APPENDIX G

EROSION AND SEDIMENT CONTROL PLAN

EXECUTIVE SUMMARY

The purpose of the Erosion and Sediment Control Plan is to minimize the potential release of pollutants directly or indirectly into the receiving waters. To achieve this objective, the permittee(s) will be required to implement the policies and procedures presented in this Erosion and Sediment Control Plan including, but not limited to, the following:

- Implement and properly maintain all erosion and sediment controls presented in this Erosion and Sediment Control Plan
- Maintain a record of the dates when major grading activities occur, when construction activities temporarily or permanently cease on a portion of the Site, and when final stabilization measures are implemented (a copy of the Record of Temporary/Permanent Ceasing of Construction Activities sheet is provided in Attachment G-1)
- Conduct regular inspections of the erosion and sediment controls. These inspections must occur at least once every 7 calendar days and within 24 hours of the end of a storm that had a rainfall accumulation of 0.5 inches or greater (a copy of the Inspection Report sheet is provided in Attachment G-2)
- Based on the outcome of the inspections, implement required repairs or modifications to the control(s) within 7 calendar days following the inspection. Modifications specific to the Project design must be approved by Atkemix Ten or its authorized representative prior to implementation by the Contractor and/or subcontractors
- This Erosion and Sediment Control Plan must be updated within 7 calendar days each time a significant modification to the construction activities or pollutant control practices occur. These modifications shall be recorded on the Record of Revision sheet located in Attachment G-3 and in additional appendix material, if required
- Maintain a copy of this Erosion and Sediment Control Plan on the Site throughout the duration of construction activities

This Erosion and Sediment Control Plan has been developed for the construction activities to occur at the Atkemix Ten Site - Interim Corrective Measure.

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CERTIFICATION PAGE FOR
EROSION AND SEDIMENT CONTROL PLAN
ATKEMIX TEN SITE- INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
LOUISVILLE, KENTUCKY

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

_____ _____

Signature of Contractor Representative Date

_____

Printed Name of Contractor Representative and Title

_____

Contracted Firm Name, Address, Telephone Number

1.0 SITE DESCRIPTION

1.1 SITE NAME

The area scheduled for construction is known as the South Landfill and Curtain Area (Site).

1.2 PROJECT LOCATION

The Atkemix Ten facility is located at 6100 Campground Road, Louisville, Kentucky, at a latitude of 35° 15' and a longitude of -85° 45'.

1.3 OWNER'S INFORMATION

Name:	Atkemix Ten Inc.
Address:	6100 Campground Road, Louisville, Kentucky
Representative:	Carol Dickerson
Telephone:	(302) 886-5123
Facsimile:	(302) 886-5933

1.4 CONTRACTOR'S INFORMATION

Name:	(to be completed following award of contract)
Address:	
Representative:	
Telephone:	
Facsimile:	

1.5 PROJECT DESCRIPTION/NATURE OF CONSTRUCTION ACTIVITY

The Project consists of implementing an Interim Corrective Measure at the Site. Earth moving activities will include land regrading, excavation of soil, backfilling with clean fill and topsoil, capping, road construction, and drainage swale construction.

1.6 SEQUENCE OF CONSTRUCTION ACTIVITIES

The anticipated sequence of construction activities which will disturb significant amounts of soil is as follows:

- Clear Areas 1, 2, 3a, 3c, 4, 5, and 6 and prepare the Site for excavation
- Install stabilized construction entrance
- Excavating, backfilling, and grading activities
- Construct engineered cap
- Road reconstruction through Areas 1, 2, 3, and 5
- Final Site restoration

1.7 ESTIMATE OF TOTAL CONSTRUCTION SITE AREA AND DISTURBED AREA

The Atkemix Ten facility is approximately 207 acres in total of which approximately 2.3 acres will be disturbed by construction activities.

1.8 ESTIMATE OF RUNOFF COEFFICIENT

The runoff coefficient is an estimate of the fraction of total rainfall that will appear as runoff. The Site is currently and will remain as open grassland which has a runoff coefficient of 0.3 (indicating that approximately 30 percent of all rainfall will run off the Site). (Source: *Stormwater Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA Document No. EPA 832-R--92-005, Typical "C" Value runoff-coefficients.)

1.9 SOIL TYPES, TOPOGRAPHY, AND CLIMATE

1.9.1 SOILS

The soils present at the Site are typically well graded gravel, coarse sand, and silt.

1.9.2 TOPOGRAPHY

A portion of the Site is within the 100-year floodplain of the Ohio River. The southeast portion of the Site drains eastwards into an existing ditch, which at first drains southwards and then westwards towards the Ohio River. The rest of the Site drains westwards towards the Ohio River.

1.9.3 CLIMATE

Monthly precipitation in this region varies from 4.7 inches in March to 2.7 inches in October with an average annual rainfall of 44.4 inches. The maximum and minimum average daily temperatures are 87°F in July and 23°F in January, respectively. (Source: www.weather.com/weather/climatology/USKY1096.)

1.10 FACILITY AND PROJECT AREA MAPS

The following maps and drawings are shown in the report:

- Figure 1 - Site Location Map
- Drawing C-03 - Soil Erosion and Sediment Control Plan
- Drawing C-04 - Soil Erosion and Sediment Control Plan Details

1.11 CONSTRUCTION AND WASTE MATERIALS TO BE STORED ON SITE

The following construction materials will be staged or stored on Site at various points during performance of the Works:

- Construction fill storage and staging areas
- Road base
- Very Flexible Polyethylene (VFPE) cap liner
- Geocomposite drainage net

The following waste materials will be stored temporarily on Site prior to appropriate disposal:

- Excess/waste plastic VFPE
- Packaging material
- Excess geocomposite drainage net
- Litter

1.12 RECEIVING WATERS

The Ohio River is the ultimate receiving water for the Site.

2.0 MEASURES AND CONTROLS

2.1 PERFORMANCE STANDARDS

Erosion and sediment controls have been designed to retain sediment on Site to the extent practicable.

All control measures will be properly selected, installed, and maintained in accordance with the manufacturer's specifications and good engineering practices. If periodic inspections or other information indicates a control has been used inappropriately or incorrectly, the control will be replaced or modified for Site-specific situations.

If sediment escapes the construction area, off-Site accumulations of sediment will be removed at a frequency sufficient to minimize off-Site impacts.

Sediment must be removed from sediment traps when design capacity has been reduced by 50 percent.

2.2 EROSION AND SEDIMENT CONTROLS

Erosion and sediment control practices can be divided into three broad categories: 1) soil stabilization, 2) structural controls, and 3) management practices. Each of these categories has temporary and permanent control measures to be considered. Soil stabilization and structural practices have been selected and designed in accordance with Metropolitan Sewer District's (MSD's) Design Manual, Standard Specifications, and Standard Drawings. Not all of the structural controls discussed in the BMP Manual will necessarily apply to this project. Management practices are construction management techniques which, if properly utilized, can minimize the need for physical controls and possibly reduce costs.

2.2.1 SOIL STABILIZATION

Where land disturbance is necessary, the following methods of soil stabilization will be implemented:

- Permanent seeding
- Vegetative buffer strips
- Preservation of trees

Sample design specifications and details for soil stabilization are provided in Attachment G-4.

Permanent vegetation will include native grasses, shrubs, and trees.

(Design Detail Source: Kentucky Construction Site BMP Planning and Technical Specifications Manual, Division of Water, Government of Kentucky).

2.2.2 STRUCTURAL CONTROLS

Erosion and sediment controls have been selected and designed according to the standards in the MSD Design Manual and construction drawings. Listed below are the structural controls to be used at the Site and a copy of construction specifications and details for these controls are provided in Attachment G-4:

- Silt fence
- Stabilized construction entrance
- Stone bags

(Design Detail Source: Kentucky Construction Site BMP Planning and Technical Specifications Manual, Division of Water, Government of Kentucky).

2.2.3 MANAGEMENT PRACTICES

The following management considerations will be employed in conjunction with the erosion and sediment controls described above:

- Sequence construction so that no area remains exposed for unnecessarily long periods of time (not longer than 30 days)
- Anticipate the Site conditions that will exist as the construction progresses toward the final product
- Have the materials on-hand to complete the work without delay
- Apply temporary stabilization immediately after grading
- Stage the construction, if possible, so that one area can be stabilized before another is disturbed

- Consider the time of year; be prepared for sudden thunderstorms
- Install erosion and sediment controls immediately
- Use straw mulch for grass seed, especially during poor germination periods
- Physically mark off limits of disturbance on the Site with tape, signs, or other methods, so that workers can see areas to be protected
- Carry out a regular maintenance schedule for erosion and sediment control practices
- Designate one individual responsible for implementing the erosion and sediment control plan. Make sure that all workers understand the provisions of the erosion and sediment control plan. Establish reporting procedures for problems identified by workers

2.3 STORMWATER MANAGEMENT CONTROLS

During the construction activities, stormwater will be managed through implementation the erosion and sediment controls presented in this Erosion and Sediment Control Plan. Permanent stormwater management controls are presented in the construction drawings.

2.4 OTHER CONTROLS

This section refers to additional controls related to construction activities at the Site.

2.4.1 SOLID WASTE DISPOSAL

No solid material, including building materials, is permitted to be discharged to surface waters. All solid waste materials, including disposable materials incidental to the construction activity, will be collected in containers or closed dumpsters. The collection containers will be emptied periodically and the collected material hauled to a landfill permitted by the state and/or appropriate local municipality to accept the waste for disposal.

A foreman or supervisor will oversee, enforce, and instruct construction workers on proper solid waste management procedures.

2.4.2 HAZARDOUS WASTE

Whenever possible, minimize the use of hazardous materials and generation of hazardous wastes. All hazardous waste materials must be disposed in the manner specified by federal, state, or local regulations or by the manufacturer.

Use contaminant berms in fueling and maintenance areas and where potential for spills is high.

A foreman or supervisor will be designated in writing to oversee, enforce, and instruct construction workers on proper hazardous waste procedures.

2.4.3 DUST CONTROL/OFF-SITE VEHICLE TRACKING

During construction, water trucks will be used, as needed, to reduce dust. After construction, the Site will be stabilized to reduce dust.

Construction traffic will enter and exit the Site at a Construction Entrance with a rock pad or equivalent device. The purpose of the rock pad is to minimize the amount of soil and mud that is tracked onto existing streets. If sediment escapes the construction area, off-Site accumulations of sediment will be removed at a frequency sufficient to minimize off-Site impacts.

2.4.4 SANITARY/SEPTIC

Contractors and subcontractors must comply with all state and local sanitary sewer, portable toilet, or septic system regulations. Sanitary facilities will be provided at the Site throughout construction activities. The sanitary facilities will be serviced regularly.

2.4.5 WATER SOURCE

Water used to establish and maintain grass, to control dust, and for other construction purposes will be obtained from the public water supply.

2.4.6 HAZARDOUS MATERIAL STORAGE

Chemicals, paints, solvents, fertilizers, and other toxic or hazardous materials will be stored in their original, or equivalent, containers (if original container is not re-sealable, products will be stored in clearly labeled, waterproof containers). Except during application, the containers will be kept in trucks or in bermed areas within covered storage facilities. Runoff containing such materials will collected, removed from the Site, and disposed of in accordance with the federal, state, and local regulations.

As required by federal, state, or local regulations, the contractor will have a Hazardous Materials Management Plan and/or Hazardous Materials Spill and Prevention Program in place. A foreman or supervisor will be designated in writing to oversee, enforce, and instruct construction workers on proper hazardous materials storage and handling procedures.

3.0 APPROVED STATE OR LOCAL PLANS

The following local regulations and/or guidelines should be followed during the construction activities:

- MSD Design Manual Standard Specifications and Standard Drawings
- Jefferson County and MSD Stormwater Control Ordinance

4.0 INSPECTION AND MAINTENANCE

The following items are to be integrated into the inspection and maintenance program.

4.1 INSPECTION SCHEDULE/REPORTING

All impacted areas, as well as all erosion and sediment control devices, will be inspected every 7 calendar days and within 24 hours after a rainfall of 0.5 inches or greater. Where sites have been finally or temporarily stabilized, or when runoff is unlikely due to winter conditions (e.g., site is covered with snow, ice, or frozen ground exists), such inspections shall be conducted at least once every month.

Inspections will be conducted and a written report be prepared by a designated and qualified person familiar with this Erosion and Sediment Control Plan and the Project. Atkemix Ten representatives, the Contractor, and subcontractors will conduct the inspections and document the findings. Inspection reports are not required for "walk throughs" in anticipation of storm events.

Inspection reports will include the scope of the inspection, the name(s) and qualifications of personnel making the inspection, the date of the inspection, observations relating to the implementation of the Erosion and Sediment Control Plan, and actions taken as a result of incidents of non-compliance noted during the inspection. The inspection reports will state whether the Site was in compliance or identify any incidents of non-compliance. A sample Inspection Report is included in Attachment G-2.

4.2 CONSTRUCTION ENTRANCE

Locations where vehicles exit the Site will be inspected for evidence of off-Site sediment tracking. The Contractor will be responsible for maintaining the Construction Entrance and other controls as described in this Erosion and Sediment Control Plan.

4.3 MATERIAL STORAGE INSPECTIONS

Inspectors will evaluate areas used for storage of materials that are exposed to precipitation to ensure that materials are protected and/or impounded so that pollutants cannot discharge from storage areas. Off-Site material storage areas used

solely by the project are considered to be part of the project and must be included in the erosion control plans and Site inspection reports.

4.4 SOIL STABILIZATION INSPECTIONS

Seeded areas will be inspected to confirm that a healthy stand of vegetation is maintained. The Site has achieved final soil stabilization once all areas are covered with pavement, or have a stand of vegetation with at least 70 percent of the background vegetation density. The density of 70 percent or greater must be maintained to be considered as stabilized. The Contractor will water, fertilize, and re-seed disturbed areas as needed to achieve this goal.

4.5 EROSION AND SEDIMENT CONTROL INSPECTIONS

All controls will be inspected at least once every 7 calendar days and following any storm event with a rainfall of 0.5 inches or greater. It is also recommended that "walk throughs" be conducted prior to storm events. The following is a list of inspection/maintenance practices that will be used for specific controls:

- Silt Fence: Remove buildup of sediment when the sediment reaches one-half the height of the fence
- Stabilized Construction Entrance: Periodically regrade and top dress with additional stones
- Vegetation: Protect newly seeded areas from excessive runoff and traffic until vegetation is established. Establish a watering and fertilizing schedule
- Good Housekeeping: Prevent litter, construction debris, and construction chemicals exposed to stormwater from becoming a pollutant source for stormwater discharges through screening of outfalls and daily pickup of litter

In the event that sediment escapes the Site, off-Site accumulations of sediment must be removed at a frequency sufficient to minimize adverse impacts.

4.6 MODIFICATIONS/REVISIONS TO EROSION AND SEDIMENT CONTROL PLAN

Based on inspection results, any necessary modifications to this Erosion and Sediment Control Plan will be implemented within 7 calendar days of the inspection. A

modification is necessary if a control measure or operational procedure does not provide adequate pollutant control. All revisions will be recorded on the Record of Revisions (included in Attachment G-3) within 7 calendar days of the inspection.

It is the responsibility of the Contractor to maintain effective pollutant discharge controls. Physical Site conditions or Contractor/subcontractor practices may make it necessary to install more controls than were originally planned. For example, localized concentrations of surface runoff or unusually steep areas might require additional silt barriers or other structural controls. Assessing the need for, and installing additional controls will be a continuing Contractor/subcontractor responsibility until final stabilization is achieved. The Contractor and subcontractors implementing this Erosion and Sediment Control Plan must remain alert to the need to periodically refine and update this Erosion and Sediment Control Plan in order to accomplish the intended goals.

5.0 NON-STORMWATER DISCHARGES

The following non-stormwater discharges are allowed as documented in this Erosion and Sediment Control Plan:

- Discharges from fire fighting activities
- Dust control runoff in accordance with permit conditions
- Spring water

6.0 PROCEDURAL REQUIREMENTS

During construction, Atkemix Ten, the Contractor, and subcontractors must comply with the following requirements:

- Atkemix and/or its designated representatives shall conduct inspections of the Site as described previously to assure compliance with this Erosion and Sediment Control Plan. Based on inspection results, this Erosion and Sediment Control Plan and BMPs may require modification by the Contractor and/or subcontractors, to assure the quality of stormwater or the identified non-stormwater discharges
- Modifications specific to the Project must be approved by Atkemix Ten or its designated representative prior to implementation by the Contractor and/or subcontractors. This Erosion and Sediment Control Plan may be amended at any time if it is found to inadequately address Site conditions
- This Erosion and Sediment Control Plan must be updated within 7 calendar days from the date of inspection each time there are significant modifications to construction activities. The Record of Revision is located in Attachment G-3
- Discharge of hazardous substances or oil into stormwater is subject to reporting requirements. In the event of a spill of a hazardous substance, the operator is required to notify the National Response Center (1-800-424-8802) to properly report the spill. In addition, Atkemix Ten or its designated representative shall submit a written description of the release (including the type and amount of material released, the date of the release, the circumstances of the release, and the steps to be taken to prevent future spills) to the EPA regional office. The Erosion and Sediment Control Plan must be revised within 14 calendar days after the release to reflect the release, stating the information above along with modifications to minimize the possibility of future occurrences. The Contractor and each subcontractor is responsible for complying with these reporting requirements

The Erosion and Sediment Control Plan must be submitted to MSD and the local municipality for review and approval.

ATTACHMENT G-1

RECORD OF TEMPORARY/PERMANENT CEASING OF CONSTRUCTION ACTIVITIES

EROSION AND SEDIMENT CONTROL PLAN
RECORD OF TEMPORARY/PERMANENT CEASING OF CONSTRUCTION ACTIVITIES
ATKEMIX TEN SITE – INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
LOUSIVILLE, KENTUCKY

Project Activity Area	*Date Activities Ceased*	*Temporary or Permanent*	*Date Soil Stabilization Implemented*	*Date Activities Resumed*

ATTACHMENT G-2

INSPECTION REPORT

EROSION AND SEDIMENT CONTROL PLAN - INSPECTION REPORT
ATKEMIX TEN SITE – INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
LOUSIVILLE, KENTUCKY

Inspector: _____ Date: _____

Site Conditions: _____

_____ Biweekly _____ Rain Event _____ Other

Measures and Controls	*In Conformance with Design Standards*	*Effective Pollutant Control Practice*
Construction Entrance	YES/NO	YES/NO
Silt Fence	YES/NO	YES/NO
Soil Stabilization	YES/NO	YES/NO
Stone Bags	YES/NO	YES/NO
Solid Waste Disposal	YES/NO	YES/NO
Equipment Fueling/Storage	YES/NO	YES/NO
Hazardous Waste	YES/NO	YES/NO
Sanitary/Septic	YES/NO	YES/NO
Off-Site Storage Erosion Controls	YES/NO	YES/NO
	YES/NO	YES/NO

VIOLATIONS NOTED: (Explain each "NO" circled above)

RECOMMENDED REMEDIAL ACTIONS:

COMMENTS

Based on the results of the inspection, necessary control modifications shall be implemented within 7 calendar days. These reports shall be kept on file as part of the Storm Water Pollution Prevention Plan for at least 3 years from the date that the Site is finally stabilized. A copy of the Erosion and Sediment Control Plan shall be kept at the Site at all times during construction.

CERTIFICATION STATEMENT:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted 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: _____ Tel. No.: _____

ATTACHMENT G-3

RECORD OF REVISIONS

EROSION AND SEDIMENT CONTROL PLAN -- RECORD OF REVISIONS
ATKEMIX TEN SITE - INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
LOUSIVILLE, KENTUCKY

Date	*Sections Modified*	*Description of Modification*	*Approval Signatures*

ATTACHMENT G-4

SOIL STABILIZATION AND STRUCTURAL CONTROL SPECIFICATIONS/DETAILS

Soil Stabilization

General Information

A variety of soil stabilization BMPs are available. All practices discussed in this section seek to vegetate or otherwise cover bare soil areas with grass, mulch, sod, or other material for the purpose of reducing raindrop erosion, muddy runoff, gullying, and dust problems. Note that for all sites with a disturbed area of one acre or more, Kentucky requires that bare areas which have not been actively worked for 14 consecutive days be temporarily or permanently stabilized if no work will occur in that area during the following 7 days. In practice, this means that seed, mulch, or other cover must be in place after 21 days if no clearing or grading has occurred in an area. Also, note that the use of erosion control blankets and turf reinforcement mats—which are specified for some bare areas, slopes, and ditches—are discussed in the Slope Protection section.

Hydraulically Applied Products

It should be noted that hydraulically applied (i.e., spray-on) seed and mulch products have undergone rapid development and improvement during the past 10 years, and now provide seed establishment and soil protection performance equivalent (or superior) to conventional seeding and mulching practices. The key benefits of hydraulically applied products are realized on large sites with steep (3H:1V to 1H:1V), long slopes or other areas where installation of erosion control blankets or turf reinforcement mats is difficult. A nearby source of water—or water tank—to mix the slurry is also necessary for large sites.

