (wing ditches or relief ditches).
Maintenance	Maintenance activities normally include: blading, surface replacement, dust abatement, spot repairs, slide removal, ditch cleaning, culvert cleaning, brush removal, litter cleanup, weed control, and snow removal.

2.3 Pipeline and Flowline Construction

General Construction BMP: Pipelines and Flowlines	
Rationale	Construction techniques and other practices should be employed during pipeline/flowline construction that would minimize surface disturbance and effects on other resources, and maintain reclamation potential of the site. The following guidelines can be used to assist in meeting these objectives and reduce the overall impacts from these construction activities.
Construction	Steep hillsides and watercourses should be avoided in the location of pipelines/flowlines. Flowline routes should take advantage of road locations wherever practicable to minimize surface disturbance. Blading of pipeline routes located on gentle topography should be limited to removal and smoothing of brush and surface irregularities, leaving most of the under story vegetation undisturbed. When clearing is necessary, the width disturbed should be kept to a minimum. Bladed materials should be placed back into the cleared route upon completion of construction. Cut and fills on pipelines should be made only where necessary. Surface soil material should be stockpiled to the side of the routes where cuts and fills or other surface disturbance occur during pipeline construction. Surface soil material should be segregated and should not be mixed or covered with subsurface material. After construction cut and fill slopes may need to be waterbarred or regraded to conform to the adjacent terrain. Trenches should be compacted during backfilling. Pipeline construction should not block, dam, or change the natural course of any drainage. Suspended pipelines should provide adequate clearance for runoff debris, wildlife, or livestock.
Maintenance	Maintenance activities normally include: Pipeline/flowline right-of-way maintenance to correct backfill settling and prevent erosion, spot repairs, slide removal, litter cleanup, and weed control.

2.4 Drainage and Drainage Structures

General Construction BMP: Drainage and Drainage Structures	
Rationale	The proper design and construction of structures for the drainage of water from or through the roadway often contributes the most to the long-term success of the structure and minimizes the maintenance and adverse environmental effects, such as erosion and sediment production.
Location and Design	The need for drainage structures can be minimized by proper road location. However, adequate drainage is essential for a stable road. A proper drainage system should be the best combination of various design elements, such as ditches, culverts, drainage dips, crown, in-slope or out-slope, low-water crossings, subsurface drains, and bridges. a. Surface Drainage. Surface drainage provides for the interception, collection, and removal of water from the surface of roads and slope areas. The design may need to allow for debris passage, mud flows, and water heavily laden with silt, sand, and gravel. b. Subsurface Road Drainage. Subsurface drainage is provided to intercept, collect, and remove groundwater that may flow into the base course and subgrade, lower high water tables, and drain locally saturated deposits or soils.
Types of Drainage Structures	Proper location and design can provide economical and efficient drainage in many cases. However, structural measures are often required to ensure proper and adequate drainage. Some of the most common structures are drainage dips, ditches, and culverts. a. Drainage Dips. The primary purpose of a drainage dip is to intercept and remove surface water from the traveled way and shoulders before the combination of water volume and velocity begins to erode the surface materials. Spacing of drainage dips depends upon local conditions such as soil material, grade, and topography. b. Ditches. The types of ditches normally used are: drainage, trap, interception, and outlet. Ditch grades should be no less than 0.5 percent to provide positive drainage and to avoid siltation. c. Road Crowning. Roads that use crowning and ditching are common and can be used with all road classes. This design provides good drainage of water from the surface of the road. Drainage of the inside ditch and sidehill runoff is essential if the traveled way is to be kept dry and passable during wet weather. Snow removal becomes a simple task for common road maintenance equipment. Because the roadbed is raised, wind often blows the snow off the travelway. d. Culverts. Culverts are used in two applications on oil and gas access roads; (1) in streams and gullies to allow normal drainage to flow under the traveled way, and (2) to drain inside road ditches. All culverts should be laid on natural ground or at the original elevation of any drainage crossed. Culverts should be placed on a 3 percent minimum grade; reverse camber is not allowed. The outlet of all culverts should extend at least one foot beyond the toe of any slope. Excavation, bedding, and backfilling of culverts should be conducted according to requirements of the surface owner/manager and good engineering practices. Some additional drainage structures, which may be employed, are ditch relief culverts, bridges & major culverts, low water crossings, and subdrainage systems.

3.0 EROSION CONTROL

These BMPs protect the soil before erosion occurs. They are primarily used around areas of construction to either limit the flows across the site, or limit the erosion in areas disturbed but not active.

SELECTION GUIDE:
BMPs FOR EROSION CONTROL

BMP Name	Primary Purpose	Rating
Interceptor Swale	Route flows around areas of disturbance	Very Effective
Diversion Dike	Route flows around areas of disturbance	Very Effective
Vegetation	Provide natural soil protection through seeding, hydro mulch or phasing	Very Effective
Mulching	Protect disturbed soil with a layer of hay	Very Effective

3.1 Interceptor Swale

Erosion Control BMP: Interceptor Swale	
Description	An interceptor swale is a small v-shaped or parabolic channel, which collects runoff and directs it to a desired location. It can either have a natural grass lining or, depending on slope and design velocity, a protective lining of erosion matting, stone or concrete.
Primary Use	The interceptor can either be used to direct sediment-laden flow from the disturbed areas into a controlled outlet or to direct 'clean' runoff around disturbed areas. Since the swale is easy to install during early grading operations, it can serve as the first line of defense in reducing runoff across disturbed areas. As a method of reducing runoff across the disturbed construction area, an interceptor swale reduces the requirement of structural measures to capture sediment from runoff downstream of the disturbed area. Runoff can be directed to a sediment basin or a protected inlet as opposed to long runs of silt fence, hay bales or other filtration methods. Based on site topography, swales can be effectively used in combination with diversion dikes.
Applications	Common applications for interceptor swales include roadway projects, site development projects with substantial offsite flow, and sites with large areas of disturbance. It can be used in conjunction with diversion dikes to intercept flows. Temporary swales can be used throughout the project to direct flows from staging areas, storage and fueling areas, and specific areas of construction. Note that runoff which crosses disturbed areas, or is directed in unstable swales, must be routed into a treatment BMP such as a sediment basin. Grass lined swales are an effective permanent stabilization technique. The grass effectively filters both sediment and other pollutants while reducing velocity.
Design Criteria	• Maximum depth of flow in the swale shall be 1.5 foot based on 2-year design storm peak flow. Positive overflow must be provided to accommodate larger storms. • Side slopes of the swale shall be 3:1 or flatter. • The minimum required channel stabilization for grades less than 2 percent and velocities less than 6 feet per second maybe grass, erosion control mats or mulching. For grades in excess of 2 percent or velocities exceeding 6 feet per second, stabilization in the form of high velocity erosion control mats, 3" layer of crushed stone or riprap is required. Velocities greater than 8 feet per second will require approval by the local jurisdiction and is discouraged. • Check dams can be used to reduce velocities in steep swales (See Appendix E, Section 3.7). • Interceptor swales must be designed for flow capacity based on Manning's Equation to insure a proper channel section. Alternate channel sections may be used when properly designed and accepted. • Consideration must be given to the possible outlet. • Swales must maintain positive grade to an acceptable outlet.
Limitations	Interceptor swales must be stabilized quickly upon excavation so as not to contribute to the erosion problem they are addressing. Swales may be unsuitable to the site conditions (too flat or steep). Limited flow capacity for temporary swales. For permanent, the 1.5-foot maximum depth can be increased as long as provisions for public safety are implemented.
Maintenance Requirements	Inspection must be made after each significant (0.5" or greater) rain event to locate and repair any damage to the channel or to clear debris or other obstructions so as not to diminish flow capacity. Damages from normal construction activities or storms such as tire ruts, or disturbance of stabilization of the swale, shall be repaired as soon as practical.