Typical hydraulic soil cover applications include a slurry-like mix of seed, fertilizer, and mulch. Also available for inclusion are other amendments such as tackifier and a variety of fibrous materials that dry to form a flexible "net" or crust that provides excellent protection for bare soil prior to seed germination.

Application equipment ranges from small hand-pulled polyethylene units with electric sprayers and tanks that hold up to 15 pounds of seed, fertilizer, and mulch to large towed or truck-mounted machines with tanks of 100–2,000 gallons. Mixing ratios will vary significantly by application, but in general a standard turf application for one acre will include 100-150 pounds of seed (or more, depending on seed variety and site conditions), 300-400 pounds of fertilizer, 140 pounds of binder, and 1,500–2,000 pounds of fiber mulch mixed with 4,000 or more gallons of water.

Soils on flatter areas are stabilized by temporary/permanent seeding and mulching. On slopes, tracking with a bulldozer or other equipment creates indentations perpendicular to runoff flow that effectively increase overall slope length and trap seed and sediment. Long, steep slopes typically require erosion control blankets or turf reinforcement mats (see Slope Protection section). Another key planning consideration for slopes is how to get upslope drainage down to the bottom, which is also covered in the Slope Protection section.

Permanent Seeding

Establishing grass through broadcast or hydro-seeding reduces erosion and sediment loss by more than 90 percent. Use mulch on short flatter slopes, and erosion control blankets or hydro-mulch on long steep slopes.

PS

Definition

Permanent seeding is the establishment of permanent, perennial vegetative cover – usually grass – on disturbed areas. Permanent seeding must be applied to disturbed areas within 14 days of reaching final grade if no temporary cover is applied.

Purpose

To maintain sheet flow, promote infiltration, and reduce problems associated with muddy runoff or dust from bare soil surfaces during construction; to reduce sediment runoff to downstream areas and improve the visual aesthetics of the construction area; and to provide permanent site stabilization in preparation for completion of the project.

Design Criteria

The area must be protected from excess runoff as necessary with upgradient diversion berms or ditches. Plant species must be selected on the basis of quick germination, growth, and time of year to be seeded. Fertilizer, lime, seedbed preparation, seed coverage, mulch, and irrigation must be applied as necessary to promote quick plant growth.

Construction Specifications

Site Preparation

Soil should be capable of supporting permanent vegetation and have at least 25 percent silt and clay to provide an adequate amount of moisture holding capacity. An excessive amount of porous sand will not consistently provide sufficient moisture for good growth regardless of other soil factors.

- Where compacted soils occur, they should be broken up sufficiently to create a favorable rooting depth of 6-8 inches.
- Stockpile topsoil to apply to sites that are otherwise unsuited for establishing vegetation. Approximately 400 cubic yards of topsoil per acre are needed for application depths of 3 inches (~9.3 cubic yards per 1,000 square feet).
- Grade as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application and anchoring, and maintenance. After the grading operation, spread topsoil where needed.
- Install the needed erosion control practices, such as diversion berms and ditches.

Seedbed Preparation

Spread lime (in lieu of a soil test recommendation) on acid soil and subsoil, at a rate of one ton per acre of agricultural ground limestone. For best results, test the soil – this can reduce the expense of unneeded lime and fertilizer and potential excess nutrient loss through runoff and leaching.

Fertilizer (in lieu of a soil test recommendation) should be applied at a rate of no more than 800 pounds per acre of 10-10-10 analysis. For best results, test the soil to determine fertilizer requirements. In limestone areas with streams and rivers impacted by high algae concentrations, use 10-0-10 fertilizer.

Work the lime and fertilizer into the soil with a disk harrow, springtooth harrow, or other suitable field equipment to a depth of 4 inches. On sloping land, the final operation must be on the contour.

Kentucky Transportation Cabinet Seed Mixes

Mixture Type	Seed Mixture
Mixture No. I	75% Kentucky 31 Tall Fescue 10% Red Top 5% White Dutch Clover 10% Ryegrass (perennial)
Mixture No. III	30% Kentucky 31 Tall Fescue 15% Red Top 15% Partridge Pea 20% Sericea Lespedeza 10% Sweet Clover – Yellow 10% Ryegrass

KYTC does not specify the seeding rate, but requires that sufficient seed be applied to ensure a "dense, uniform vegetative cover."

Recommended Seeding Rates and Other Information for Various Species and Seed Mixtures

Seed species & mixtures	Seeding rate/ acre	Per 1000 sq. ft	Soil pH	Other Information
Seed and seed mixtures for relatively flat or slightly sloping areas				
Perennial ryegrass	25 to 35 lbs	1 lb	5.6 to 7.0	Apply lime at 2 tons per acre if soil pH is below 5.5; use 400-800 lb fertilizer (10-10-10) on poor soils. Use wildflower mixes to save on mowing and watering costs.
+ tall fescue	15 to 30 lbs	1 lb	5.5 to 7.5	
Tall fescue	40 to 50 lbs	1.5 lb		
+ ladino or white clover	1 to 2 lbs	2 oz		
Steep slopes, banks, cuts, and other low maintenance areas (not mowed)				
Smooth bromegrass	25 to 35 lbs	1 lb	5.5 to 7.5	Track steep slopes with dozer up and down hill before seeding. Mulch slopes after seeding with 2 to 3 tons of straw or 6 tons of wood chips per acre. Use tackifier on mulch, disk it in, or punch in with sheep-foot roller. Disk or sheep-foot on the contour (across slope, on the level). For extremely steep slopes, use erosion control blankets after seeding. Use 20" spacing on blanket staples
+ red clover	10 to 20 lbs	0.5 lb		
Tall fescue	40 to 50 lbs	1 lb	5.5 to 7.5	
+ white or ladino clover	1 to 2 lbs	2 oz		
Orchardgrass	20 to 30 lbs	1 lb	5.6 to 7.0	
+ red clover	10 to 20 lbs	0.5 lb		
+ ladino clover	1 to 2 lbs	2 oz		
Crownvetch	10 to 12 lbs	0.25 lb	5.6 to 7.0	
+ tall fescue	20 to 30 lbs	1 lb		

Seed species & mixtures	Seeding rate/ acre	Per 1000 sq. ft	Soil pH	Other Information
Lawns and other high traffic or high maintenance areas (mowed)				
Bluegrass	105 to 140 lbs	3 lb	5.5 to 7.0	Use wildflower mixes to save on mowing and watering costs. Do not establish grassed lawns near streams or wetlands – leave a 15 to 30 ft buffer of natural vegetation.
Perennial ryegrass (turf)	45 to 60 lbs	2 lb	5.6 to 7.0	
+ bluegrass	79 to 90 lbs	2.5 lb		
Tall fescue (turf type)	130 to 170 lbs	4 lb	5.6 to 7.5	
+ bluegrass	20 to 30 lbs	1 lb		
Channels and other areas of concentrated water flows				
Perennial ryegrass	100 to 150 lbs	3 lb	5.6 to 7.0	Seed ditches and channels thickly. Do not use fertilizer near ditch or channel bottom. Use erosion control blankets or turf reinforcement mats when channel bottom slopes exceed 3 percent.
+ white or ladino clover	1 to 2 lbs	2 oz		
Kentucky bluegrass	20 lbs	0.5 lb	5.5 to 7.5	
+ smooth bromegrass	10 lbs	.25 lb		
+ switchgrass	3 lbs	2 oz		
+ timothy	4 lbs	.25 lb		
+ perennial ryegrass	10 lbs	.25 lb		
+ white or ladino clover	1 to 2 lbs	2 oz		Silt check dams are needed when channel slopes exceed 5 percent or when channels begin downcutting (gullying) on the bottom. Do not use silt fencing or straw bales as silt check dams in channels with slopes greater than 3 percent; use rock or brush instead.
Tall fescue	100 to 150 lbs	3 lb	5.5 to 7.5	
+ ladino or white clover	1 to 2 lbs	2 oz		
Tall fescue	100 to 150 lbs	3 lb	5.5 to 7.5	
+ perennial ryegrass	15 to 20 lbs	0.5 lb		
+ Kentucky bluegrass	15 to 20 lbs	0.5 lb		

Inspection and Maintenance

Water the soil until the grass is firmly established. This is especially needed when seedings are made late in the planting season, in abnormally dry and hot season, or on sites with steep slopes or other adverse conditions.

Inspect all seeded areas for failures and make necessary repairs, replacements, reseedings, and remulching within the planting season.

If stand is inadequate, (less than 85 percent groundcover) seed over the site and fertilize, using half of the seeding rate originally applied, and apply mulch.

If stand is more than 60 percent damaged, reestablish the stand. Follow the original seedbed preparation methods, seeding and mulching recommendations, and apply lime and fertilizer as needed according to a soil test.

Hydraulically applied seed, mulch, tackifier, and soil amendments (e.g., lime, fertilizer) offer excellent results at a reasonable price on large sites, especially those with long, steep slopes. Follow manufacturer's recommendation regarding materials mixing and application rates.

Seed ditches immediately after construction. Use mulch, netting, or erosion control blankets to protect newly seeded areas.

Mulching

Mulch can be hand-scattered or blown straw or other material used on temporary or final grades. Use chemical tackifiers, netting, or blankets if wind is a concern. Mulch alone can reduce erosive forces by more than 90 percent; with seeding, the reductions approach 99 percent.

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M

Definition

Mulching is the application of a protective layer of straw, cellulose, or other suitable material to the soil surface. Straw mulch and/or hydromulch are also used in conjunction with seeding and hydroseeding of critical areas for the establishment of temporary or permanent vegetation.

Purpose

To temporarily stabilize seeded or unseeded bare soil areas, to protect the soil surface from raindrop impact, to increase infiltration, to conserve moisture, to prevent soil compaction or crusting, and to decrease runoff. Mulching also fosters growth of vegetation by protecting the seeds from predators, reducing evaporation, and insulating the soil. Mulching with straw or fiber mulches is commonly used as a temporary measure to protect bare or disturbed soil areas that have not been seeded.

Design Criteria

Mulch can be applied to any site where soil has been disturbed and the protective vegetation has been removed. The most common use of a mulch is to provide temporary stabilization of soil, usually until permanent stabilizing vegetation is established. Where mulches are used to complement vegetation establishment, they should be designed to last as long as it takes to establish effective vegetative erosion control.

Where mulches are used as surface cover only (i.e. bark, wood chips, or straw mulch cover) the serviceable duration of the application and maintenance requirements, including augmentation or replication should be specified.

On steep slopes, greater than 2.5H:1V, or where the mulch is susceptible to movement by wind or water, the mulch material should be hydraulically applied or the straw mulch should be appropriately anchored. Hydraulic fiber mulches and/or tackifying agents are used effectively to bind the straw together and prevent displacement by wind or rain. Straw can also be covered by degradable netting or secured by crimping (see below).

NOTE: For steep slopes—especially long ones—specify erosion control blankets (see Section 3) or hydraulically applied mulches with sufficient tackifier to protect seedbed. Nets can be used with straw mulch if properly staked down.

Summary of Mulch Design and Application Considerations

Mulch product	Application rate	Benefits	Limitations
Straw or hay	1½ to 2½ tons per acre	Readily available and inexpensive; very effective in controlling erosion; can be applied on large sites via blower	May carry unwanted seeds; may need tackifier or anchoring, especially on steep slopes
Wood chips, bark, sawdust	5 to 8 tons per acre	Very low cost in some locations; chips effective on slopes up to 35 percent	High nitrogen demand when decomposing; may float away or blow away during rain storms
Rock	200 to 500 tons or more per acre	May be inexpensive and readily available in some localities; may be suitable for smaller sites	Inhibits plant growth; adds no nutrients to the soil; can be costly to apply on slopes and large sites; adds "hardened" look to slopes
Hydraulic mulches and soil binders	1½ to 2 tons per acre	Easily and rapidly applied with sprayer equipment; can include seed, fertilizer, flexible/fibrous mulches, and soil binders	May be too expensive for small or very remote sites; must dry for at least 24 hours before rainfall
Compost	2 to 3 tons per acre	Adds nutrients to the soil; readily available and inexpensive in some locations	Limited erosion control effectiveness; not suitable for steep slopes; may be expensive in some areas

Construction Specifications

Straw

Straw is an excellent mulch material. Because of its length and bulk, it is highly effective in reducing the impact of raindrops and in moderating the microclimate of the soil surface. Straw mulch can be applied by hand on small sites and blown on by machine on large sites. Straw blowers have a range of about 50 feet. Some commercial models advertise a range up to 85 feet and a capacity of 15 tons per hour.

- Mulch should not be applied more than 2 inches deep on seeded sites, unless it is incorporated into the soil by tracking, disking (crimping), or other 'punching in' techniques. If the straw is applied at rates higher than 3 tons/acre, the mulch may be too dense for the sunlight and seedlings to penetrate.

- Prior to mulching, install any needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, grass-lined channels and sediment basins.

- Obtain clean wheat, barley, oat, or rice straw in order to prevent the spread of noxious weeds. Avoid moldy, compacted straw because it tends to clump and is not distributed evenly.

- The straw must be evenly distributed by hand or machine to the desired depth of 2-4 inches and should cover the exposed area to a uniform depth. One bale (approximately 80 lbs) of straw covers about 1000 ft^2 adequately. The soil surface should be barely visible through the straw mulch. On steep or high wind sites, straw must be anchored to keep it from blowing away.

- For seeded sites, apply 1.5-2 tons per acre, 1-2 inches deep, covering 80% of the soil surface. For unseeded sites, use 2-3 tons per acre, apply 2-4 inches deep, covering 90% of the soil surface.

- Mulch must be anchored immediately to minimize loss by wind or water. Straw mulch is commonly anchored by crimping, tracking, disking, or punching into the soil; covering with a netting material; spraying with asphaltic or organic tackifier; or tacking with cellulose fiber mulch at a rate of 750 pounds per acre.

- On small sites where straw has been distributed by hand, it can be anchored by hand punching it into the soil every 1-2 feet with a dull, round-nosed shovel. A sharp shovel will merely cut the straw and not anchor it. A mulch anchoring tool is a tractor drawn implement designed to punch and anchor mulch into the top 2-8 inches of soil. This practice affords maximum erosion control but is limited to flatter slopes where equipment can operate safely. A set of disk harrows can be used for this purpose, if the disks straightened (not angled) so they cut the straw into the soil. Tracking is the process of cutting straw into the soil using a bulldozer or other equipment that runs on cleated tracks. Tracking is used primarily on slopes 3:1 or flatter where this type of equipment can safely operate. This is an effective way to crimp straw on fill slopes. Tracking equipment must operate up and down the slope so the cleat tracks are perpendicular to flow.

- Netting material made of biodegradable paper, plastic or cotton netting can be used to cover straw mulch. Netting should be specified judiciously since birds, snakes and other wildlife can get trapped in the nettings.

- Polymer tackifiers are generally applied at rates of 40-60 lbs/ac, however manufacturers recommendations vary. Organic tackifiers are generally applied at rates of 80-120 lbs/acre, however manufacturer's recommendations vary. Applications of liquid mulch binders should be heavier at edges, in valleys, and at crests of banks and other areas where the mulch may be moved by wind or water. All other areas must have a uniform application of the tackifier.

Wood Chips or Bark

Apply at a rate of 5 to 8 6 tons per acre.

The mulch should be evenly distributed across the soil surface to a depth of 2-3 inches.

If decomposition, soil building and re-vegetation are desired, increase the application rate of nitrogen fertilizer by 20 lbs of N/acre, to compensate for the temporary diversion (loss) of available N to the soil microbes.

Hydraulic Mulches

Hydraulic mulches can be made of recycled newsprint, magazines, wood or other wood/paper waste sources. This type of mulch is to be mixed in a hydraulic application machine (hydroseeder) and applied as a liquid slurry that contains the recommended rates of seed and fertilizer for the site. It can be specified with or without a tackifier.

Apply at rate of 1.5 to 2 tons per acre – mixed with seed and fertilizer at recommended rates – in order to achieve uniform, effective coverage.

Paper mulch used to tack and bind straw mulch can be specified at a lower rate, i.e., about 750 pounds per acre.

Hydraulic mulches from wood and paper fiber are combination mulches generally comprised of 70% wood fiber and 30% paper fiber, manufactured from lumber mill waste, virgin wood chips, recycled newsprint, office paper and other waste paper. The mulch is mixed in a hydraulic application machine (hydroseeder) and applied as a slurry in combination with the recommended seed and fertilizer. The mulch can be specified with or without a tackifier.

Wood, paper or combination fiber mulches are typically applied with a hydraulic applicator (hydroseeder) at a minimum rate of 1.5 tons/ac. A typical construction specification and application for this type of mulch is as follows:

- Moisture content (total weight basis) not to exceed 12% +/- 3%.

- Organic matter content (oven dry weight basis) is 98% minimum.

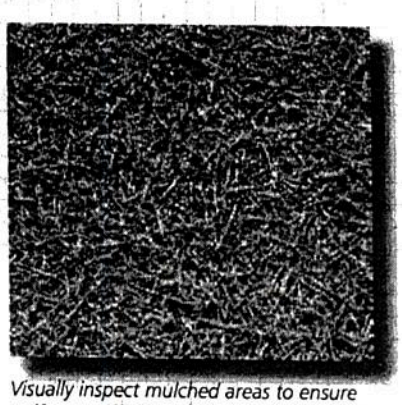
- Inorganic matter (ash) content (oven dried basis) 2% maximum.

- pH at 3% consistently in water should be 4.9.

- Fiber must be dyed to aid in visual metering during application. The dye must be biodegradable and must not inhibit plant growth.
- Water holding capacity (oven dried basis) minimum 1.0 gal/lb of fiber.
- The mulch must be mixed with seed and fertilizer as specified and applied at a rate recommended by the manufacturer in order to achieve uniform, effective coverage and provide adequate distribution of seed.

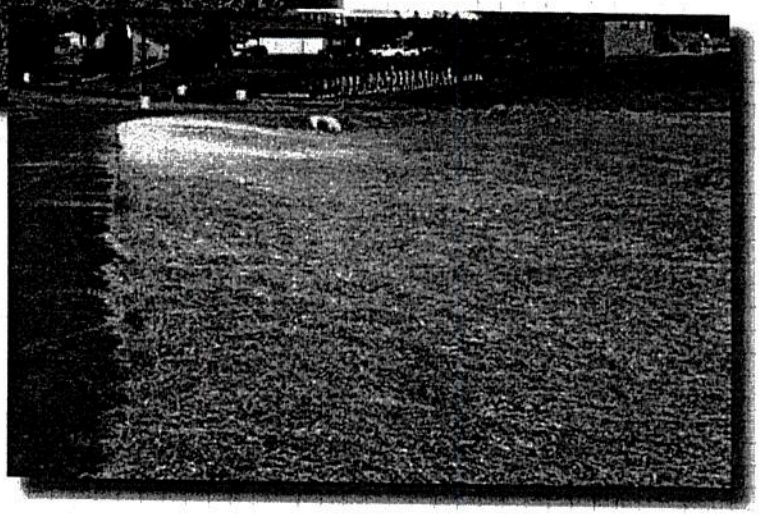
Inspection and Maintenance

Inspect weekly and repair/replace any bare areas promptly. If properly applied and anchored, little additional maintenance is required during the first few months. After high winds, or significant rainstorms, mulched areas should be checked for adequate cover and re-mulched if necessary. Mulch needs to last until vegetation develops to provide permanent erosion resistant cover. Straw mulch can last from 6 months to 3 years.



Visually inspect mulched areas to ensure uniform, sufficient coverage. Application must cover all bare areas, with less than five percent soil showing through mulch cover.

Good use of straw mulch and grass seed in relatively flat and fairly wide swale. For more concentrated flows, triple seed the ditch and use erosion control blankets.



Use netting to secure loose straw on steep or long slopes. Above: Good coverage with straw mulch. Mulch alone can reduce erosion by more than 90 percent. Apply temporary or permanent mulch as soon as final grade is established.

Sodding

Sod reduces erosion potential to near zero. Make sure surface is properly prepared with appropriate soil amendments; use fresh sod and keep well watered during first two weeks after application.

SO

Definition

Sod consists of rectangular strips of live turf grass held together by matted roots laced through an organic growing medium.

Purpose

To immediately establish a permanent turf grass cover over bare soil and improve visual aesthetics, during almost any time of year.

To prevent erosion and damage from sediment and runoff by stabilizing the soil surface, and to promote the infiltration of precipitation and reduction of stormwater runoff.

To reduce the production of dust and mud associated with bare soil surfaces.

To stabilize swales, ditches, and channels where concentrated flows will occur; and to protect areas around drop inlets from muddy inflows.