3.2 Diversion Dike

Erosion Control BMP: Diversion Dike	
Description	A diversion dike is a compacted soil mound, earthen berm, or waddle which redirects runoff to a desired location. The dike is typically stabilized with natural grass for low velocities or with stone or erosion control mats for higher velocities.
Primary Use	The diversion dike is normally used to intercept offsite flow upstream of the construction area and direct the flow around the disturbed soils. It can also be used down stream of the construction area to direct flow into a sediment reduction device such as a sediment basin or protected inlet. The diversion dike serves the same purpose and, based on the topography of the site, can be used in combination with an interceptor.
Applications	By intercepting runoff before it has a chance to cause erosion, diversion dikes are very effective in reducing erosion at a reasonable cost. They are applicable to a large variety of projects including site developments and linear projects such as roadways and pipeline construction. Diversion dikes are normally used as perimeter controls for construction sites with large amounts of offsite flow from neighboring properties. Used in combination with swales, the diversion dike can be quickly installed with a minimum of equipment and cost, using the swale excavation as the dike. No sediment removal technique is required prior to crossing disturbed areas if the dike is properly stabilized and the runoff is intercepted. Significant savings in structural controls can be realized by using diversion dikes to direct flow to a central area, such as a sediment basin or other sediment reduction structure if the runoff crosses disturbed areas.
Design Criteria	• The maximum contributing drainage area should be 10 acres or less depending on site conditions. • Maximum depth of flow at the dikes shall be 1 foot for 2 year design storm. • The maximum width of the flow at the dikes shall be 20 feet. • Side slopes of the diversion dikes shall be 3:1 or flatter. • Minimum width of the embankment at the top shall be 2 feet. • Minimum embankment height shall be 18 inches as measured from the toe of the slope on the upgrade side of the berm. • For velocities of less than 6 feet per second, the minimum stabilization for the dike and adjacent flow areas is grass, erosion control mats, or mulch. For velocities greater than 6 feet per second, stone stabilization or high velocity erosion control mats should be used. Velocities greater than 8 feet per second must be approved by the local jurisdiction. • The dikes shall remain in place until all disturbed areas, which are protected by the dike, are permanently stabilized unless other controls are put into place to protect the site. • Flow line at dike shall have a positive grade to drain to a controlled outlet.
Limitations	Compacted earth dikes require stabilization immediately upon placement so as not to contribute to the problem they are addressing. The diversion dike can be a hindrance to construction equipment moving on the site, therefore their locations must be carefully planned prior to installation.
Maintenance Requirements	Dikes must be inspected on a weekly basis and after each significant rainfall (> 0.5 in) to determine if silt is building up behind the dike, or if erosion is occurring on the face of the dike. Silt shall be removed in a timely manner. If erosion is occurring on the face of the dike, the slopes of the face shall either be stabilized through mulch or seeding or the slopes of the face shall be reduced.

3.3 Vegetation

Erosion Control BMP: Vegetation	
Description	Vegetation, as a Best Management Practice, is the sowing of annual grasses, small grains or legumes to provide interim and permanent vegetation stabilization for disturbed areas.
Primary Use	Vegetation is used as a temporary or permanent stabilization technique for areas disturbed by other structures. As a temporary control, vegetation is used to stabilize stockpiles and barren areas, which are inactive for long periods of time. As a permanent control, grass and other vegetation provide for good protection for the soil along with some filtering for overland runoff. Subjected to acceptable runoff velocities, vegetation can provide a good method of permanent storm water management as well as a visual amenity to the site. Other BMPs may be required to assist in the establishment of vegetation. These other techniques include erosion control matting, swales and dikes to direct flow around newly seeded areas and proper grading to limit runoff velocities during construction.
Applications	Vegetation techniques can and should apply to every construction project with few exceptions. Vegetation effectively reduces erosion in swales, stockpiles, berms, mild to medium slopes and along roadways. Vegetation strips can provide some protection when used as a perimeter control for utility and site development construction. In many cases, the initial cost of temporary seeding may be high for stockpiles or other barren areas subject to erosion yet inactive. This initial cost should be weighed with the amount of time the area is to remain inactive, since maintenance cost for vegetated areas is much less than most structural controls.
Design Criteria	Surface Preparation • Interim or final grading must be completed prior to seeding, minimizing all steep slopes. • Install all necessary erosion structures such as dikes, swales, diversions, etc., prior to seeding. • Groove or furrow slopes steeper than 3:1 on the contour line before seeding. • Provide 4 to 6 inches of topsoil over rock, gravel, or otherwise unsuitable soils. • Seedbed should be well pulverized, loose and uniform. Plant Selection, Fertilization and Seeding • Use only high quality, USDA certified seed. • Use an appropriate species or species mixture adapted to local climate, soil conditions and season according to the following table. Consult with the local office of the U.S. Soil Conservation Service (SCS) or Engineering Extension service as necessary for the selection of proper species and application technique in this area. • Seeding rate should be in accordance with local land use requirements. (See SWPPP, Table 1) • Fertilizer shall be applied according to the manufacturer's recommendation with proper spreader equipment. Typical application rate for 10-10-10 grade fertilizer is 700-1000 lb/acre. DO NOT OVER APPLY FERTILIZER. • If hydro seeding is used, do not mix seed and fertilizer more than 30 minutes before application. • Evenly apply seed using cyclone seeder, seed drill, or hydro seeder. • Provide adequate water to add in establishment of vegetation. • Use appropriate mulching techniques where necessary.
Limitations	Vegetation is not appropriate for areas subjected to heavy pedestrian or vehicular traffic. As a temporary technique, vegetation may be costly when compared to other techniques. Vegetation is not appropriate for rock, gravel or course grained soils unless 4 to 6 inches of topsoil is applied.
Maintenance Requirements	Protect newly seeded areas from excessive runoff and traffic until established. A watering and fertilizing schedule will be required as part of the SWPPP to assist in the establishment of the vegetation.

3.4 Mulching

Erosion Control BMP: Mulching	
Description	Mulching is the application of a layer of chopped straw, hay, or other material, which is spread uniformly over barren areas to reduce the effects of erosion form rainfall. Types of mulch include organic materials, straw, wood chips, bark or other fibers, decomposed granite, and gravel. Mulch also comes in prepackaged forms using straw, hay, or other materials with organic and inorganic binding systems.
Primary Use	Mulch is used to temporarily and/or permanently stabilize clear or freshly seeded areas. It protects the soil from erosion and moisture loss by leasing the effects of wind, water, and sunlight. It also decreases the velocity of sheet flow, thereby reducing the volume of sediment-laden water flow leaving the mulched area.
Applications	Mulch may be used on any construction-related disturbed area for surface protection including: • Freshly seeded or planted areas; • Areas at risk due to the time period being unsuitable for growing vegetation; or • Areas that are not conducive to seeding or planting.
Design Criteria	• Mulch may be used by itself or in combination with netting or other anchors to promote soil stabilization. • Several manufacturers provide organic mulch with an attached netting to simplify installation. Installation requirements should adhere to manufacturer's specifications and requirements. • Choice of mulch depends largely on slope, climate, and soil type in addition to availability of different materials. Straw and hay are the recommended choice due to their availability and biodegradability. • Mulch should be applied in an even and uniform manner where concentrated water flow is negligible. • For areas using straw mulch and having a slope greater than 3-5%, anchoring of the mulch is required.
Limitations	Mulches are subject to removal by wind or water under severe climatic conditions. Mulches lower the soil temperature, which may result in longer seed germination period.
Maintenance Requirements	Mulched areas must be inspected on a weekly basis, and after significant rainfall, for thin or bare spots caused by natural decomposition or weather related events. Mulch in high traffic areas should be replaced on a regular basis to maintain uniform protection.

4.0 SEDIMENT LOSS PREVENTION

Construction activities normally result in disturbance on the site due to grading operations, clearing, and other operations. Erosion will occur in these disturbed areas and BMPs must be used to contain the sediment from these disturbed areas. The following techniques reduce soil loss from the site by retaining the soil through sedimentation or filtration of the runoff.

SELECTION GUIDE:
BMPs FOR SEDIMENT LOSS PREVENTION

BMP Name	Primary Purpose	Rating
Silt Fence	Slow and filter runoff to retain sediment	Effective
Straw Bales	Slow and filter runoff to retain sediment	Effective
Check Dams	Provides minor detention and retention of sediment for small swales and concentrated flows	Effective
Sandbag Berm	Provide sedimentation and filtration for runoff under concentrated conditions in creeks, channels and drainage swales	Effective for severe applications