Design Criteria

- Sod should be machine-cut and contain ½ inch to 1 inch of soil, not including roots/shoots or thatch.
- Specify that sod will be installed within 36 hours of digging and removal from the field.
- Avoid planting when subject to frost heave or hot weather if irrigation is not available.
- Sod should not be used on slopes steeper than 2H:1V. If it is to be mowed, installation should be on slopes no greater than 3H:1V.

Construction Specifications

Cutting and Handling of Sod

The sod should consist of strips of live, vigorously growing grasses. The sod should be free of noxious and secondary noxious weeds and should be obtained from good, solid, thick-growing stands. The sod should be cut and transferred to the job in the largest continuous pieces that will hold together and that are practical to handle.

- The sod must be cut with smooth clean edges and square ends to facilitate laying and fitting. The sod must be cut to a uniform thickness of not less than three-fourth inch measured from the crown of the plants to the bottom of the sod strips for all grasses except bluegrass. Bluegrass sod must be cut to a uniform thickness of not less than one and one-half inches.

- The sod must be mowed to a height of not less than two inches and no more than four inches prior to cutting.
- The sod must be kept moist and covered during hauling and preparation for placement on the sod bed.

Site Preparation

Soils in areas to be sodded must be capable of supporting permanent vegetation and must consist of at least 25 percent silt and clay to provide an adequate amount of moisture holding capacity. An excessive amount of porous sand will not consistently provide sufficient moisture for the sod regardless of other soil factors.

- Compacted soils must be broken up sufficiently to create a favorable rooting depth of 6-8 inches.
- Stockpile topsoil to apply to sites that are otherwise unsuited for establishing vegetation.
- Grade as needed and feasible to permit the use of conventional equipment for the sod bed preparation. After the grading operation, spread topsoil where needed.

Sod Bed Preparation

Apply lime (in lieu of a soil test) on acid soil and subsoil at a rate of one ton per acre. The lime should be agricultural ground limestone or equivalent. For best results, conduct a soil test. This can reduce expense of unneeded lime and fertilizer and potential excess nutrient loss through runoff and leaching.

- Apply fertilizer (in lieu of a soil test) at 1,000 pounds per acre of 10-10-10 analysis. For best results, conduct a soil test.
- Work lime and fertilizer into the soil with a disk harrow, springtooth harrow, or other suitable field equipment to a depth of four inches.
- Prior to sodding, the soil surface must be cleared of all trash, debris, and stones larger than one and one-half inches in diameter, and of all roots, brush, wire, and other objects that would interfere with the placing of the sod.
- After the lime and fertilizer have been applied and just prior to the laying of the sod, the soil in the area to be sodded must be loosened to a depth of one inch. The soil must be thoroughly dampened immediately after the sod is laid if it is not already in a moist condition.

Placing of Sod

No sod must be placed when the temperature is below 32°F. No frozen sod must be placed nor must any sod be placed on frozen soil.

- Sod must be carefully placed and pressed together so it will be continuous without any voids between the pieces. Joints between the ends of strips must be staggered in a brick-like pattern. The edge of the sod at the outer edges of all gutters must be sufficiently deep so that the surface water will flow over onto the top of the sod.
- On gutter and channel sodding, the sod should be carefully placed on rows or strips at right angles to the centerline of the channel (i.e., at right angles to the direction of flow). On steep graded channels, each strip of sod must be staked with at least two stakes not more than 18 inches apart. The stakes must be wood and must be approximately 1/2" X 3/4" X 12". They must be driven flush with the top of the sod and with the flat side against the slope.
- On slopes 3:1, or steeper, and where drainage into a sod gutter or channel is one-half acre or larger, the sod must be rolled or tamped and then chicken wire, jute, or other

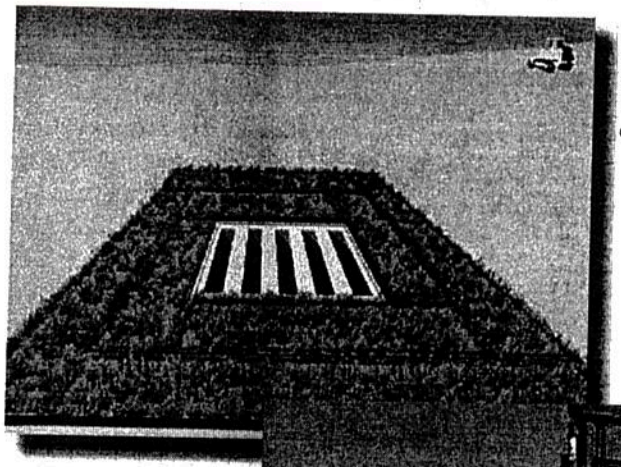
netting pegged over the sod for protection in the critical areas. The netting and sod must be staked with at least two stakes not more than 18 inches apart. The stakes must be wood arid be approximately 1/2" X 3/4" X 12". They must be driven with the flat side against the slope and on an angle toward the slope. The netting must be stapled on the side of each stake within two inches of the top of the stake. The stake should then be driven flush with the top of the sod.

- The sod must be tamped or rolled after placing and then watered. Watering must consist of a thorough soaking of the sod and of the sod bed to a depth of at least 4 inches. The sod should be maintained in a moist condition by watering for a period of 30 days.

Inspection and Maintenance

Inspect sod twice a week after installation to check on moisture conditions and grass viability. Irrigate sod immediately after installation and every few days afterwards if no significant rainfall occurs during the first two weeks. Soak area thoroughly to a depth of three inches during irrigation.

- Where sodding does not establish properly, the old sod should be removed and the area should be re-sodded as soon as possible. The cause of the failure should be identified and corrected as soon as possible.
- Once established, a regular maintenance program for fertilization (if needed) and mowing of grasses should be performed.



Use sod in ditches and around drop inlets for superior protection against scouring flows. Sod slows down concentrated flows and promotes filtration and settling of sediment-laden runoff.

Rolled sod should be moist, flexible, green, and fresh. For best results, install as soon as possible after final grade is established.

4.5 Slope Protection

General Information

Relatively flat areas—those with slopes of 2 percent or less—can be treated to a large extent through controlled clearing and grading, mulch, and temporary or permanent seed. Slopes greater than that, however, require more attention to sheet runoff volume and the management of areas where flows converge and are transported to downstream receiving waters. Sediment barriers, rolled erosion control products, and greater attention to downslope drainage are usually needed on slopes, especially those that are steep and long.

This section addresses erosion protection and sediment control approaches specifically for slopes. In general slopes that are long (50 feet or more), steep (5 percent plus), and composed of highly erodible (silty) soils require more protection that shorter, flatter slopes of less erodible soil. Slope protection approaches discussed below include erosion control blankets and turf reinforcement mats, which can also be used for ditch protection, surface roughening, slope drains, gabion structures, and cellular mats.

Approximate Slope Conversions

Approximate slope conversions (horizontal:vertical)		
Percent	*Slope Ratio*	*Degrees*
100%	1:1	45°
50%	2:1	27°
33%	3:1	18°
25%	4:1	14°
10%	10:1	6°

Slope Protection Basics

Protecting slopes from erosion requires several actions that must be taken together. No single approach will be successful, especially if the slope is steep or has highly erodible soils (see table). Use one or more of the following actions to reduce erosion on slopes:

Divert upland runoff—Install a berm or channel above the slope to divert upland rain runoff around the bare soil area or a stable ditch to move upland flows through the site without picking up additional sediment.

Control slope runoff—If slopes are broken up into benches or steps, runoff can be collected and diverted along berms or in channels to pipe or channel slope drains.

Till seedbed or condition the soil—Dozer tracks up and down slopes help hold soil in place. See the table below for information on how the condition of the soil surface (e.g., compacted, tracked) can increase or decrease erosion.

Seed and mulch—This is the best and cheapest protection by far. See temporary and permanent seeding Fact Sheets for details on seed types, application rates, and mulch, blanket, and mat products.

Silt fence or brush barrier—These should be installed at the toe of the slope, and every 75 to 125 feet apart on long slopes.

Retaining wall—Extremely steep slopes can be leveled out and shortened into two or more steps or benches by installing retaining walls of rock, brick, block, wood, logs, or other material. If rock layers are present along the slope, use these to establish firm benches in a stair-step pattern.

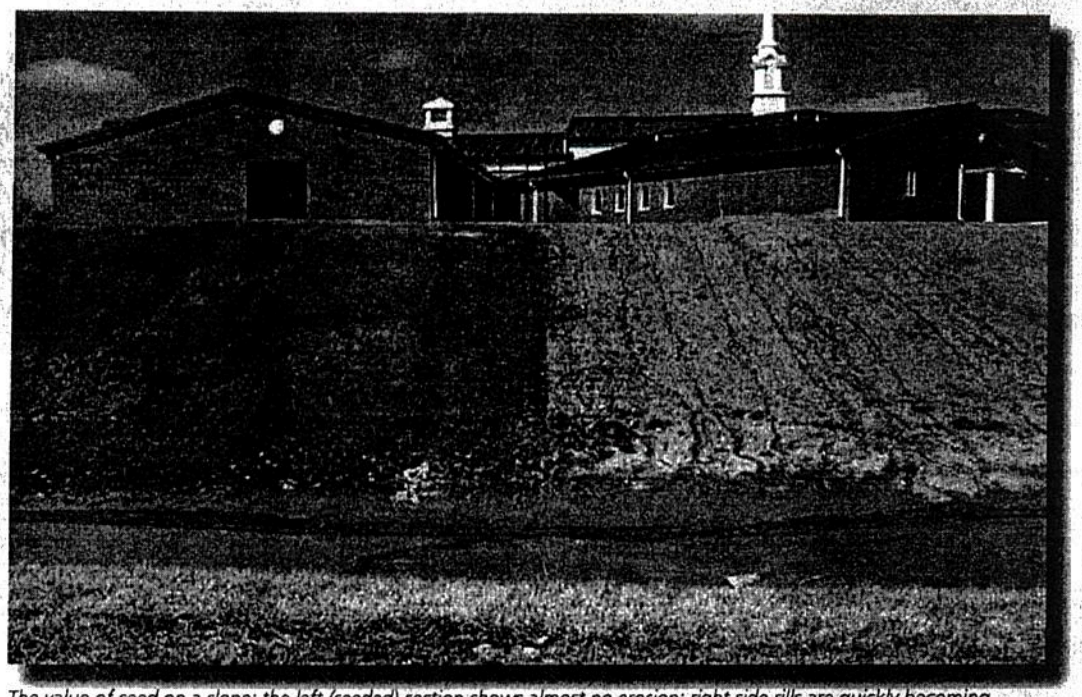
Blankets or armoring—Long slopes (greater than 100 feet) exceeding 3H:1V with highly erodible soils need to be protected with erosion control blankets or turf reinforcement mats. Rock mulch and lined downdrain channels might be needed on steep slopes to control gullying.

Soil Conditions vs. Erosion

Soil Conditions vs. Erosion	
If soil is:	***Erosion will be:***
Compacted and smooth	30 percent more
Tracks across slopes	20 percent more
Tracks up & down slopes	10 percent less
Rough and irregular	10 percent less
Rough & loose to 12" deep	20 percent less

Slope Angle and Soil Type vs. Erodibility

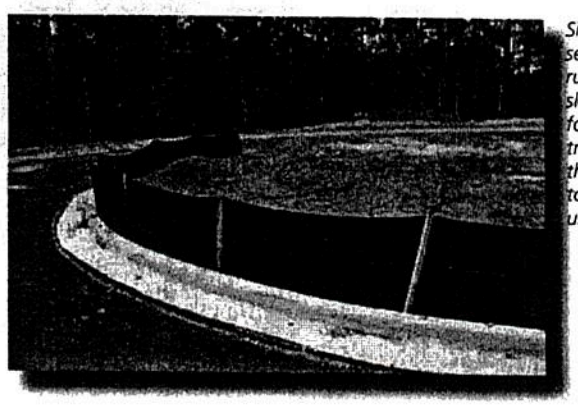
Slope angle	Erodibility	Soil type
50%	**Very high**	Silt
40%		Silty sand
30%		Clayey sand
20%		Organic soil
15%		Clays
10%		Silty gravel
5%		Sand
< 5%		Gravel
	Very Low	



The value of seed on a slope: the left (seeded) section shows almost no erosion; right side rills are quickly becoming gullies. Seed and mulch slopes as soon as final grade is established for best results. Bare areas must be seeded or mulched within 14 days if no work is planned during the next week.

4.5 **Slope Protection**

4.5.1 **Silt Fence**



Silt fencing is commonly used to pond, settle, and filter sediment from sheet runoff. Install at proper spacing on slopes; set back from slope toe to allow for maintenance. Make sure fencing is trenched in properly and stakes are on the downhill side. Inspect frequently to detect and address bypasses, undercutting, and overtopping.

SF

Definition

A silt fence is a temporary sediment barrier consisting of filter fabric entrenched into the soil and attached to supporting posts. Silt fences are downhill from bare soil areas and are installed with a trencher or by a slicing machine to prevent against common silt fence failures.

Purpose

Silt fences are common sediment control devices. Silt fencing should be installed where sediment-laden water can pond, thus allowing the sediment to fall out of suspension and separate from the runoff. Runoff will also *bleed through* the silt fence fabric, providing physical filtering for larger sediment particles. Reasons for the high failure rate of improperly designed (located) and installed silt fence include

- Improper placement on the site
- Allowing excessive drainage area to the silt fence structure
- Shallow trenches with little or no soil compaction
- Inadequate attachment to posts
- Failure to maintain the silt fence after installation
- Installing silt fence along property boundaries, producing *concentrated* runoff

Design Criteria

Silt fencing must be installed only where water can pond. Specify silt fencing downgradient from bare soil areas, installed on the contour if possible, with the ends turned up to prevent bypassing. Provide adequate setbacks from slope toe for routine maintenance and access. Silt fencing can be used where

- Non-concentrated sheet flow will occur
- Protection of adjacent property or nearby surface waters is required
- The size of the drainage area is no more than 1/4 acre per 100 linear feet of silt fence
- The maximum flow path length above the barrier is 100 feet for slopes less than 2 percent, and 50 feet for slopes up to 10 percent

- The maximum slope gradient above the barrier is 2H:1V
- Silt fencing can be used in flat, short swales (i.e., slope is less than 2 percent; length is less than 200 feet) that drain less than 2 acres, if silt fencing is spaced every 50 feet.
- Reinforced silt fence must be required when the contributing slope is longer than 100 feet and greater than 3 percent and the design life of the silt fence is greater than 6 months.

Silt Fence Spacing on Long Slopes

Land Slope	Max. Slope Distance
3% – 5%	100 ft.
5% – 10%	75 ft.
10% – 20%	50 ft.
20% – 50%	25 ft.

Silt fencing should not be used

- Around the perimeter of the construction site, unless J-hooks are used. Long continuous runs of silt fence will divert and concentrate sediment-laden runoff and almost certainly result in failure. A good general rule is to drain no more than 1/3 acre of disturbed area into each discrete J-hook;
- In ditches, channels, or streams. Silt fences cannot handle the volumes generated by concentrated channel flows. When installed across a concentrated flow path, undercutting or *end cutting* of the fence often occurs, or the fence is pushed over by the force of the flow.

Construction Specifications

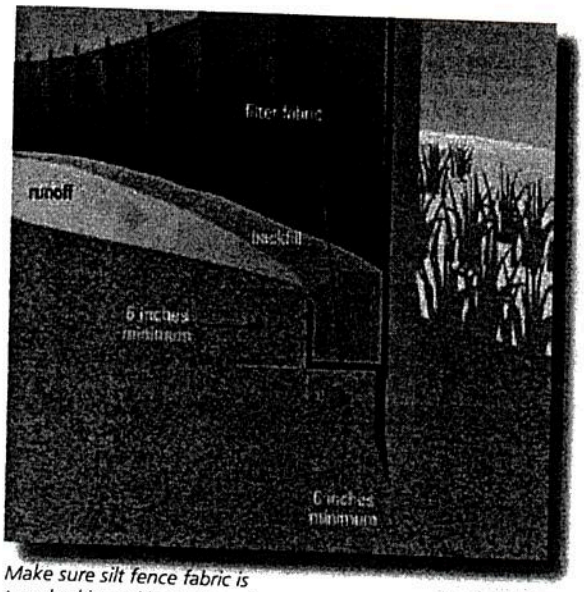
Silt fences have a useful life of one season. Their principal mode of action is to slow and pond the water and allow soil particles to settle with some minor filtration through the fabric. Silt fences are not designed to withstand high heads of water, and therefore should be located where only shallow pools (i.e., 1.5 feet or less) can form. Their use is limited to situations in which sheet or overland flows are expected.

- Dig a trench on the contour at least 6 inches wide and 6 inches deep below the area to be treated, taking care to install J-hooks where flows will travel along the silt fence. Turn fence ends uphill to trap potential bypasses as needed.
- If posts are already attached to fabric, position the fencing so the posts are installed on the downhill side of the fabric. Drive posts to a depth of 1 foot below the bottom of the trench, against downslope trench wall for extra support. Posts for all silt fencing are spaced 6 feet apart.
- Push fabric into the trench, and spread fabric along trench bottom and sides; backfill the trench and compact the soil. A preferred installation technique in deep, easily-worked soils with minimal rock content involves static slicing of the fence into the ground with a chisel-plow implement such as the *Tommy Silt Fence Machine* or equivalent. The filter fabric is wire-tied directly to the posts with three diagonal ties.
- The height of a silt fence must be 18 inches minimum and 30 inches maximum. Sediment storage height and ponding height must not exceed 18 inches.
- Silt fences placed at the toe of a slope must be set at least 6 feet back from the toe to increase ponding volume and provide room for maintenance.

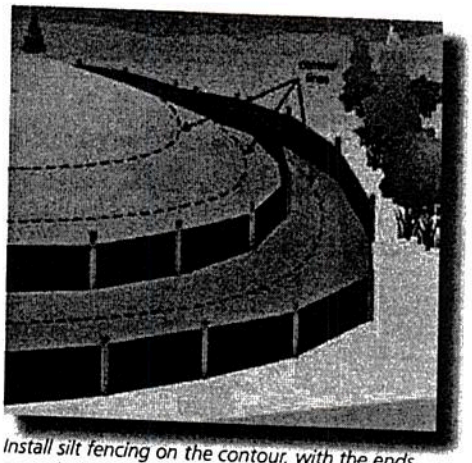
Inspection and Maintenance

All sediment barriers should be placed downgradient from bare areas to be treated. The ends of the barrier should be turned uphill or otherwise configured to prevent end-around bypasses.

- Inspect fence for proper installation and compaction by pulling up on the fence while kicking the toe of the fabric. If the fence comes out of the ground, do not *accept* the installation.
- If there are long, linear runs of silt fence without J-hooks, do not *accept* the installation.
- Silt fences and filter barriers must be inspected weekly and after each storm of greater than one-half inch. Any required repairs must be made immediately.
- Sediment should be removed when it reaches 1/3 height of the fence or 18 inches maximum.
- The removed sediment must be spread and vegetated or otherwise stabilized so that it does not result in muddy runoff to nearby ditches or surface waters.
- Silt fences must be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized (e.g., vegetated) and any sediment stored behind the silt fence has been removed. Silt fences and other temporary controls must be removed before project close-out.

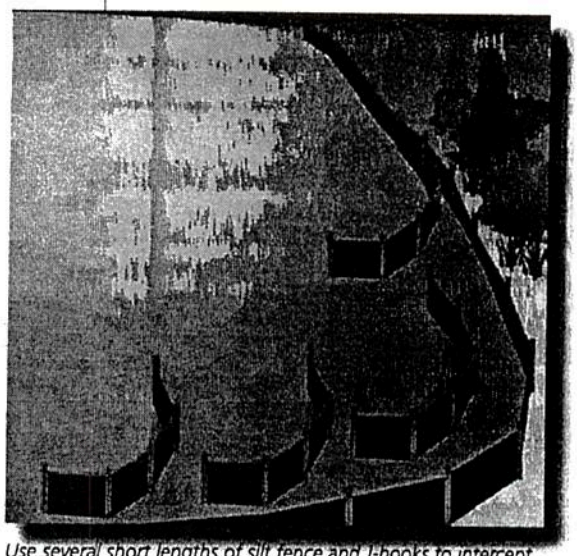


Make sure silt fence fabric is trenched in and is upslope of stakes. Leave room between the fencing and the upgradient slope for removing accumulated sediment.