4.1 Silt Fence

Sediment Loss Prevention BMP: Silt Fence	
Description	A silt fence consists of geotextile fabric supported by poultry netting or other backing stretched between either wooden or metal posts with the lower edge of the fabric securely embedded in the soil. The fence is typically located downstream of disturbed areas to intercept runoff in the form of sheet flow. Silt fence provides both filtration and time for sedimentation to reduce sediment and it reduces the velocity of the runoff. Properly designed silt fence is economical since it can be relocated during construction and reused on other projects.
Primary Use	Silt fence is normally used as a perimeter control for downstream of disturbed areas. It is only feasible for non-concentrated, sheet flow conditions.
Applications	Silt fence is an economical means to treat overland, non-concentrated flows for all types of projects. Silt fences are used as perimeter control devices for both site developments and linear (roadway) type projects. They are most effective with coarse to silty soil types. Due to the potential of clogging, silt fence should not be used with clay soil types. In order to reduce the length of the silt fence, it can be placed adjacent to the downstream side of the construction activities.
Design Criteria	• Fences are to be constructed along a line of constant elevation (along a contour line), where possible. • Maximum slope adjacent to the fence is 1:1. • Maximum distance of flow to the silt fence shall be 200 feet. • Maximum concentrated flow to silt fence shall be 1 CFS, per 20 feet of fence. • If 50% or less of the soil, by weight, passes the U.S. Standard sieve No. 200, Select the Equivalent Opening Size (EOS) to retain 85% of the soil. • Maximum EOS shall be 70 (#70 sieve). • Minimum EOS shall be 100 (#100 sieve). • If 85% or more of the soil, by weight, passes the U.S. Standard sieve No. 200, silt fences shall not be used due to clogging. • Sufficient room for the operation of sediment removal equipment shall be provided between the silt fence and other obstructions in order to properly maintain the fence. • The ends of the fence shall be turned upstream to prevent bypass of storm water.
Limitations	Minor ponding will occur at the upstream side of the silt fence resulting in minor localized flooding. Fences which are constructed in swales or low areas subject to concentrated flow may be overtopped resulting in failure of the filter fence. Silt fences subject to areas of concentrated flow (waterways with flows > 1 cfs) are not acceptable. Silt fence can interfere with construction operations; therefore planning of access routes onto the site is critical. Silt fence can fail structurally under heavy storm flows, creating maintenance problems and reducing the effectiveness of the system.
Maintenance Requirements	Inspections should be made on a regular basis, especially after a large storm event. If the fabric becomes clogged, it should be cleaned or if necessary, replaced. Sediment should be removed when it reaches approximately one-half the height of the fence.

4.2 Straw Bale Dike

Sediment Loss Prevention BMP: Straw Bale Dike	
Description	A straw bale dike is a temporary barrier constructed of straw bales anchored with wood posts, which is used to intercept sediment-laden runoff generated by small-disturbed areas. The hay bales can serve as both a filtration device and a dam/dike device to treat and redirect flow. Bales can consist of hay or straw in which straw is defined as best quality straw from wheat, oats or barley, free of weed and grass seed and hay is defined as straw, which includes weed and grass seed.
Primary Use	A straw bale dike is used to trap sediment-laden storm runoff from small drainage areas with relatively level grades, allowing for reduction of velocity thereby causing sediment to settle out.
Applications	Straw bale dikes are used to treat flow after it leaves a disturbed area on a relatively small (<acre) site. Due to the limited life of the hay bale, it is cost effective for small projects of a short duration. The limited weight and strength of the hay bales makes it suitable for small, flat (<2 percent slope) contributing drainage areas. Due to the problems with the straw degradation and the lack of uniform quality in hay bales, their use is discouraged except for small residential applications. Straw bales can also be used as check dams (See Appendix A, Section 3.2) for small watercourses such as interceptor swales and borrow ditches. Due to the problems in securely anchoring the bales, only small watercourses can effectively use hay bale check dams.
Design Criteria	• Straw bale dikes are to be constructed along a line of constant elevation (along a contour line). • Straw bale dikes are suitable only for treating sheet flows across grades of 2% or flatter. • Maximum contributing drainage area shall be 0.25 acre per 100 linear feet of dike. • Maximum distance of flow to dike shall be 100 feet. • Dimensions for individual bales shall be 30 inches minimum length, 18 inches minimum height, 24 inches minimum width and shall weigh no less than 50 pounds when dry. • Each straw bale shall be placed into an excavated trench having a depth of 4 inches and a width just wide enough to accommodate the bales themselves. • Straw bales shall be installed in such a way that there is no space between bales to allow for any kind of seepage. • Individual bales should be held in place by no less than two wood or steel stakes driven a minimum distance of 6 inches into undisturbed ground, with the first stake driven at an angle toward the previously installed bale. • The ends of the dike shall be turned upgrade to prevent bypass of storm water. • Place bales on sides such that bindings are not buried.
Limitations	Due to a short effective life caused by biological decomposition, straw bales must be replaced after a period of no more than 3 months. During the wet and warm seasons, however, they must be replaced more frequently as is determined by periodic inspections, for structural integrity. Straw bale dikes are not recommended for use with concentrated flows of any kind except for small flows in which they can service as a check dam. The effectiveness of straw bales in reducing sediment is very limited. Improperly maintained, straw bales can be a negative impact on the water quality of the runoff.
Maintenance Requirements	Straw bales shall be replaced if there are signs of degradation, such as straw located down stream from the bales, structural deficiencies due to rotting straw in the bale, or other signs of deterioration. Sediment should be removed from behind the bales when it reaches a depth of approximately 6 inches. If the bales become clogged, they should be replaced immediately.

4.3 Check Dams

Sediment Loss Prevention BMP: Check Dams	
Description	Check dams are small barriers consisting of straw bales, rock, or earth berms placed across a drainage swale or ditch. They reduce the velocity of small concentrated flows, provided a limited barrier for sediment and help disperse concentrated flows, reducing potential erosion.
Primary Use	Check dams are used for long drainage swales or ditches in which permanent vegetation may not be established and erosive velocities are present. They are typically used in conjunction with other techniques such as inlet protection, riprap, or other sediment reduction techniques. Check dams provide limited treatment. They are more useful in reducing flow to acceptable levels for other techniques.
Applications	Check dams are typically used early in construction in swales for long linear projects such as roadways. They can also be used in short swales with a steep slope to reduce unacceptable velocities.
Design Criteria	• Check dams should be placed at a distance and height to allow small pools to form between each one. Typically, dam height should be between 18" and 36". Dams should be spaced such that the top of the downstream dam should be at the same elevation as the toe of the upstream dam. • See design criteria for straw bales, sand bag berms, etc. for specific design criteria. Maximum allowable flow shall be based on the specific technique utilized and the velocity of flow. • Major flows (greater than 2 year design storm) must pass the check dam without causing excessive upstream flooding. • Check dams should be used in conjunction with other sediment reduction techniques prior to releasing flow offsite.
Limitations	Minor ponding will occur upstream of the check dams. For heavy flows or high velocity flows, extensive maintenance or replacement of the dams will be required. Check dams are not a total treatment technique.
Maintenance Requirements	Maintenance of the dams should adhere to the maintenance requirements of the management practice used for the dam.

4.4 Sandbag Berm

Erosion Control BMP: Sandbag Berm	
Description	Sandbag berms consist of stacked sandbags installed across a watercourse to direct flow downstream of disturbed areas. There are overflow pipes located in the top of the berm to allow controlled outflow of water after sedimentation has occurred.
Primary Use	A sandbag berm is a temporary sediment control method that addresses the problem of construction in creeks, channels and other watercourses that carry a constant flow and is subjected to high, concentrated flows. A sandbag berm can also be used to create a small sedimentation pond prior to the completion of a permanent detention basin. Sandbag berms can be used as check dams to temporary swales or borrow ditches. Sandbag berms are not suitable for typical perimeter controls where sheet flow is prevalent.
Applications	During utility or any type of construction in channels or stream beds, sandbag berms can be used as check dams across channels or stream beds, sandbag berms can be used as check dams across channels, serve as a barrier for utility trenches or even provide a temporary channel crossing for construction equipment without seriously affecting stream conditions. Sandbag berms can also be installed parallel to the road, providing a corridor of sediment control similar to that provided by a silt fence or hay bales, with the exception that a sandbag dike is capable of controlling much higher flows and is much more durable. For site construction sandbag berms can be used to divert or direct flow or create a temporary sediment basin with the added dimension of being able to be moved to accommodate changes in construction much more easily than compacted earth berms.
Design Criteria	• Dikes are to be constructed along level contours for use as perimeter control devices. • Maximum flow through rate shall be 0.1 CFS per square foot of berm surface. • Minimum height shall be 18 inches. • Minimum width of the berm shall be 18 inches at the top and 48 inches measured at the bottom. • Maximum side berms shall be 2:1. • Sandbags shall consist of polypropylene, polyethylene or polyamide woven fabric with a minimum unit weight of 4 ounces per square yard, a mullen burst strength of 300 psi minimum and ultraviolet stability exceeding 70 percent, and shall be filled with coarse sand or pea gravel. • 4” diameter SDR-35 or greater PVC pipe segments approximately 24 inches in length shall be used immediately below the top layer of sandbags to allow for overflow of the berm. • For severe velocities or high flows, woven mesh wire can be used to maintain the integrity of the berm. • Sufficient room for the operation of sediment removal equipment shall be provided between the berm and other obstructions in order to properly remove sediment. • The ends of the berm shall be turned upgrade or shall tie into natural grades to prevent bypass of storm water.
Limitations	• Sandbag berms are a costly, labor-intensive technique, which is suitable only for areas subjected to high concentrated flows. The permeability of the berms makes it unsuitable for low flow, perimeter conditions. • Ponding will occur directly upstream from the berm creating the possibility of a flooding concern, which should be considered prior to its placement. • For sandbag berms located in high flow areas such as creeks, the potential for berm damage during high flow increases the requirement for maintenance.
Maintenance Requirements	Inspections should be made on a daily basis and after each rain event. The sandbags shall be reshaped or replaced as needed during the inspection. Silt should be removed when it reaches a depth of six (6) inches. In addition, regular inspections should be made on the PVC pipe segments to assure clear flow.