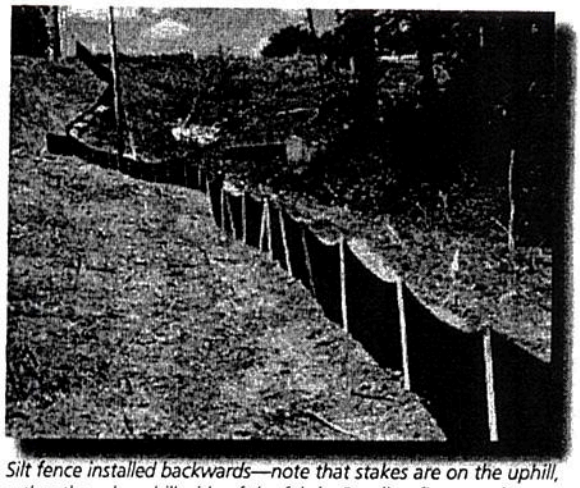


Install silt fencing on the contour, with the ends turned uphill to trap muddy runoff and prevent bypasses. Remove silt fences when grass is established.

Do not use silt fencing in areas of concentrated flows. For best results, triple-seed ditches and line with erosion control blankets.



Use several short lengths of silt fence and J-hooks to intercept converging runoff in critical areas, such as property corners. This can help relieve stress and prevent failure at the corners.

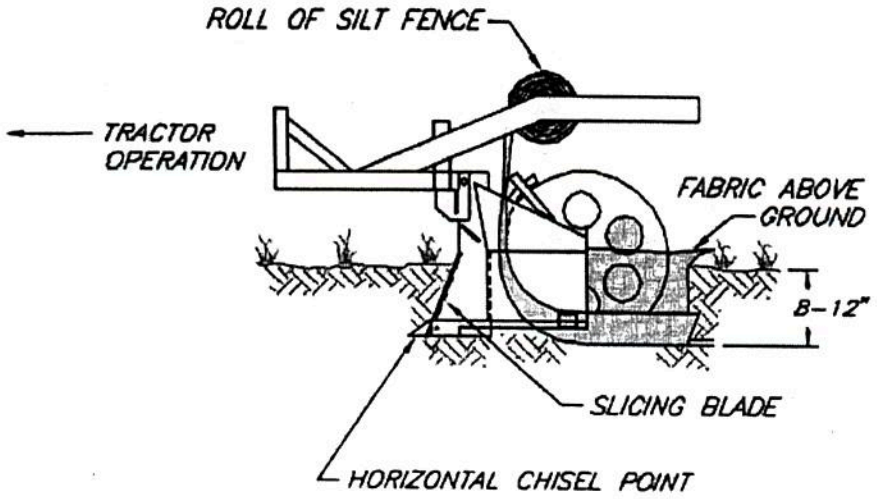


Silt fence installed backwards—note that stakes are on the uphill, rather than downhill, side of the fabric. Ponding flows against this fence will push the fabric away from the stakes, causing failure and releasing sediment to the small stream on the right.

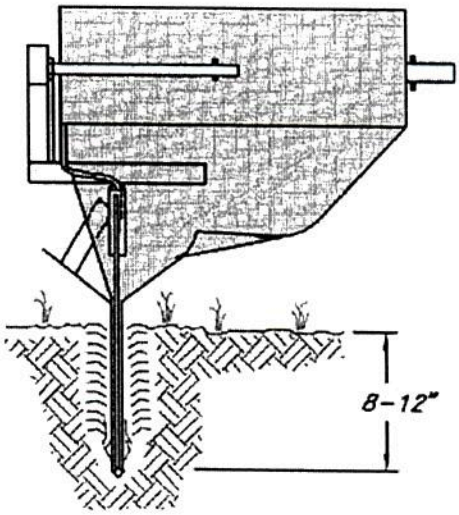
Use multiple silt fences at proper spacing (see table) to protect long, unvegetated slopes. Fences provide only temporary protection and can be removed when the area is seeded and mulched.

Silt fence is functioning well, but needs maintenance. Set fences back from the toe of the slope, to allow room for sediment to accumulate and maintenance.

Good installation of "super" (i.e., wire reinforced) silt fence. Note that wire is installed between the fabric and stakes, and provides a web of support as the ponded flow pushes against the fabric. Also, note the grass strip between the bare area and the fence, which helps to slow and filter flows before ponding along the fence line.



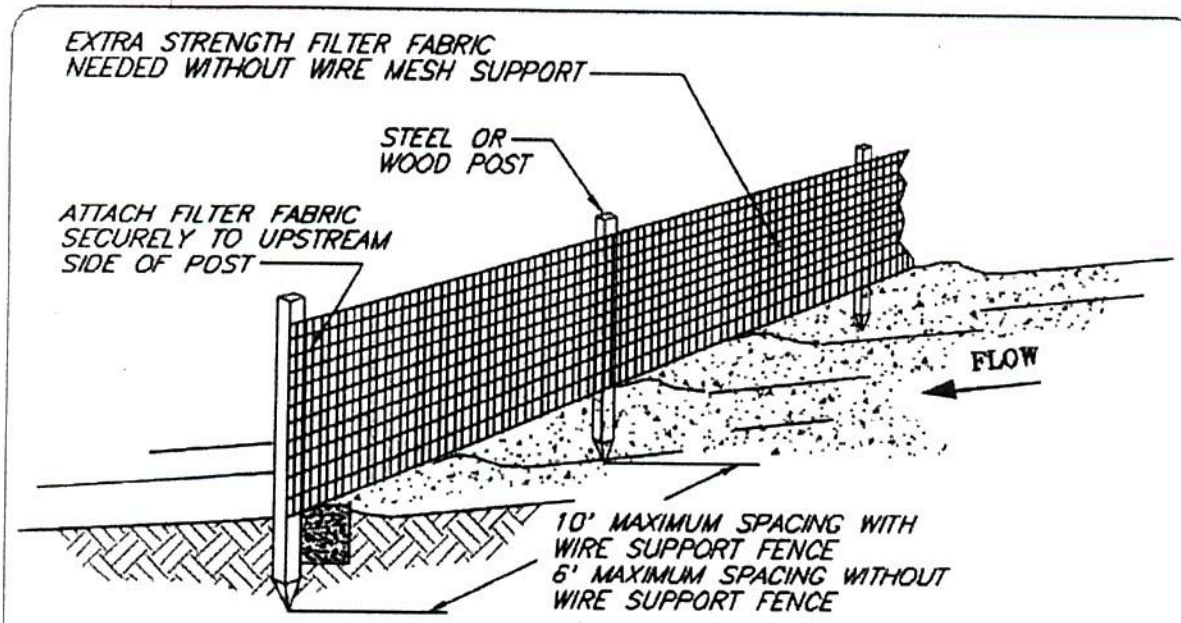
STATIC SLICING METHOD
SIDE VIEW

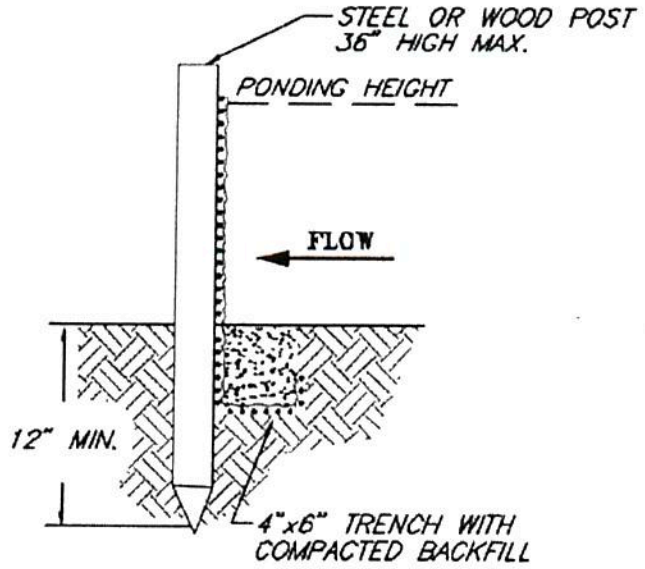


STATIC SLICING METHOD
BACK VIEW

SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

SILT FENCE INSTALLATION: SLICING METHOD





TRENCH DETAIL

NOTES:

1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.

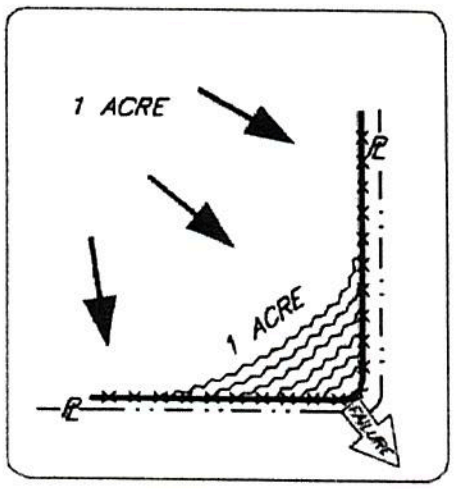
2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY. 9" MAXIMUM RECOMMENDED STORAGE HEIGHT.

3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.

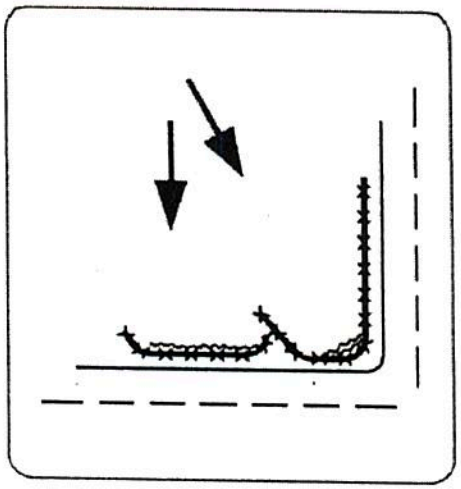
SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

NOT TO SCALE

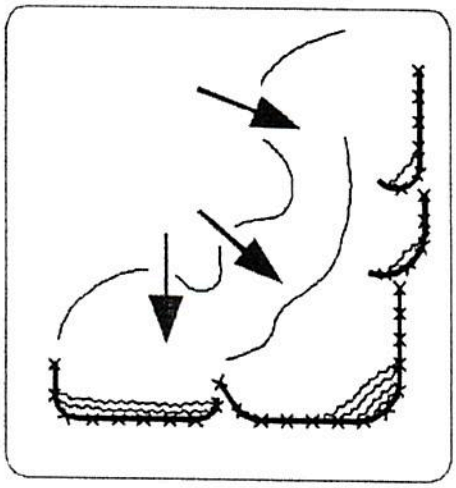
SILT FENCE INSTALLATION: TRENCH METHOD

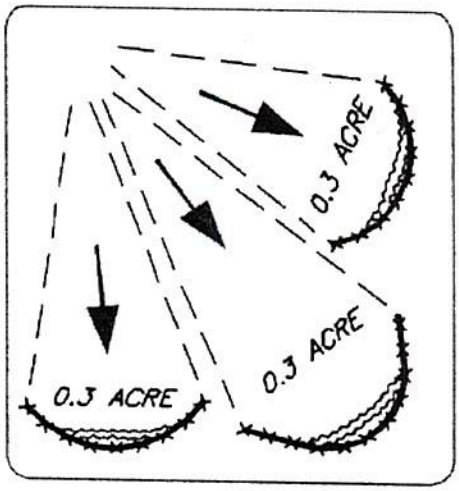


Incorrect – *Do Not* layout "perimeter control" silt fences along property lines. All sediment laden runoff will concentrate and overwhelm the system.



Correct – Install J–hooks

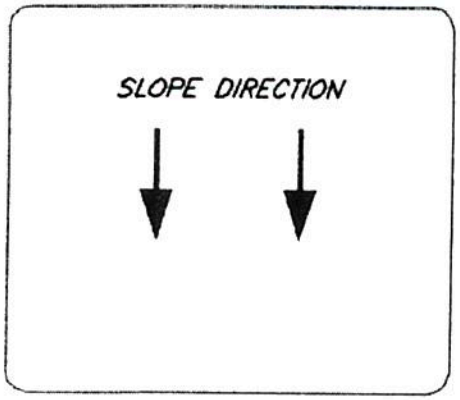


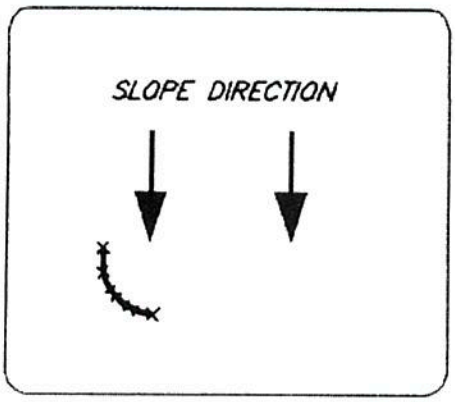


Discreet segments of silt fence, installed with J–hooks will be much more effective.

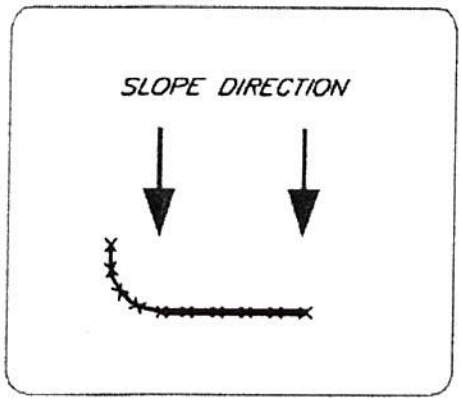
SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

SILT FENCE PLACEMENT FOR PERIMETER CONTROL

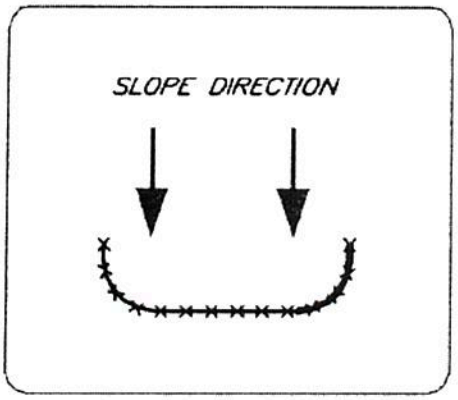




STEP 1 – CONSTRUCT LEG



STEP 2 – CONSTRUCT DAM

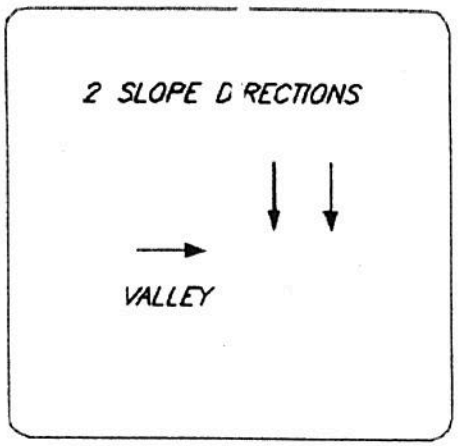


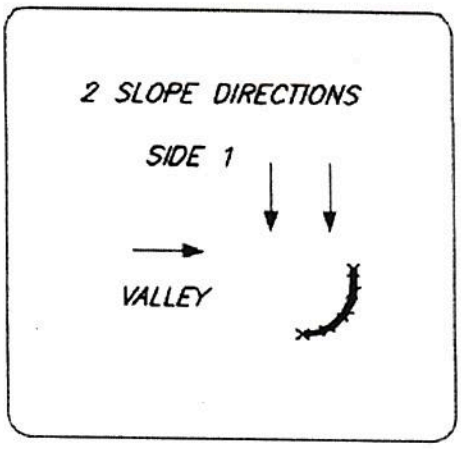
STEP 3 – CONSTRUCT LEG 2

INSTALLATION WITH J-HOOKS INCREASE SILT FENCE EFFICIENCY.

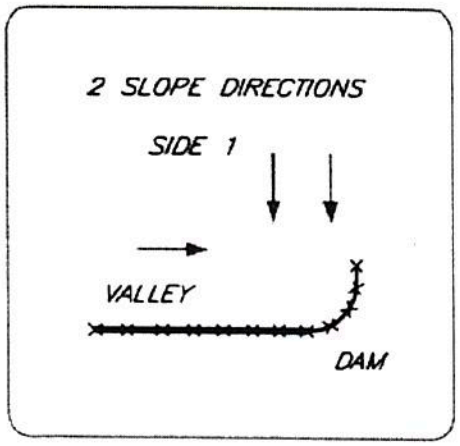
SILT FENCE: TYPICAL PLACEMENT ON SLOPE

SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

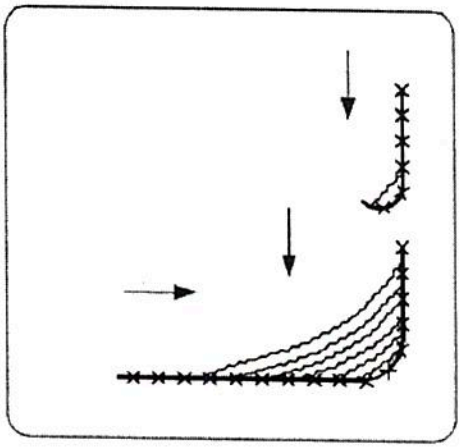




STEP 1 – CONSTRUCT A DAM



STEP 2 – CONSTRUCT SIDE 2



STEP 3 – CONSTRUCT J-HOOKS AS NEEDED

INSTALLATION WITH J-HOOKS WILL INCREASE SILT FENCE EFFICIENCY AND REDUCE EROSION-CAUSING FAILURES.

SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

SILT FENCE: TYPICAL PLACEMENT TWO SLOPES

4.5.3 Erosion Control Blankets and Turf Reinforcement Mats

Erosion control blankets provide excellent protection for seedbeds, especially on slopes and in areas of high winds. Blankets can be used to stabilize ditches with flatter slopes. For steeper ditches, use turf reinforcement mats.

ECB

TRM

Definition

Temporary erosion control blankets (ECBs) and permanent turf reinforcement mats (TRMs), known generally as rolled erosion control products, are single or multiple layer sheets composed of natural or synthetic material that is woven, sewn, bonded, or otherwise manufactured for placement on bare soil slopes or flow channels. They have been described as a temporary, degradable products composed of processed natural or polymer fibers mechanically, structurally, or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment.

Purpose

ECBs are used to temporarily stabilize and protect disturbed soil from raindrop impact and surface erosion, to increase infiltration, decrease compaction and soil crusting, and to conserve soil moisture. Mulching with ECBs will increase the germination rates for grasses and legumes and promote vegetation establishment. ECBs also protect seeds from predators, reduce desiccation and evaporation by insulating the soil and seed environment.

Some types of ECBs and turf reinforcement mats are specifically designed to stabilize channelized flow areas. These blankets and mats can aid the establishment of vegetation in waterways and increase the maximum permissible velocity of the given channel by reinforcing the soil and vegetation to resist the forces of erosion during runoff events. Stems, roots and rhizomes of the vegetation become intertwined with the mat, reinforcing the vegetation and anchoring the mat.

Design Criteria

All final slopes 2H:1V or steeper should be protected with an ECB. ECBs are constructed of various degradable organic / synthetic fibers that are woven, glued or structurally bound with nettings or meshes. The most widely used ECBs are made from straw, wood excelsior, coconut, polypropylene or a combination thereof stitched or glued together or into or between biaxially oriented process nettings or woven natural fiber nettings. They are useful on sites requiring greater, more durable or longer-lasting erosion protection. Applications include gradual to steep slopes, low to moderate flow channels and low-impact shore linings. Because these degradable materials are designed to provide temporary erosion protection, they generally are limited to areas where natural, unreinforced vegetation alone will provide long-term soil stabilization.

The functional longevity of ECBs can be varied to accommodate the site-specific requirements. Some ECBs are designed to last for less than 3 months for use in high-maintenance areas that will be mowed soon after turf establishment, while others are made to provide longer-lasting protection in applications requiring erosion control/mulch for up to 3 years.

TRMs consist of various UV-stabilized, synthetics fibers and filaments processed into permanent, high-strength, 3-D matrices. Common examples include cuspated polyethylene meshes heat-bonded together, extruded monofilaments of nylon or PVC heat-bonded at their intersections, and crimped polyolefin fibers and other materials mechanically stitched between high-strength nettings. TRMs are designed for permanent and critical hydraulic applications such as drainage channels, where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation. Though some TRMs also contain degradable components to supplement their permanent structures, all TRMs by definition have a permanent three dimensional structure with high-tensile strength that functions as a matrix for entangling plant roots, stems and soils.

Together, the TRM and vegetation form a continuous composite—a unified, living mat. This synergism increases root systems' lateral strength, reducing plant dislodgement under high-velocity, high-shear stress flows. The TRM's permanent structure also functions to consolidate and protect the soils in which the plants are anchored, preventing soil from being stripped out of the vegetative cover and the resulting weakening of the root support. TRMs are often used in situations where the *green* alternative is preferred to hard armor.

Select the ECB or TRM according to slope steepness and length and expected sheer stress if application is to a flow channel or ditch. If the area will be mowed eventually, consider the specified breakdown time for ECB plastic netting. TRM areas should not be mowed until vegetation is well established, and then as little (or as high) as possible. The table at the end of this section provides guidance on the application of various blankets and mats. An ECB or mat should be used in all drainage channels with slopes of 2 percent or more, and in the following conditions:

- Slopes and disturbed soils where mulch must be anchored and other methods such as crimping or tackifying are not feasible nor adequate
- Steep, long slopes, generally steeper than 3H:1V and longer than 50 feet
- Slopes where erosion hazards are high
- Critical slopes adjacent to sensitive areas such as streams and wetlands
- Disturbed soil areas where planting is likely to be slow in providing adequate protective cover

Take care to choose the type of blanket or matting that is appropriate for the specific needs of a project. There are many soil stabilization products available today, and it is very difficult to cover all the advantages, disadvantages and specifications of all the manufactured blankets and mats. Therefore, as with many erosion control type products, there is no substitute for a thorough understanding of manufacturer's instructions and recommendations and a site visit by a designer or plan reviewer to verify a product's appropriateness.

Construction Specifications

ECBs and TRMs are designed to cover germinating seed and provide a protective matrix that helps anchor seed to the underlying soil. (Note: a few TRMs have seed embedded in the mat.) This requires complete, uniform contact with the soil, solid stapling, and attention to topslope anchoring, overlaps, and other installation details, as noted below.

Site Preparation

Proper site preparation is essential to ensure complete contact of the protection matting with the soil.

- Grade and shape area of installation
- Remove all rocks, roots, clods, vegetative, or other obstructions so that the installed blankets or mats will have direct contact with the soil
- Prepare seedbed by loosening 2–3 inches of topsoil above final grade
- Incorporate amendments, such as lime and fertilizer, into soil according to soil test and the seeding plan

Seeding

Seed the area before installing blanket for erosion control and revegetation. Seeding after mat installation is sometimes specified for turf reinforcement application—check the manufacturer's instructions. When seeding before blanket installation, reseed all check slots and other areas disturbed during installation.

Where soil filling is specified for certain TRMs, seed the matting and the entire disturbed area after installation and before filling the mat with soil. Follow the manufacturer's instructions to ensure proper installation.

Anchoring

U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor ECBs and TRMs to the ground surface. Wire staples should be a minimum of 11 gauge. Metal stake pins should be 3/16 inch diameter steel with a 1.5 inch steel washer at the head of the pin. Wire staples and metal stakes should be driven flush to the soil surface. All anchors should be 6–8 inches long and have sufficient ground penetration to resist pullout. Longer anchors might be required for loose soils. Use biodegradable composite or wooden stakes where dislodged metal staples or stakes might cause extreme hazards, such as near airport runways or areas where future mowing might cause risk.

Installation on Slopes

Begin at the top of the slope and anchor the blanket in a 6 inch deep by 6 inch wide trench. Backfill trench and tamp earth firmly.

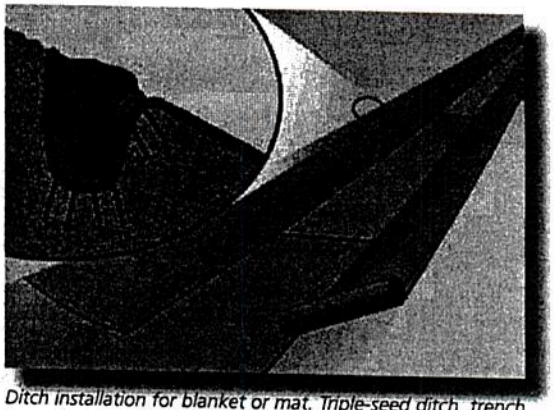
- Unroll blanket downslope in the direction of the water flow.
- The edges of adjacent parallel rolls must be overlapped at least 3 inches and be stapled through the overlapped area at least every 3 feet on slopes less than 4H:1V and every 2 feet on steeper slopes.
- When blankets must be spliced, place uphill blanket end over downhill blanket (shingle style) with 6-inch overlap. Staple through overlapped area, approximately 12 inches apart.

Install blankets and mats vertically on long slopes. Trench and staple top section, overlap sides 3 to 6 inches. Follow manufacturer's directions regarding stapling and slope limitations. For areas that will be mowed, specify blankets without plastic netting or material designed to decompose within 6 months.

- Lay blankets and mats loosely and maintain direct contact with the soil—do not stretch. Ensure good, consistent, direct soil contact.
- ECBs and TRMs must be stapled sufficiently to anchor the blanket and maintain contact with the soil. Staples must be placed down the center and staggered with the staples placed along the edges. Steep slopes (1H:1V to 2H:1V) require at least two staples per square yard. Moderate slopes (2H:1V to 3H:1H) require 1-2 staples per square yard (1 staple 3 every feet on center). Gentle slopes require one staple per square yard.

Installation in ditches and channels

Dig initial anchor trench 12 inches deep and 6 inches wide across the channel (i.e., parallel to the flow direction) at the lower end of the project area.



Ditch installation for blanket or mat. Triple-seed ditch, trench in upslope blanket sides, and staple down securely. Lay ditch sections horizontally, lapping upslope sections over downslope sections. Use plenty of staples below the water line.

- Excavate intermittent check slots, 6 inches deep and 6 inches wide across the channel at 25–30 foot intervals along the channel.
- Cut longitudinal channel anchor slots 4 inches deep and 4 inches wide along each side of the installation to bury edges of matting. These anchor slots will mark the upper elevation of the ECB or TRM along the channel side slopes, and should be above the 10 year, 24-hour peak flow line. Whenever possible extend the ECB or TRM 1 foot or more above the crest of channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 1-foot intervals. Note: Matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in the anchor trench, overlapping the preceding roll a minimum of 6–8 inches.
- Secure these initial ends of mats with anchors at 1-foot intervals, backfill and compact soil.
- Unroll the center strip of matting upstream. Stop at the next check slot or terminal anchor trench.
- Unroll adjacent mats upstream in similar fashion, maintaining a 3-inch overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay the mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 1-foot intervals, then backfill and compact the soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for noncritical installations: place two rows of anchors on 6-inch centers at 25–30 feet intervals in lieu of excavated check slots. Shingle-lap the spliced ends by a minimum of 1 foot with the upstream mat on top (to prevent uplifting by water) or begin new rolls in a check slot. Anchor the overlapped area by placing two rows of anchors, 1 foot apart on 1-foot intervals.
- Place the edges of outside mats in previously excavated longitudinal slots, anchor them using the prescribed staple pattern, then backfill and compact the soil.
- Anchor, fill, and compact the upstream end of the mat in a 12-inch by 6-inch terminal trench.
- Secure the mat to the ground using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill the TRM with soil, if specified.
- Soil filling (if specified for TRM)
- After seeding, spread and lightly rake one-half to three-quarter inch of fine topsoil into the mat apertures to completely fill the mat thickness. Use the backside of a rake or other flat implement. Spread topsoil using lightweight loader, backhoe, or other power equipment. Avoid making sharp turns with the equipment.

Erosion Control Technology Council Standard Specification for Temporary Rolled Erosion Control Products

For use where natural vegetation alone will provide permanent erosion protection

ULTRA SHORT TERM: Typical 3-Month Functional Longevity

Type	Product Description	Material Composition	Slope Applications* Maximum Gradient	Slope Applications* C Factor [2, 5]	Channel Applications* Permissible Shear Stress [3, 4, 6]	Minimum Tensile Strength[1]
1.A	Mulch Control Nets	A photodegradable synthetic mesh or woven biodegradable natural fiber netting.	5:1 (H:V)	< 0.10 @ 5:1	= 0.25 lbs/ft²	5 lbs/ft
1.B	Netless Rolled ECBs	Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form a RECP.	4:1 (H:V)	< 0.10 @ 4:1	= 0.5 lbs/ft²	5 lbs/ft
1.C	Single-net ECBs & Open Weave Textiles	Processed degradable natural and/or polymer fibers mechanically bound together by a single rapidly degrading, synthetic or natural fiber netting or an open weave textile of processed rapidly degrading natural or polymer yarns or twines woven into a continuous matrix.	3:1 (H:V)	< 0.15 @ 3:1	= 1.5 lbs/ft²	50 lbs/ft
1.D	Double-net ECBs	Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nettings.	2:1 (H:V)	< 0.20 @ 2:1	= 1.75 lbs/ft²	75 lbs/ft

SHORT-TERM: Typical 12-Month Functional Longevity

Type	Product Description	Material Composition	Slope Applications* Maximum Gradient	Slope Applications* C Factor [2, 5]	Channel Applications* Permissible Shear Stress [3, 4, 6]	Minimum Tensile Strength[1]
2.A	Mulch Control Nets	A photodegradable synthetic mesh or woven biodegradable natural fiber netting.	5:1 (H:V)	< 0.10 @ 5:1	= 0.25 lbs/ft²	5 lbs/ft
2.B	Netless Rolled ECBs	Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form a RECP.	4:1 (H:V)	< 0.10 @ 4:1	= 0.5 lbs/ft²	5 lbs/ft
2.C	Single-net ECBs & Open Weave Textiles	An erosion control blanket composed of processed degradable natural or polymer fibers mechanically bound together by a single degradable synthetic or natural fiber netting to form a continuous matrix or an open weave textile composed of processed degradable natural or polymer yarns or twines woven into a continuous matrix.	3:1 (H:V)	< 0.15 @ 3:1	= 1.5 lbs/ft²	50 lbs/ft
2.D	Double-net ECBs	Processed degradable natural and/or polymer fibers mechanically bound together between two degradable, synthetic or natural fiber nettings.	2:1 (H:V)	< 0.20 @ 2:1	= 1.75 lbs/ft²	75 lbs/ft

Erosion Control Technology Council Standard Specification for Temporary Rolled Erosion Control Products (continued)

For use where natural vegetation alone will provide permanent erosion protection

EXTENDED TERM: Typical 24-Month Functional Longevity

Type	Product Description	Material Composition	Slope Applications*		Channel Applications*	Minimum Tensile Strength[1]
			Maximum Gradient	C Factor [2, 5]	Permissible Shear Stress [3, 4, 6]	
3.A	Mulch Control Nets	A slow degrading synthetic mesh or woven natural fiber netting.	5:1 (H:V)	< 0.10 @ 5:1	= 0.25 lbs/ft²	25 lbs/ft
3.B	ECBs & Open Weave Textiles	An ECB composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix or an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix.	1.5:1 (H:V)	< 0.25 @ 1.5.:1	= 2.00 lbs/ft²	100 lbs/ft

LONG TERM: Typical 36-Month Functional Longevity

Type	Product Description	Material Composition	Slope Applications*		Channel Applications*	Minimum Tensile Strength[1]
			Maximum Gradient	C Factor [2, 5]	Permissible Shear Stress [3, 4, 6]	
4	ECBs & Open Weave Textiles	An ECB composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix or an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix.	1:1 (H:V)	< 0.25 @ 1:1	= 2.25 lbs/ft²	125 lbs/ft

NOTES:

* "C" factor and shear stress for Types 1.A., 2.A. and 3.A mulch control nettings must be obtained with netting used in conjunction with pre-applied mulch material.

1 Minimum Average Roll Values when tested in the machine direction using ECTC Modified ASTM D 5035.

2 Factor calculated as ratio of soil loss from RECP protected slope (tested at specified or greater gradient, H:V) to ratio of soil loss from unprotected (control) plot in large-scale testing. Performance test values should be supported by periodic bench scale testing under similar test conditions using ECTC Test Method # 2.

3 Minimum shear stress RECP (unvegetated) can sustain without physical damage or excess erosion (0.5 in soil loss) during a 30-minute flow event in large-scale testing. Performance test values should be supported by periodic bench-scale testing under similar test conditions and failure criteria using ECTC Test Method #3.

4 The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01–0.05.

5 Acceptable large-scale test methods may include ASTM D6459 or other independent testing deemed acceptable by the engineer.

6 Acceptable large-scale testing protocol may include ASTM D6460 or other independent testing deemed acceptable by the engineer.

Erosion Control Technology Council Standard Specification for Permanent Rolled Erosion Control Products

For applications in ditches and channels, and on slopes not exceeding 0.5H:1V where vegetation alone will not sustain expected flow conditions and/or provide sufficient long-term erosion protection

Type[1]	Product Description	Material Composition	Minimum Tensile Strength[2,3]	Minimum Thickness (ASTM D 6525)	UV Stability (ASTM D 4355 @ 500 Hours)	Channel Applications Permissible Shear Stress[4,5]
5.A	TRM	Long term, non-degradable rolled erosion control product composed of UV stabilized, nondegradable, synthetic fibers, filaments, nettings and/or wire mesh processed into three dimensional reinforcement matrices designed for permanent and critical hydraulic applications where design discharges exert velocities and shear stresses that exceed the limits of mature, natural vegetation.	125 lbs/ft	0.25 inches	80%	= 6.0 lbs/ft²
5.B	TRM		150 lbs/ft	0.25 inches	80%	= 8.0 lbs/ft²
5.C	TRM		175 lbs/ft	0.25 inches	80%	= 10.0 lbs/ft²
		TRMs provide sufficient thickness, strength and void space to permit soil filling and/ or retention and the development of vegetation within the matrix.				

NOTES:

1 For TRMs containing degradable components, all property values must be obtained on the non-degradable portion of the matting alone.

2 Minimum Average Roll Values, machine direction only for tensile strength determination using ASTM D6818 (Supersedes Mod. ASTM D5035 for RECPs)

3 Field conditions with high-loading and/or high survivability requirements may warrant the use of a TRM with a tensile strength of 3,000 lb/ft or greater.

4 Shear stress that fully vegetated TRM can sustain without physical damage or excess erosion (0.5 in) soil loss) during a 30-minute flow in large-scale testing.

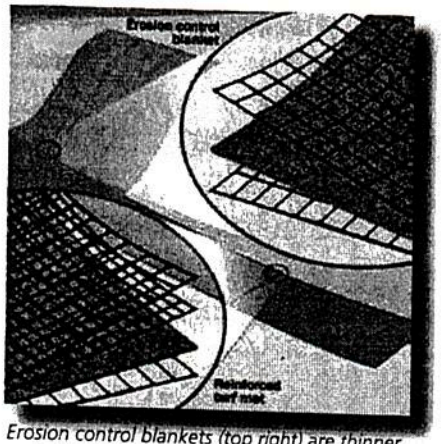
5 Acceptable large-scale testing protocol may include ASTM D6460 or other independent testing deemed acceptable by the engineer.

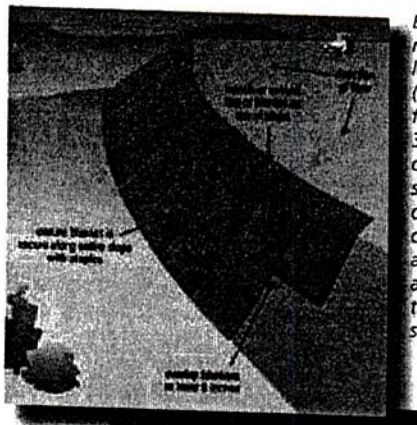
- Do not drive tracked or heavy equipment over the mat. Avoid any traffic over the matting if loose or wet soil conditions exist.
- Use shovels, rakes or brooms for fine grading and touch up. Smooth out soil filling, just exposing the top netting of matrix.

Inspection and Maintenance

All blankets and mats should be inspected periodically following installation.

- Inspect installation after significant rainstorms to check for erosion and undermining. Any failure should be repaired immediately.
- If washout or breakage occurs, reinstall the material after repairing the damage to the slope or drainageway.



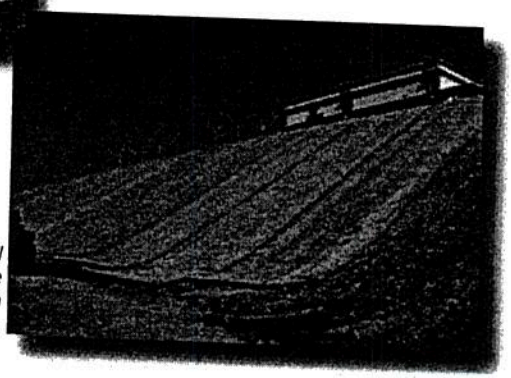


Blankets are highly recommended for long, steep slopes (i.e., longer than 75 feet and steeper than 3H:1V). Trench in top of blankets, overlap sides, and use plenty of staples. Blankets can become saturated and heavy after a rain and begin to slip down the slope if not staked securely.

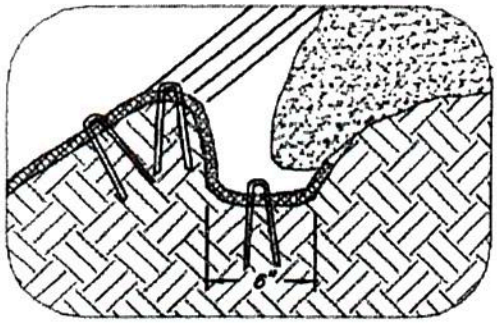
Erosion control blankets (top right) are thinner and degrade quicker than turf reinforcement mats (lower left). Blankets are used on shorter, flatter slopes and low-flow ditches. Mats can be used on steep slopes and high-velocity ditches.

Very good installation of turf mat in long, steep, high-flow ditch below long slope.

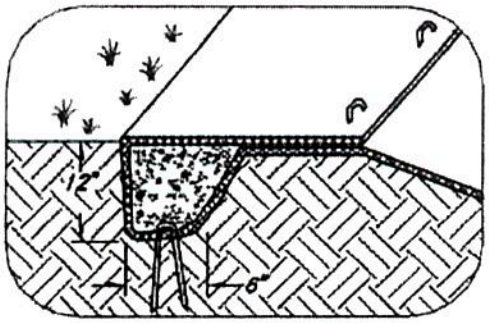
Good use of straw and excelsior blankets on streambank stabilization project. Note that the bottom of stream is not disturbed to preserve habitat. This site is ready for live stakes, tree plantings, or other vegetation (see Section 4.7, Stream and Wetland Protection).



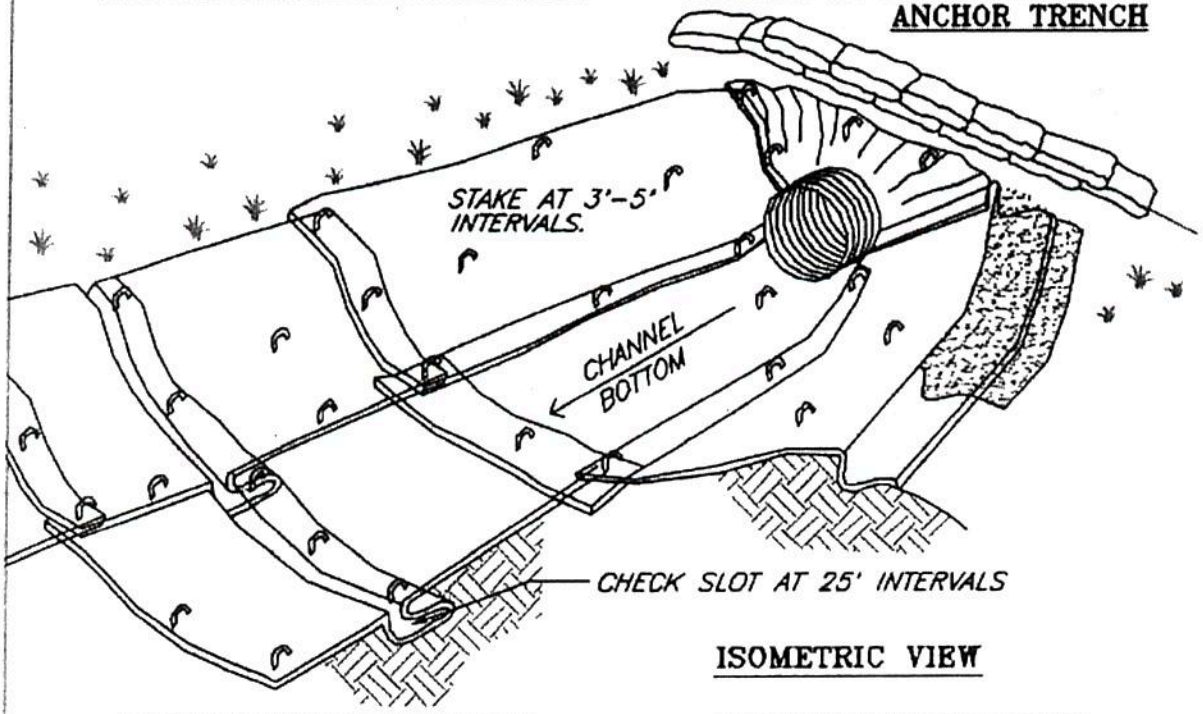
Seeding on long, steep slope protected by straw erosion control blanket. Make sure blankets are stapled down securely for these applications to prevent blankets from sliding downhill when weighted down with rain and fugitive sediment.