5.0 WASTE MANAGEMENT

These techniques will be used on the majority of construction projects due to their general application of reducing waste from construction activities. They form the basis of general housekeeping procedures, which should be followed during construction.

SELECTION GUIDE:
BMPs FOR WASTE MANAGEMENT

BMP Name	Primary Purpose	Rating
Solid Waste Management	Techniques for management of paper, packaging, general building materials, etc.	Very Effective
Hazardous Waste Management	Management of paints, chemicals, fertilizer, oil and grease, etc.	Very Effective

5.1 Solid Waste Management

Waste Management BMP: Solid Waste Management	
Description	Large volumes of solid waste are often generated at construction site including: packaging, pallets, wood waste, concrete waste, soil, electrical wiring, cuttings, and a variety of other materials. The solid waste management practice lists techniques to minimize the potential of storm water contamination from solid waste through appropriate storage and disposal practices.
Primary Use	These practices should be part of all construction practices. By limiting the trash and debris on site, storm water quality is improved along with reduced clean up requirements at the completion of the project.
Applications	The solid waste management practice for construction sites is based on proper storage and disposal practices by construction workers and supervisors. Key elements of the program are education and modification of improper disposal habits. Cooperation and vigilance is required on the part of supervisors and workers to ensure that the recommendations and procedures are followed. Following are lists describing the targeted materials and recommended procedures: *Targeted Solid Waste Materials* • Paper and cardboard containers • Plastic packaging • Styrofoam packing and forms • Insulation materials (non-hazardous) • Wood pallets • Wood cuttings • Pipe and electrical cuttings • Concrete, brick, and mortar waste • Shingle cuttings and waste • Roofing tar • Steel (cuttings, nails, rust residue) • Gypsum board cuttings and waste • Sheathing cuttings and waste • Miscellaneous cutting and waste • Food waste • Demolition waste
Design Criteria	*Storage Procedures* • Wherever possible, minimize production of solid waste materials. • Designate a foreman or supervisor to oversee and enforce proper solid waste procedures. • Instruct construction workers in proper solid waste procedures. • Segregate potentially hazardous waste from non-hazardous construction site debris. • Keep solid waste materials under cover in either a closed dumpster or other enclosed trash container that limits contact with rain and runoff. • Store waste material away from drainage ditches, swales and catch basins. • Do not allow trash containers to overflow. • Do not allow waste materials to accumulate on the ground. • Prohibit littering by workers and visitors. • Police site daily for litter and debris. • Enforce solid waste handling and storage procedures. *Disposal Procedures* • If feasible, segregate recyclable wastes from non-recyclable waste materials and dispose of properly . • General construction debris may be hauled to a licensed construction debris landfill (typically less expensive than sanitary a landfill). • Use waste facilities approved by local jurisdiction. • Runoff which comes into contact with unprotected waste shall be directed into structural treatment such as silt fence to remove debris.