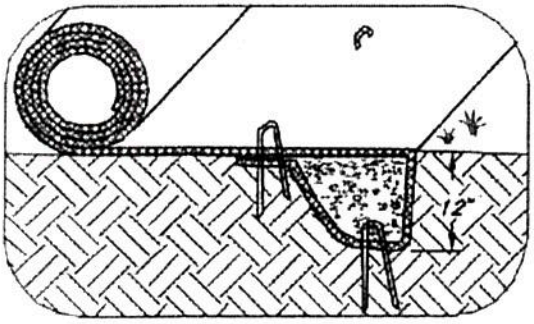
LONGITUDINAL ANCHOR TRENCH



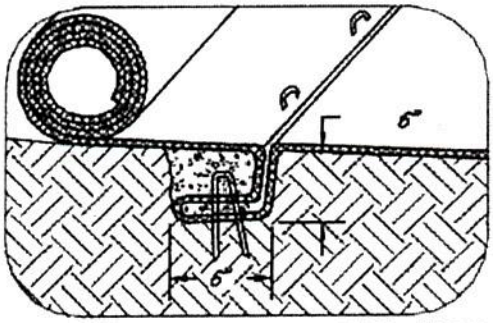
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH



ISOMETRIC VIEW



INITIAL CHANNEL ANCHOR TRENCH



INTERMITTENT CHECK SLOT

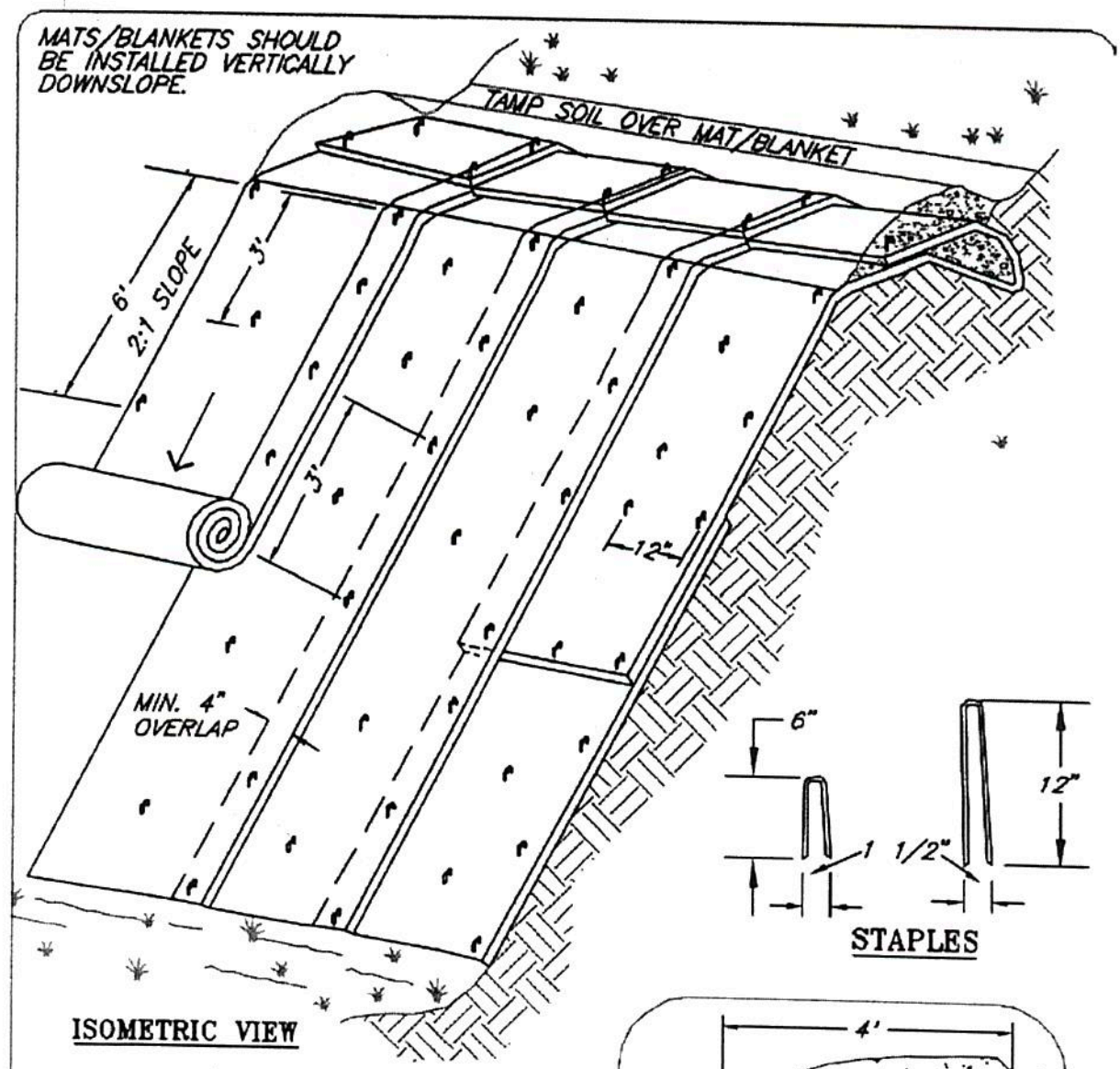
NOTES:

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.

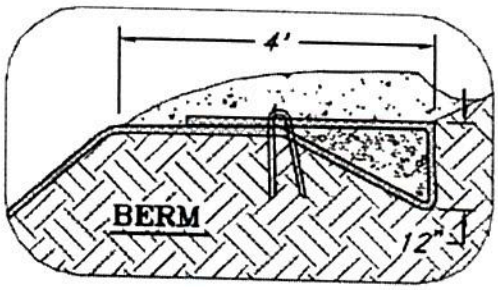
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.

SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

EROSION BLANKETS & TURF REINFORCEMENT MATS CHANNEL INSTALLATION



TYPICAL SLOPE SOIL STABILIZATION



NOT TO SCALE

NOTES:

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.

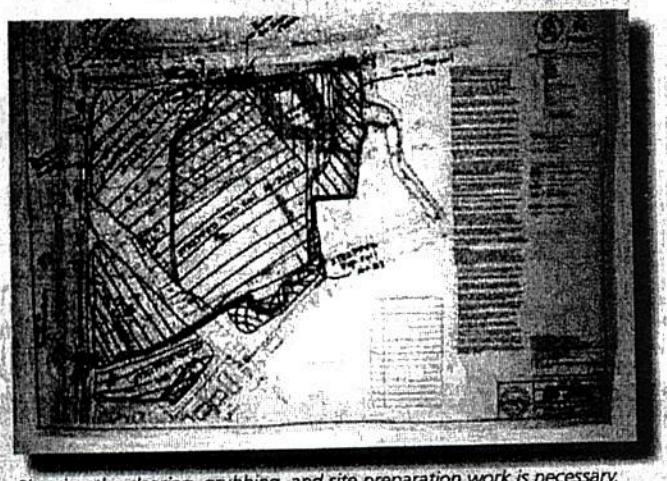
SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

EROSION BLANKETS & TURF REINFORCEMENT MATS SLOPE INSTALLATION

4.3 Site Preparation

Initial clearing and grading work on a site requires attention to a fairly common set of general goals:

- Minimize site disturbance to preserve and maintain existing vegetative cover
- Limit the number of access points to the site to control off-site mud tracking
- Phase and sequence construction activities by dividing the project into logical work zones
- Locate temporary and permanent soil disposal areas, haul roads, and construction staging areas to minimize erosion, sediment transport, and disturbance to existing vegetation



Planning the clearing, grubbing, and site preparation work is necessary, especially for larger sites. Written plans—even very basic ones—help to ensure that everyone understands where the active work zones are, various activity phases, and the schedule.

- Install sediment barriers and controls before land clearing and grading wherever possible
- Get to final grade, seed and mulch as soon as you can

Construction site work includes clearing, grading, and preparing the site for built features like roads, utilities, buildings, parking lots, and the site drainage system. This section covers a broad range of site preparation tasks including land grading, installation of the construction exit, topsoil storage, identifying buffer zones around drainage features, and initial preparation of soil surfaces by roughening.

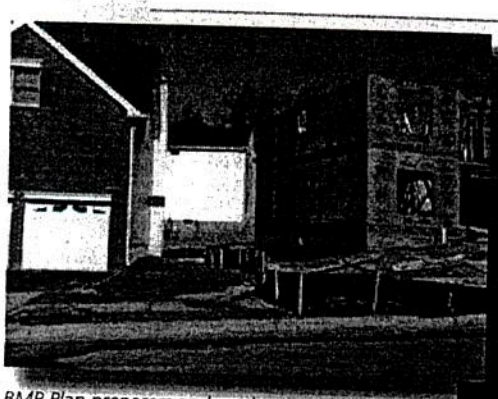
Contractors and equipment operators should understand erosion control plans developed by engineers and be prepared to adapt the controls as the job progresses. Key control points are areas of concentrated runoff and sheet runoff. Make sure the design, location, schedule, installation, and maintenance of BMPs is logged in the KPDES permit files if the site has a disturbed area of one acre or more.

For more information about designing construction projects that cost less and minimize water resource impacts, see the *Low Impact Development Design Strategies* guide posted at **www.epa.gov/owow/nps/lid/lidnatl.pdf**, or see the *Best Management Practices Manual for Erosion Prevention and Sediment Control* published by the Kentucky MS4 Work Group, posted at **www.bgky.org/publicworks/planningdesign/bmpindex.htm**.

The normal sequence for basic site preparation work begins with the installation of controls before clearing and excavation work and ends with all bare areas covered with grass, gravel, or built surfaces, and stable ditches with functioning stormwater systems (see table that follows).

Typical Construction Phasing Schedule for Site Preparation Work

Construction Activity	Scheduling Considerations
Identify work zones and construction phases by analyzing proposed cut/fill work, location of proposed structures, site conditions, and site resources	Construction phase and work zone identification will ensure that land clearing and grading exposes a minimum amount of soil at any one time.
Identify and flag off areas to be protected, such as buffer zones near creeks or sinkholes, drainage features, vegetated filter strips, mature trees, and so on.	All areas should be flagged and posted before land clearing and grading begins.
Install construction entrance/exit and designate vehicle parking areas	First land disturbing activity. Use geotextile liner under rock to maintain effectiveness; stabilize bare areas as soon as possible.
Install upgradient diversion swales or berms.	Seed and mulch as soon as construction of swales or berms is completed.
Size and install sediment barriers (e.g., silt fences), sediment traps, sediment basins, and outlet protection.	Install principal sediment basin(s) first; install other basins and traps as needed during clearing/grading or construction.
Install inlet protection dams, dikes, filters, screens, and such.	Applies to all curb, drop, pipe, or other inlets.
Construct drainage / runoff conveyance system; stabilize ditches and culvert outlets.	Seed and mulch as soon as possible. Use triple seeding (see seeding rates in Section 4.4.1) in ditches, and blankets/mats as necessary. Ensure that drainage entering streams or other waterbodies does not cause sedimentation.
Begin clearing, grubbing, and grading.	Strip and grade areas only as needed. Get to final grade and apply seed and mulch as soon as possible. Direct runoff toward appropriate controls; install new controls as needed.
Stabilize bare areas after final grade is reached.	Apply temporary or permanent seed, mulch, or other controls as soon as work is completed, but no later than 14 days after grading work in each area is finished.
Construct roads, buildings, parking lots and install utilities.	Install runoff controls as needed to deal with muddy runoff, rutting, and such.
Install landscaping and other final features.	Stabilize all bare areas and ditches. Remove all temporary controls.
Maintenance	Inspect and maintain controls weekly and after each rain of one-half inch or more.



BMP Plan preparers and work crews should understand that controls change as the site is graded and construction proceeds. For example, fiber rolls (logs) can control sediment along curbs and roads in relatively flat residential developments, rather than silt fences, which function well in large areas of sheet runoff but are often moved or damaged on small lot applications.

Designating a logical progression for active project work zones and phasing work within those zones helps to minimize the area requiring erosion and sediment controls. Try to match cut and fill needs to minimize disturbed area and material handling.

4.3.2 Construction Exit

Stabilized construction exits are installed before clearing and grading work begins, and maintained until the site is stabilized. Inspections should note whether mud is being tracked onto paved roads.

SCE

Definition

A construction exit is a stabilized pad of 2-inch or larger rock at any point where vehicles or equipment leave a construction site and enter a public right-of-way, street, alley, sidewalk, or parking area.

Purpose

A stabilized construction exit is intended to reduce off-site sedimentation and improve public safety by eliminating the tracking or other movement of sediment onto public rights-of-way.

Design Criteria

Construction plans must limit traffic exiting the site to properly constructed and stabilized construction exits.

- The entrance must be constructed at a location that minimizes the impact to streams and storm drains and maximizes public safety.
- The aggregate size for construction of the pad must be 2–3 inch stone, at a minimum (KYTC No. 1 or No. 2, not 57s or DGA).
- The thickness of the pad must not be less than 6 inches. Use geotextile fabrics below the rock, if necessary, to improve stability of the foundation in locations subject to seepage or high water table.
- The width of the pad must not be less than the full width of all points of ingress or egress and, in any case, must not be less than 12 feet wide. Allow for necessary turning radii for trucks and equipment. The length of the pad must be as required, but not less than 50 feet.

Construction Specifications

- Construct rock construction exit before clearing, grubbing, and grading the site. Place the gravel to the specific grade and dimensions shown on the plans, and level it out. A geotextile underliner helps to keep rock up out of the mud and functioning properly to remove mud from vehicle and equipment tires.
- Construction entrances will be located as shown on the development plans, or as directed by approving regulatory agency. Any deviation from this location must receive regulatory agency approval.

- Provide drainage to direct muddy runoff from the construction exit toward a sediment trap or other controlled area. In no case should muddy runoff from the construction exit flow onto roads, parking lots, or adjacent properties.
- When necessary, wheels must be cleaned with a shovel, scraper, or high-pressure water hose to remove sediment before entrance onto roads or other paved areas. When washing is required, it must be done on an area stabilized with KYTC No. 1 or No. 2 rock that drains into an approved sediment trap or sediment basin.

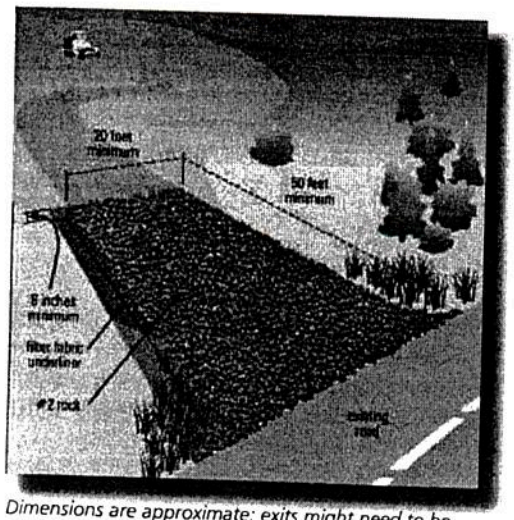
Inspection and Maintenance

Inspect all construction exits twice a day during dry weather and more often during wet weather. Encourage equipment operators and other personnel to immediately report any mud tracking onto paved off-site areas.

- All sediment spilled, dropped, washed or tracked onto public rights-of-way must be removed immediately.
- The entrance must be maintained in a condition that will prevent tracking or flowing of sediment onto public rights-of-way. This could require periodic top dressing with additional stone as conditions demand, and repair or maintenance of any measures used to trap sediment.
- Replace gravel material when surface voids are filled with soil, or use a grubbing rake mounted to a front-end loader to stir the rock during dry conditions and shake down fine soil particles.

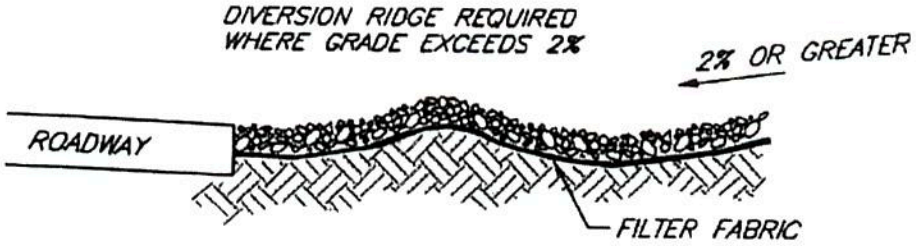
A well-maintained construction exit keeps mud off the pavement and helps to reduce potential legal liability.

- Sediment from construction entrances and exits must be prevented from entering any storm drain, ditch, or watercourse through use of sediment traps, sand bags, commercial sediment dikes, inlet filters, or other approved methods. Maintain traps or other sediment trapping structures as needed.

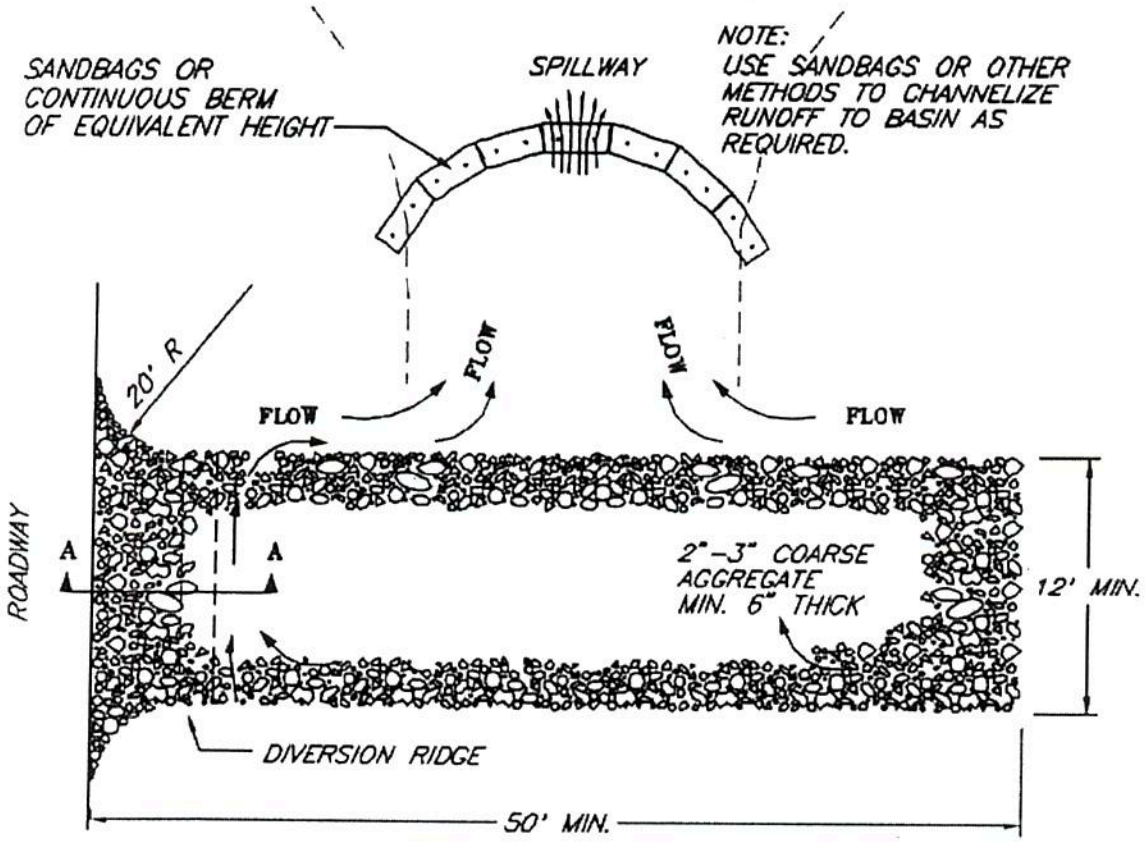


Dimensions are approximate; exits might need to be wider or longer to keep mud off paved public roads.

The construction exit will be one of the first things an inspector sees at the construction site and is often a good indication of how other controls are installed and maintained.



SECTION A – A



PLAN

NOTES:

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEAN OUT OF ANY MEASURES USED TO TRAP SEDIMENT.

2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.

3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

SOURCE: SALIX APPLIED EARTHCARE – EROSION DRAW 5.0

CONSTRUCTION ENTRANCE

Temporary Sediment (Silt) Traps

Simple traps or "checks" with rock berm containment structures can be installed as needed by field personnel with or without specific notations on plan documents. Standard notes on plans should call for installation of temporary traps in concentrated flow areas subject to rutting on an as-needed basis. Make sure containment berms are designed for overflow in the center of the berm, to prevent sidecutting and bypasses. Install traps in a series to control sediment from large upland areas.

Definition

A temporary sediment or silt trap is formed by excavation or by constructing a small embankment of stone, stone-filled bags, or other material to retain sediment. Sediment traps are considered temporary structures and often placed at the site on an "as needed" basis by field personnel. They should not be placed in flowing streams.

Purpose

Sediment traps pond and settle sediment from muddy runoff. Traps are used where physical site conditions or other restrictions prevent other erosion control measures from adequately controlling erosion and sedimentation. Sediment traps may be used down slope from construction operations that expose areas to erosion.

Design Criteria

Bermed sediment traps confined by rock, rock-filled fiber bags, or other material are preferred over excavated traps or those with soil berms. Traps are placed in converging flow areas (i.e., where ruts or washouts may form) or in ditches, where they are often called ditch checks or check dams. All traps are sized based upon a design volume of 3,600 cubic feet per disturbed acre in the upstream drainage area. Multiple sediment traps constructed in a series are needed when the storage volume of each cannot meet this design requirement.

Sediment traps are generally used to treat a drainage area of five acres or less. When the total drainage area to a single structure exceeds 10 acres, an engineered sediment basin is necessary. Traps cannot be placed in blue-line streams or other regulated waters unless space limitations or design limitations provide no other feasible option. A US ACE CWA Section 404 permit is required in these cases. Sediment traps must be cleaned out before they are half full of sediment.

KYTC Silt Trap Types A, B, and C

The Kentucky Transportation Cabinet specifies three types of temporary sediment or silt traps. Type A is an excavated basin with or without a soil berm constructed in a ditch or drainageway. Type B is one or more small berms of rock (KYTC No. 2 or shot rock) placed in a drainageway or ditch, with a geotextile underliner covered by 4 inches of KYTC No. 4 stone. A 12 inch overflow depression appears in the middle of the berm(s). Type C traps are berms constructed of porous fabric bags filled with crushed aggregate (e.g., KYTC No. 57), placed individually or in a series to create small ponding dams around drop inlets, curb inlets, or to form check dams in a drainageway or ditch.

General

- Construct traps of rock (KYTC No. 2 mixed with smaller stone), rock-filled fiber bags, or use approved commercial sediment trap products installed and spaced according to manufacturer's instructions.
- Site sediment traps in areas where they can be maintained (i.e., sediment removed).
- Set traps back from property lines or water bodies as much as possible.
- Do not site sediment traps at culvert or pipe outlets if possible.
- Minimum sediment storage capacity is 3600 cubic feet per acre of upland area drained by the trap. Where space restrictions exist, install multiple traps in a series at least 50 feet apart.
- Maximum drainage area is 5 acres.
- Basin flow length should be at least 2 times the flow width.
- Recommended trap depth for open areas is 2 feet at the inlet and 4 feet at the outlet.
- Trap height must be 1.5 feet minimum in ditches, 3-5 feet in open area drainageways.
- Trap berm width at base must be sufficient to support 2H:1V berm.
- Trap length must be sufficient to tie into upper banks in ditches or high enough to prevent side bypasses in drainageways. Overflows must be in the center of the berm.
- Construct the trap, seed and stabilize before clearing and grading work begins.

Embankment requirements

- Maximum height of 5 feet.
- Maximum inside and outside slopes of 2:1.
- Side slopes, containment berms, and inflowing ditches should be seeded and mulched or blanketed as soon as possible after construction.

Outlet requirements

- The outlet must consist of an overflow spillway wide made of stone (KYTC No. 2 minimum).

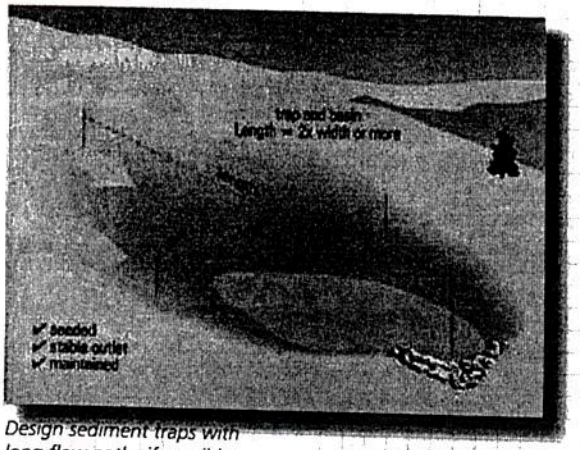
Construction Specifications

- Construct initial series of sediment traps prior to general site clearing and grading.
- The area to be excavated or ponded must be cleared of all trees, stumps, roots, brush, boulders, and debris. All topsoil containing excessive amounts of organic matter must be removed.
- Seeding, fertilizing, and mulching of the material taken from the excavation must comply with the applicable soil stabilization sections of this manual.
- Any material excavated from the trap must be uniformly spread to a depth not exceeding 3 feet and graded to a continuous slope away from the trap.
- Field-approved installations should be noted on weekly inspection reports and on plan documents within 7 days.

Inspection and Maintenance

The trap must be inspected weekly and after every rainfall greater than 0.5 inches. Sediment must be removed from the trap before the capacity is reduced to 50 percent of the design volume. Plans for the sediment trap must indicate the methods for disposing of sediment removed from the pond.

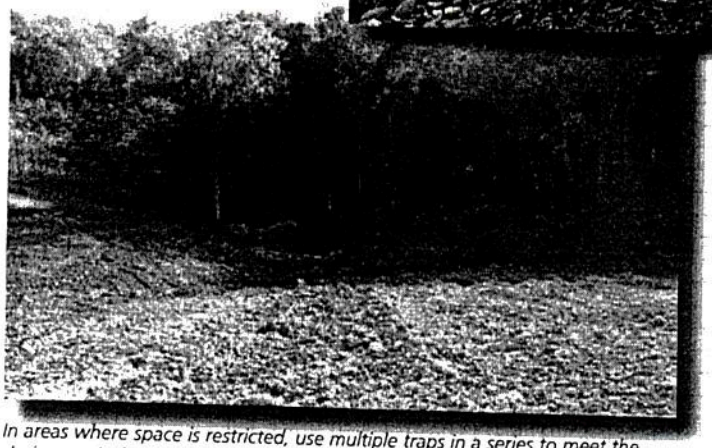
Temporary sediment traps are removed upon stabilization or cover of the upland drainage area with vegetation, pavement, etc. The trap area should be graded, seeded, and mulched or blanketed. Excess sediment should be spread and stabilized where it will not enter the drainage system.



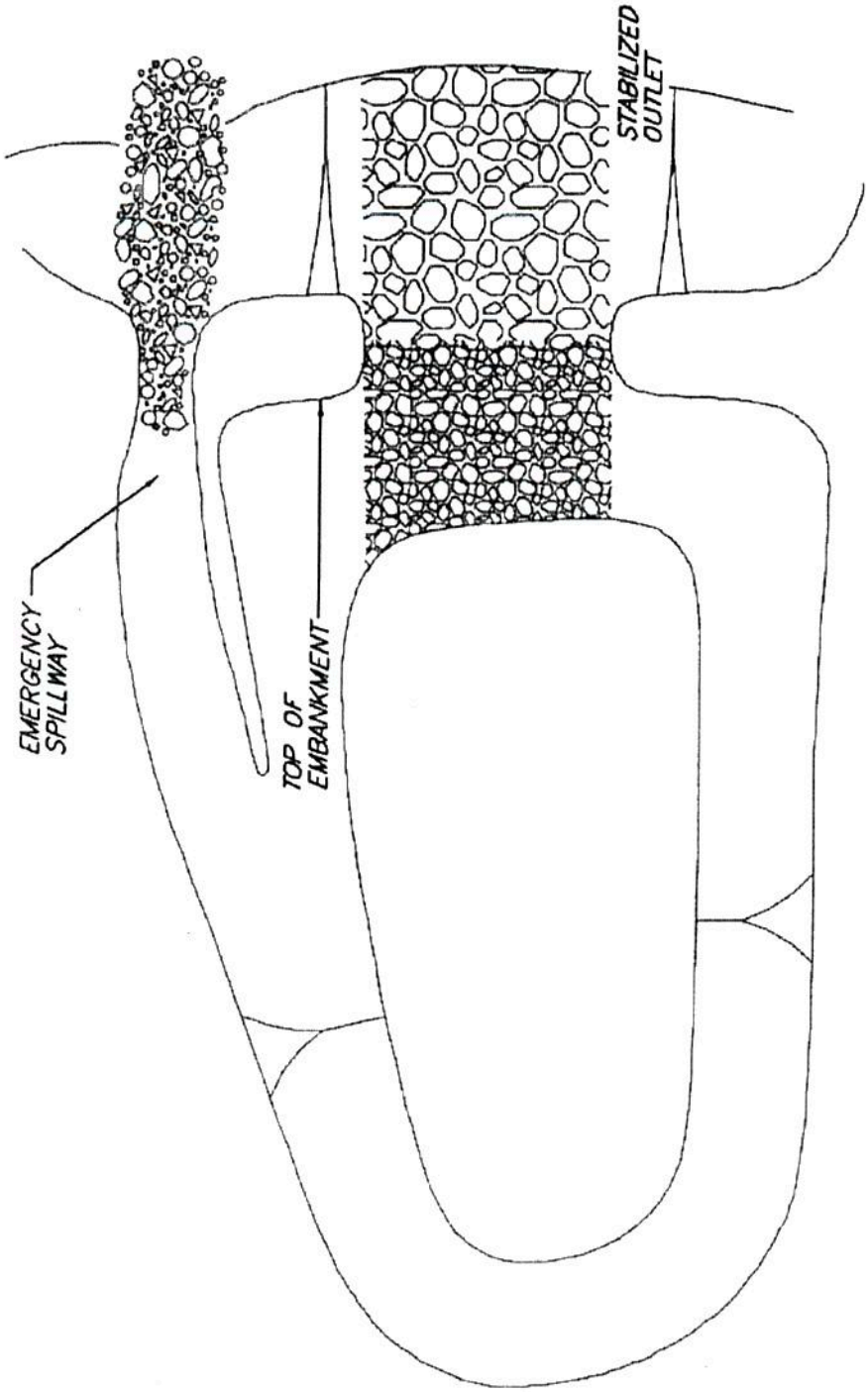
Design sediment traps with long flow paths if possible. Make sure overflow area is protected with rock or other armoring. For best results, seed trap and upland areas immediately after construction.

Make sure overflow outlet or riser is designed for maximum detention times. Note rock berm around riser, which ensures maximum detention for muddy flows after small storms.

Good trap placement and performance; poor maintenance. Remove accumulated sediment before trap is half full. Spread material removed in a vegetated upland area or other site where it will not wash into nearby surface waters.



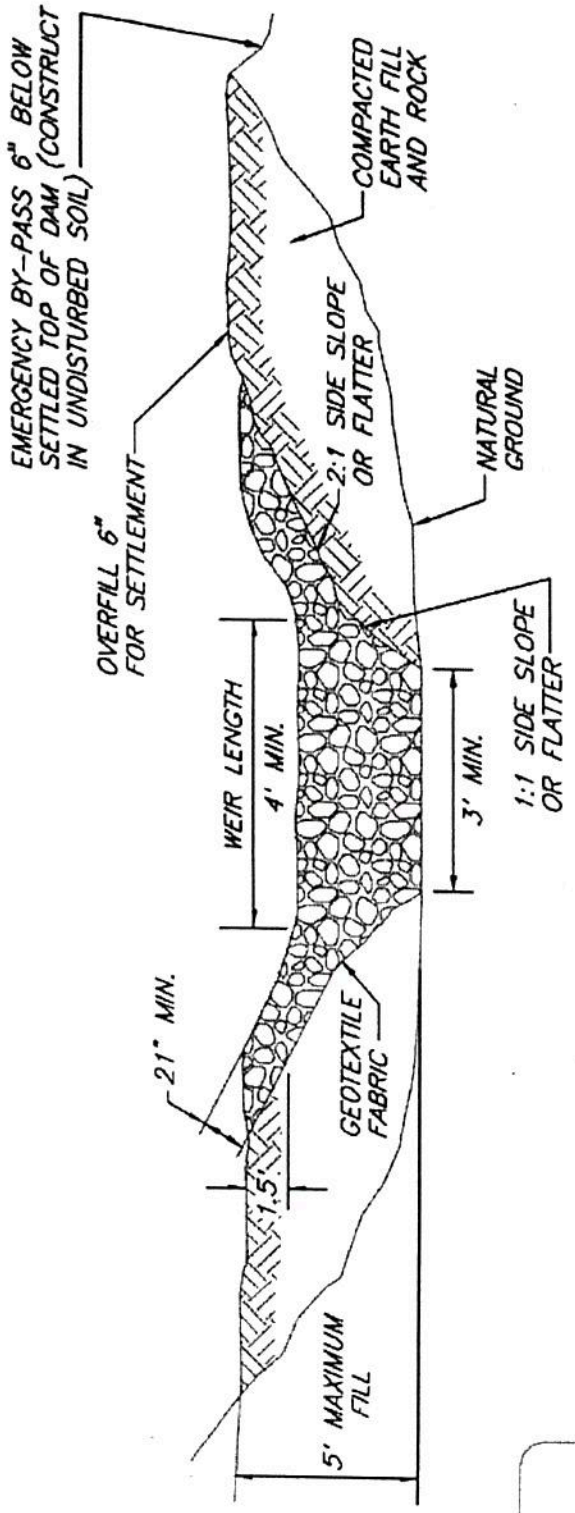
In areas where space is restricted, use multiple traps in a series to meet the design goal of 3600 cubic ft per acre of upland drainage. Get to final grade, seed and mulch as soon as possible to reduce trap maintenance and upkeep.



NOTE:
A SEDIMENT TRAP CAN BE USED FOR DISTURBED AREAS LESS THAN 5 ACRES.

PLAN

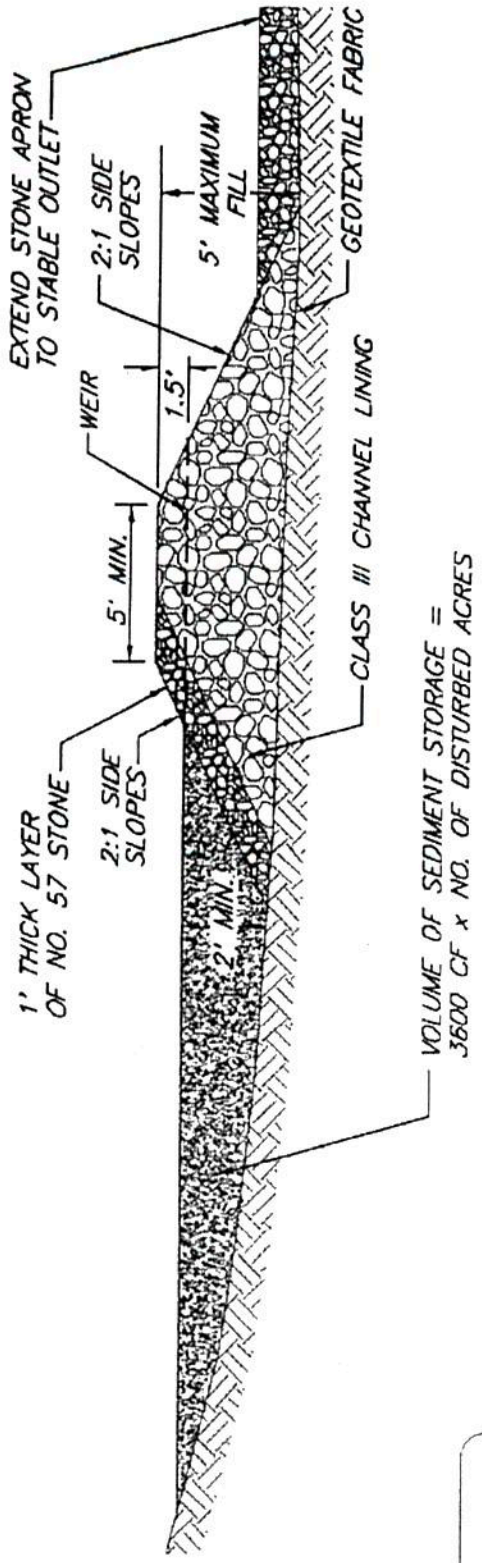
SEDIMENT TRAP



NOTE:
A SEDIMENT TRAP CAN BE USED FOR DISTURBED AREAS LESS THAN 5 ACRES.

EMBANKMENT AND SPILLWAY ELEVATION

SEDIMENT TRAP



NOTE:
A SEDIMENT TRAP CAN BE USED FOR DISTURBED AREAS LESS THAN 5 ACRES.

STONE SECTION

SEDIMENT TRAP

APPENDIX H

QUALITY ASSURANCE PROJECT PLAN

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is Site-specific and has been prepared for the Interim Corrective Measure (ICM) for the South Landfill and Curtain Area at the Atkemix Ten Inc. site located in Louisville, Kentucky.

The objectives of this QAPP are to provide data and documentation that confirmatory samples from excavated areas have concentrations of hexachlorobenzene at or below the Kentucky Department for Environmental Protection (KYDEP) industrial criteria. This QAPP provides comprehensive information regarding the project personnel responsibilities, and sets forth specific procedures to be used during sampling of soil and analyses of data.

2.0 PROJECT BACKGROUND

A detailed description of the history and background information for the Site is presented in the ICM Design Report.

2.1 GENERAL

This QAPP provides quality assurance/quality control (QA/QC) criteria for work efforts associated with sample analyses of soil. Methods for sample analyses have been selected to provide results which characterize the samples, such that the sampling objectives can be met.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Conestoga-Rovers & Associates (CRA) will undertake the sampling and oversee the sample analyses. Laboratory analysis will be performed by an approved laboratory under the National Environmental Laboratory Approval Program (NELAP).

3.1 PROJECT RESPONSIBILITIES

A brief description of the duties of the key personnel is presented below.

Project Manager - CRA

- Provides overall project management
- Ensures professional services by CRA are cost effective and of highest quality
- Ensures all resources of CRA are available on an as-required basis
- Participates in key technical negotiations with KYDEP and/or USEPA
- Provides managerial and technical guidance to the CRA Project Coordinator

Project Coordinator- CRA

- Provides day-to-day project management
- Provides managerial guidance to the CRA technical group
- Provides technical representation at meetings as appropriate
- Acts as liaison between the CRA and the KYDEP and/or USEPA
- Prepares/reviews reports

CRA QA/Q C Officer Analytical Activities

- Oversees and reviews laboratory data and activities
- Determines laboratory data corrective action
- Performs analytical data validation and assessment
- Reviews laboratory QA/QC
- Assists in preparation of final report
- Provides technical representation for analytical activities

Field Sampling Supervisor

- Provides immediate supervision of all on-Site activities
- Provides field management of sample collection and field QA/QC
- Provides technical representation for field activities
- Responsible for maintenance of the field equipment

Laboratory - Project Manager, Analytical Contractor

- Ensures resources of laboratory are available on an as-required basis
- Coordinates laboratory analyses
- Supervises laboratory's in-house Chain of Custody
- Schedules analyses of samples
- Oversees review of data
- Oversees preparation of analytical reports
- Approves final analytical reports

Laboratory - Quality Assurance/Quality Control Officer, Analytical Contractor:

- Overviews laboratory QA/QC
- Overviews QA/QC documentation
- Conducts detailed data review
- Decides laboratory corrective actions, if required
- Provides technical representation for laboratory QA/QC procedures

4.0 PROJECT OBJECTIVES

4.1 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective is to develop and implement procedures for sample collection and analyses which will provide data with an acceptable level of accuracy and precision.

Quality assurance measures for this project will begin with sample containers. Sample containers for waters will be purchased from a certified manufacturer and will be precleaned (I-Chem Series 200 or equivalent).

4.2 LABORATORY QUALITY ASSURANCE

The following subsections define the QA goals required to meet the Data Quality Objectives (DQOs) of the project.

4.2.1 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSES

The fundamental QA objective with respect to the accuracy, precision, and sensitivity of analytical data is to meet the QC acceptance criteria of each analytical protocol. Analytical methods and targeted detection limits listed have been specified to meet the industrial standards.

A summary of the targeted detection limits is provided in Table H.1. It should be noted that these limits are targeted detection limits only; limits are highly matrix dependent and may not always be achieved.

The method accuracy (percent recovery) will be determined by spiking selected samples (matrix spikes) with the method recommended spiking compounds. Accuracy will be reported as the percent recovery of the spiking compound(s) and will compare with the criteria given in the appropriate methods, as identified in Section 7.0.

The method(s) precision (reproducibility between duplicate analyses) will be determined based on the duplicate analysis of matrix spike samples for organic parameters and duplicate sample analyses for inorganic parameters. Precision will be reported as Relative Percent Differences (RPDs) between duplicate analyses; acceptance criteria will be as specified in the appropriate methods identified in Section 7.0.

4.2.2 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

A completeness requirement of 90 percent will be targeted for the program (see Section 13.1.3 for definition of completeness).

The quantity of samples to be collected has been estimated in an effort to effectively represent the population being studied. A summary of the sampling and analysis program is presented in Table H.2.

5.0 SAMPLING PROCEDURES

The sample collection procedures are described in the Field Sampling Plan (Appendix C).

The sample container, preservation, shipping, and packaging requirements are identified in Table H.3 and Section 6.3.