Waste Management BMP: Solid Waste Management, Cont'd	
Design Criteria, Cont'd	*Education* • Educate all workers on solid waste storage and disposal procedures. • Instruct workers in identification of solid waste and hazardous waste. • Have a regular meeting to discuss and reinforce disposal procedures (incorporate in regular safety seminars). • Clearly mark on all solid waste containers which materials are acceptable. Quality Control • Foreman and/or construction supervisor shall monitor on-site solid waste storage and disposal procedures. • Displine workers who repeatedly violate procedures. *Requirements* • Job-site waste handling and disposal education and awareness program. • Commitment by management to implement and enforce Solid Waste Management Program. • Compliance by workers. • Sufficient and appropriate waste storage containers. • Timely removal of stored solid waste materials. • Possible modest cost impact for additional waste storage containers. • Small cost impact for training and monitoring. • Minimal overall cost impact.
Limitation	Only addresses non-hazardous solid waste. One part of a comprehensive construction site management program.

5.2 Hazardous Waste Management

Waste Management BMP: Hazardous Waste Management	
Description	The hazardous waste management BMP addresses the problem of storm water polluted with hazardous waste through spills or other forms of contact. The objective of the Management Program is to minimize the potential of stormwater contamination from common construction site hazardous wastes through appropriate recognition, handling, storage and disposal practices. It is not the intent of this Management Program to supercede or replace normal site assessment and remediation procedures. Significant spills and/or contamination warrant immediate response by trained professionals. Suspected job-site contamination should be immediately reported to regulatory authorities and protective actions taken. The General Permit requires reporting of significant spills to the National Response Center (NRC) at (800) 424-8802.
Primary Use	These management practices along with applicable OSHA and EPA guidelines should be incorporated at all construction sites, which use or generate hazardous wastes. Many wastes such as fuel, oil, grease, fertilizer and pesticide are present at most construction sites.
Installation, Application, and Disposal Criteria	The hazardous waste management techniques presented here are based on proper recognition, handling, and disposal practices by construction workers and supervisors. Key elements of the management program are education, proper disposal practices, as well as provisions for safe storage and disposal. Following are lists describing the targeted materials and recommended procedures: Targeted Hazardous Waste Materials • Paints • Solvents • Stains • Wood Preservatives • Cutting oils • Greases • Roofing tar • Pesticides • Fuels & lube oils • Lead based paints (Demolition) Storage Procedures • Wherever possible, minimize use of hazardous materials. • Minimize generation of hazardous waste from non-hazardous construction site debris. • Segregate potentially hazardous waste from non-hazardous construction site debris. • Designate a foreman or supervisor to oversee hazardous materials handling procedures. • Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover. • Store waste materials away from drainage ditches, swales and catch basins. • Use containment berms in fueling and maintenance areas and where the potential for spills is high. • Ensure that adequate hazardous waste storage volume is available. • Ensure that hazardous waste collection containers are conveniently located. • Do not allow potentially hazardous waste materials to accumulate on the ground. • Enforce hazardous waste handling and disposal procedures. • Clearly mark on all hazardous waste containers which materials are acceptable for container. Disposal Procedures • Regularly schedule hazardous waste removal to minimize on-site storage. • Use only reputable, licensed hazardous waste haulers.

Waste Management BMP: Hazardous Waste Management, Cont'd	
Installation, Application, and Disposal Criteria, Cont'd	Education • Instruct workers in identification of hazardous waste. • Educate workers of potential dangers to humans and the environment from hazardous wastes. • Instruct workers on safety procedures for common construction site hazardous wastes. • Educate all workers on hazardous waste storage and disposal procedures. • Have regular meetings to discuss and reinforce identification, handling and disposal procedures (incorporate in regular safety seminars). • Establish a continuing education program to indoctrinate new employees. Quality Assurance • Foreman and/or construction supervisor shall monitor on-site hazardous waste storage and disposal procedures. • Educate and if necessary, discipline workers who violate procedures. • Ensure that the hazardous waste disposal contractor is reputable and licensed. Requirements • Job-site hazardous waste handling and disposal education and awareness program. • Commitment by management to implement hazardous waste management practices. • Compliance by workers. • Sufficient and appropriate hazardous waste storage containers. • Timely removal of stored hazardous waste material. Costs • Possible modest cost impact for additional hazardous storage containers. • Small cost impact for training and monitoring. • Potential cost impact for hazardous waste collection and disposal by licensed hauler – actual cost depends on type of material and volume.
Limitations	This practice is not intended to address site-assessments and pre-existing contamination. Major contamination, large spills and other serious hazardous waste incidents require immediate response from specialists. Demolition activities and potential pre-existing materials, such as asbestos, are not addressed by this program. Site specific information on plans is necessary. Contaminated soils are not addressed. One part of a comprehensive construction site waste management program.