6.0 SAMPLE CUSTODY AND DOCUMENT CONTROL

The following documentation procedures will be used during sampling and analysis to provide Chain of Custody control during transfer of samples from collection through storage. Recordkeeping documentation will include use of the following:

i) Field log books (bound with numbered pages) to document sampling activities in the field

ii) Labels to identify individual samples

iii) Chain of Custody record sheet to document analyses to be performed

iv) Laboratory sample custody log book

6.1 FIELD LOG BOOK

In the field, the sampler will record the following information in the field log book (bound) for each sample collected:

i) Project number

ii) Sample matrix

iii) Name of sampler

iv) Sample source

v) Time and date

vi) Pertinent data (e.g., depth)

vii) Analysis to be conducted

viii) Sampling method/equipment used

ix) Appearance of each sample (i.e., color, evidence of soil staining)

x) Sample preservation added, if any

xi) Number of sample bottles collected

xii) Pertinent weather data

Each field log book page will be signed by the sampler.

6.2 SAMPLE NUMBERING

A unique sample numbering system will be used to identify each collected sample. This system will provide a tracking number to allow retrieval and cross-referencing of sample information. The sample numbering system to be used is described as follows:

Example: S-121695 - AA-XXX

Where:

S	-	Designates sample Type (S-Soil)
121695	-	Date of collection (mm/dd/yy)
AA	-	Sampler initials
XXX	-	Unique sample number

QC samples will also be numbered with a unique sample number.

6.3 CHAIN OF CUSTODY RECORDS

Chain of Custody forms will be completed for all samples collected during the program.

The Chain of Custody form will document the transfer of sample containers. Custody seals will be placed on each cooler. The cooler will then be sealed with packing tape. Sample container labels will include sample number, place of collection and date and time of collection. All samples will be refrigerated using wet ice at 4°C (±2°C) and delivered to the analytical laboratory within 24 to 48 hours of collection. All samples will be delivered to the laboratory by commercial courier or Contractor personnel. All samples will be stored at 4°C (±2°C) at the laboratory.

The Chain of Custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The Chain of Custody document will be signed, timed, and dated by the sampler when transferring the samples.

Each sample cooler being shipped to the laboratory will contain a Chain of Custody form. The Chain of Custody form will consist of four copies which will be distributed as follows: The shipper will maintain a copy while the other three copies will be enclosed in a waterproof envelop within the cooler with the samples. The cooler will then be

sealed properly for shipment. The laboratory, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records. One copy will be returned to the QA/QC Officer-Sampling and Analytical Activities upon receipt of the samples by the laboratory. One copy will be returned with the data deliverables package.

Upon receipt of the cooler at the laboratory, the shipping cooler and the custody seal will be inspected by the Sample Custodian. The condition of the cooler and the custody seal will be noted on the Chain of Custody record sheet by the Sample Custodian. The Sample Custodian will record the temperature of one sample (or temperature blank) from each cooler and the temperature will be noted on the Chain of Custody. If the shipping cooler seal is intact, the sample containers will be accepted for analyses. The Sample Custodian will document the date and time of receipt of the container, and sign the form.

If damage or discrepancies are noticed (including sample temperature exceedances), they will be recorded in the remarks column of the record sheet, dated and signed. Any damage or discrepancies will be reported to the Laboratory Project Manager and Laboratory QA/QC Officer before samples are processed.

6.4 SAMPLE DOCUMENTATION IN THE LABORATORY

Each sample or group of samples shipped to the laboratory for analysis will be given a unique identification number. The Sample Custodian will record the client name, number of samples and date of receipt of samples in the Sample Control Log Book. Samples removed from storage for analyses will be documented in the Sample Control Log Book.

The laboratory will be responsible for maintaining analytical log books and laboratory data as well as a sample (on hand) inventory for submittal to CRA on an "as required" basis. Raw laboratory data produced from the analysis of samples submitted for this program will be inventoried and maintained by the laboratory for a period of 5 years at which time CRA will advise the laboratory regarding the need for additional storage.

6.5 STORAGE OF SAMPLES

After the Sample Custodian has completed the Chain of Custody forms and the incoming sample log, the Chain of Custody will be checked to ensure that all samples

are stored in the appropriate locations. All samples will be stored within an access controlled custody room and will be maintained at 4°C (±2°C) until all analytical work is complete.

7.0 ANALYTICAL PROCEDURES FOR CHEMICAL ANALYSES

Samples collected for laboratory chemical analyses will be analyzed for the parameters listed in Table H.1, using the methods cited in Table H.2. These methods have been selected to meet the DQOs for each sampling activity. Table H.4 describes the minimum of deliverables required by the laboratory. However, supplemental requests for additional QA/QC data including raw chromatograms and spectra, etc., may be made periodically by CRA or its representative.

All sample results will be calculated using external standards with the exception of the samples analyzed by gas chromatograph/mass spectrometer (GC/MS); these methods employ the use of internal standards or isotopic dilution for analyte quantitation. The specific procedures for target analyte quantitation are detailed in the appropriate analytical methods.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established reporting limits. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method. The frequency of calibration and the concentration of calibration standards is determined by the manufacturers guidelines, the analytical method, or the requirements of special contracts.

A bound notebook will be kept with each instrument requiring calibration in which the activities associated with QA monitoring and repairs program will be recorded. These records will be checked during periodic equipment review and internal and external QA/QC audits.

8.1 GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

It is necessary to establish that a given GC/MS meets the standard mass spectral abundance criteria prior to initiating any ongoing data collection. This is accomplished through the analyses of tuning compounds as specified in the analytical methods.

Calibration of the GC/MS system will be performed daily at the beginning of the day or with each 12 hours of instrument operating time. All method-specified calibration criteria must be met prior to sample analyses. All calibrations must be performed using either average response factors or first-order linear regression (with a correlation coefficient requirement of ≥0.995). Higher order fits will not be allowed.

8.2 HIGH RESOLUTION GAS CHROMATOGRAPHY/ HIGH RESOLUTION MASS SPECTROMETRY (HRGC/HRMS)

All calibration and quantitation will be in accordance with the cited method.

8.3 GAS CHROMATOGRAPHY (GC)

Quantification of samples that are analyzed by GC/MS with element selective detectors shall be performed by external standard calibration. Standards containing the compounds of interest will be analyzed at a minimum of three concentrations to

establish the linear range of the detector. Single point calibration will be performed at the beginning of each day and at every tenth injection. The response factors from the single point calibration will be checked against the average response factors from multi-level calibration. If deviations in response factors are greater than those allowed by the analytical method protocols, then system recalibration will be performed. Alternatively, fresh calibration standards will be prepared and analyzed to verify instrument calibration.

All method-specified calibration criteria must be met prior to sample analyses. All calibrations must be performed using either average response factors or first-order linear regression (with a correlation coefficient requirement of ≥0.995). Higher order fits will not be allowed.

8.4 INSTRUMENTATION FOR INORGANIC ANALYSES

Inductively coupled argon plasma (ICAP) instrumentation, including ICP-MS, will be calibrated using a minimum of a blank and one standard. Mercury and cyanide instrumentation will be calibrated using a blank and a minimum of three calibration standards (four for mercury), with a correlation coefficient requirement of ≥0.995. All remaining method-specified calibration procedures will be performed and acceptance criteria will be met prior to sample analyses.

9.0 DATA REDUCTION, VALIDATION, ASSESSMENT, AND REPORTING

9.1 GENERAL

The contract laboratory will perform analytical data reduction and validation in-house under the direction of the Laboratory QA/QC Officer. The Laboratory QA/QC Officer will be responsible for assessing data quality and advising of any data which were rated "preliminary" or "unacceptable" or other qualifications based on the QC criteria outlined in the relevant methods, which would caution the data user of possible unreliability. Data reduction, validation and reporting by the laboratory will be conducted as detailed in the following:

i) Raw data produced and checked by the responsible analysts is turned over for independent review by another analyst

ii) The area supervisor reviews the data for attainment of quality control criteria presented in the referenced analytical methods

iii) Upon completion of all reviews and acceptance of the raw data by the laboratory operations manager, a computerized report will be generated and sent to the Laboratory QA/QC Officer

iv) The Laboratory QA/QC Officer will complete a thorough inspection of all reports

v) The Laboratory QA/QC Officer and area supervisor will decide whether any sample reanalysis is required

vi) Upon acceptance of the preliminary reports by the Laboratory QA/QC Officer, final reports will be generated and signed by the Laboratory Project Manager

Validation of the analytical data will be performed by the QA/QC Officer - Sampling and Analytical Activities. The data validation will be performed in accordance with the following documents: "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", United States Environmental Protection Agency (USEPA) 540/R-99/008, October 1999; and "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", USEPA 540-R-04-004, October 2004.

Assessment of analytical and in-house data will include checks on data consistency by looking for comparability of duplicate analyses, comparability to previous data from the same sampling location (if available), adherence to accuracy and precision control criteria detailed in this QAPP and anomalously high or low parameter values. The

results of these data validations will be reported to the Project Manager and the contract laboratory, noting any discrepancies and their effect upon acceptability of the data.

Raw data from field measurements and sample collection activities that are used in project reports will be appropriately identified and appended to the report. Where data have been reduced or summarized, the method of reduction will be documented in the report. Field data will be audited for anomalously high or low values that may appear to be inconsistent with other data.

9.2 LABORATORY REPORTING, DATA PRESENTATION, AND FINAL REPORT

Reporting and deliverables shall include, but not be limited to, all items listed in Table H.4.

All sample data and corresponding QA/QC data as specified in the analytical methods, shall be maintained accessible either in hard copy or on magnetic tape or disk (computer data files).

The laboratory will submit one copy of the final analytical report within 14 calendar days of receipt of the final sample included in the sample delivery group (SDG). An electronic copy of the results and QC in EQuIS format will also be required with the data package.

9.3 DOCUMENT CONTROL SYSTEM

A document control system ensures that all documents are accounted for when the project is complete.

A project number will be assigned to the project. This number will appear on sample identification tags, log books, data sheets, control charts, project memos and analytical reports, document control logs, corrective action forms and logs, QA plans, and other project analytical records.

9.4 QC CHECK POINTS AND DATA FLOW

The following specific QC check points will be common to all metals, GC, and GC/MS analyses. They are presented with the decision points:

Chemist - bench level checks

i) Systems check: sensitivity, linearity, and reproducibility within specified limits

ii) Duplicate analyses within control limits

iii) Matrix spike results within control limits

iv) Surrogate spike results within control limits (organics only)

v) Calculation/data reduction checks: calculations cross-checked, any discrepancies between forms and results evident, results tabulated sequentially on the correct forms

Laboratory Project Manager

i) Systems operating within limits

ii) Data transcription correct

iii) Data complete

iv) Data acceptable

Sample Control

i) Samples returned to sample control following analysis

Laboratory QA/QC Officer

i) QA objectives met

ii) QC checks are completed

iii) Final data and report package is complete

10.0 INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

10.1 QC FOR LABORATORY ANALYSES

Specific procedures related to internal laboratory QC samples are described in the following subsections.

10.1.1 REAGENT BLANKS

A reagent blank will be analyzed by the laboratory at a frequency of one blank per analytical batch. The reagent blank, an aliquot of analyte-free water or solvent, will be carried through the entire analytical procedure.

10.1.2 MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD)/ ANALYSES

An MS/MSD sample will be analyzed for organic parameters and a duplicate and MS will be analyzed for inorganic parameters at a minimum frequency of one per analytical batch. Acceptable criteria and analytes that will be used for MS are identified in the methods. Where method specified limits were not available, general control limits were used. Percent spike recoveries will be used to evaluate analytical accuracy while percent relative standard deviation or the RPD between duplicate analyses will be used to assess analytical precision.

10.1.3 SURROGATE ANALYSES

Surrogates are organic compounds which are similar to the analytes of interest, but which are not normally found in environmental samples. Surrogates are added to samples to monitor the effect of the matrix on the accuracy of the analysis. Every blank, standard and environmental sample analyzed by GC or GC/MS, including MS/MSD samples, will be spiked with surrogate compounds prior to sample preparation.

The compounds that will be used as surrogates and the levels of recommended spiking are specified in the methods. Surrogate spike recoveries must fall within the control limits specified in the methods. If surrogate recoveries are excessively low (<10 percent), the laboratory will contact the QA/QC Officer - Sampling and Analytical Activities for further instructions. Dilution of samples to bring the analyte concentration

into the linear range of calibration may dilute the surrogates out of the quantification limit. Reanalysis of these samples is not required. Assessment of analytical quality in these cases will be based on the MS/MSD sample analysis results.

10.2 QC FOR FIELD SAMPLING

To assess the quality of data resulting from the field sampling program, field duplicate and field blank samples will be collected (where appropriate) and submitted to the analytical laboratory as samples.

10.2.1 FIELD (RINSE) BLANKS

When well-dedicated equipment is not used and/or on the first sampling event in which non-certified clean equipment is used, field blanks will be used during the sampling programs to detect contamination introduced through sample collection procedures and equipment, external field conditions, sample transport, sample container preparation, sample storage, and/or the analytical process.

10.2.2 TRIP BLANKS

Trip blanks for volatile analyses will be prepared by the laboratory using analyte-free water and submitted with the sample collection containers. Trip blanks will be kept unopened in the field with sample bottles. Two trip blanks will be transported to the laboratory on a daily basis with each batch of aqueous volatile samples. The laboratory will analyze trip blanks as samples.

10.2.3 FIELD DUPLICATE SAMPLES

Field duplicate samples will be collected and used to assess the aggregate precision of sampling techniques and laboratory analysis. For every twenty investigative samples, a field duplicate sample will be collected using standard sampling procedures. This duplicate will be packed and shipped to the laboratory for analysis.

11.0 PERFORMANCE AND SYSTEM AUDITS

For the purpose of external evaluation, performance evaluation check samples are analyzed periodically by the laboratory. Internally, the evaluation of data from these samples is done on a continuing basis over the duration of a given project.

The QA/QC Officer - Sampling and Analytical Activities may carry out performance and/or systems audits to insure that data of known and defensible quality are consistently produced during this program.

Systems audits are qualitative evaluations of all components of field and laboratory quality control measurement systems. They determine if the measurement systems are being used appropriately. The audits may be carried out before all systems are operational, during the program, or after completion of the program. Such audits typically involve a comparison of the activities given in the QA/QC plan described herein, with activities actually scheduled or performed. A special type of systems audit is the data management audit. This audit addresses only data collection and management activities.

The performance audit is a quantitative evaluation of the measurement systems used for a monitoring program. It requires testing the measurement systems with samples of known composition or behavior to quantitatively evaluate precision and accuracy. A performance audit may be carried out by or under the auspices of the QA/QC Officer - Sampling and Analytical Activities without the knowledge of the analyst during each sampling event for this program.

It should be noted, however, that any additional external QA audits will only be performed if deemed necessary.

12.0 PREVENTATIVE MAINTENANCE

This section applies to both field and laboratory equipment. Specific preventive maintenance procedures for field equipment will be consistent with the manufacturer's guidelines. Specific preventive maintenance protocols for laboratory equipment will be consistent with the contract laboratory's Standard Operating Procedures (SOPs).

All analytical instruments to be used in this project will be serviced by laboratory personnel at regularly scheduled intervals in accordance with the manufacturers' recommendations. Instruments may also be serviced at other times due to failure. Requisite servicing beyond the abilities of laboratory personnel will be performed by the equipment manufacturer or their designated representative.

Routine maintenance of the instruments will be performed as per manufacturers' recommendations. The Laboratory Project Manager is responsible for the preventive maintenance of the instruments.

13.0 SPECIFIC ROUTINE PROCEDURES USES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

13.1 QA MEASUREMENT QUALITY INDICATORS

13.1.1 PRECISION

Precision will be assessed by comparing the analytical results between duplicate spike analyses. Precision as percent relative difference will be calculated as follows for values significantly greater than the associated detection limit:

$$\text{Precision} = \left| \frac{(D_2 - D_1)}{(D_1 + D_2)/2} \right| \times 100$$

D_1 = matrix spike recovery

D_2 = matrix spike duplicate spike recovery

For results near the associated detection limits, precision will be assessed based on the following criteria:

$$\text{Precision} = \left| \text{Original result - duplicate result} \right| < \text{CRDL}^1$$

13.1.2 ACCURACY

Accuracy will be assessed by comparing a set of analytical results to the accepted or "true" values that would be expected. In general, MS/MSD and check sample recoveries will be used to assess accuracy. Accuracy as percent recovery will be calculated as follows:

$$\text{Accuracy} = \frac{A - B}{C} \times 100$$

A = The analyte determined experimentally from the spike sample

B = The background level determined by a separate analysis of the unspiked sample

C = The amount of spike added

---

1 CRDL - Contract Required Detection Limit.

In some cases, MS and/or MSD recoveries may not be available due to elevated levels of the spiked analyte in the investigative sample. In such cases, accuracy will be assessed based on surrogate spike recoveries and/or laboratory control samples.

13.1.3 COMPLETENESS

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under normal conditions.

To be considered complete, the data set must contain all QC check analyses verifying precision and accuracy for the analytical protocol. In addition, all data are reviewed in terms of stated goals in order to determine if the database is sufficient.

When possible, the percent completeness for each set of samples will be calculated as follows:

$$\text{Completeness} = \frac{\text{usable data obtained}}{\text{total data planned}} \times 100 \text{ percent}$$

13.1.4 OUTLIERS

Procedures discussed previously will be followed for documenting deviations. In the event that a result deviates significantly from method established control limits, this deviation will be noted and its effect on the quality of the remaining data assessed and documented.

14.0 CORRECTIVE ACTION

The need for corrective action may be identified by system or performance audits or by standard QC procedures. The essential steps in the corrective actions system will be:

i) Checking the predetermined limits for data acceptability beyond which corrective action is required

ii) Identifying and defining problems

iii) Assigning responsibility for investigating the problem

iv) Investigating and determining the cause of the problem

v) Determination of a corrective action to eliminate the problem (this may include reanalysis or resampling and analyses)

vi) Assigning and accepting responsibility for implementing the corrective action

vii) Implementing the corrective action and evaluating the effectiveness

viii) Verifying that the corrective action has eliminated the problem

ix) Documenting the corrective action taken

For each measurement system, the laboratory QA/QC Officer will be responsible for initiating the corrective action and the Laboratory Project Manager will be responsible for implementing the corrective action.

15.0 QUALITY ASSURANCE REPORTS

Final reports will contain a discussion on QA/QC summarizing the quality of the data collected and/or used as appropriate for each phase of the project. The Project Manager who has responsibility for these summaries, will rely on written reports/memoranda documenting the data assessment activities, performance and systems audits and footnotes identifying qualifications to the data, if any.

Each summary of sampling activities will include a tabulation of the data including:

i) Field blank and field duplicate sample results

ii) Maps showing well locations

iii) An explanation of any sampling conditions or quality assurance problems and their effect on data quality

QA reports will be prepared by the QA/QC Officer - Sampling and Analytical Activities following receipt of all analytical data. These reports will include discussions of the following and their effects on the quality of the data reported:

i) Sample holding times

ii) Laboratory/reagent blank data

iii) Surrogate spike, matrix spike and matrix spike duplicate data

iv) Field QA/QC data

v) Pertinent instrument performance per method protocols

vi) Audit results (if performed)

In addition, the QA reports will summarize all QA problems, and give a general assessment of QA results versus control criteria for such parameters as accuracy and precision.

The QA reports will be forwarded to the Project Manager.

TABLE H.1

TARGET QUANTITATION LIMITS
INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
ATKEMIX TEN INC.
LOUISVILLE, KENTUCKY

	CAS Number	*Targeted Quantitation Limits (µg/Kg)*
Semi-Volatile Organic Compounds		
2,4,6-Trichlorophenol	88-06-2	330
2,4-Dichlorophenol	120-83-2	330
2,4-Dimethylphenol	105-67-9	330
2,4-Dinitrophenol	51-28-5	830
2-Chlorophenol	95-57-8	330
4,6-Dinitro-o-cresol	534-52-1	830
o-Nitrophenol	88-75-5	330
p-Chloro-m-cresol	59-50-7	330
Pentachlorophenol	87-86-5	830
Phenol	108-95-2	330
p-Nitrophenol	100-02-7	830
Bis(2-ethylhexyl) phthalate	117-81-7	330
Butyl benzyl phthalate	85-68-7	330
Diethyl phthalate	84-66-2	330
Dimethyl phthalate	131-11-3	330
Di-n-butyl phthalate	84-74-2	330
Di-n-octyl phthalate	117-84-0	330
2,4-Dinitrotoluene	121-14-2	330
2,6-Dinitrotoluene	606-20-2	330
Isophorone	78-59-1	330
Nitrobenzene	98-95-3	330
Acenaphthene	83-32-9	330
Acenaphthylene	208-96-8	330
Anthracene	120-12-7	330
Benzo[a]anthracene	56-55-3	330
Benzo[a]pyrene	50-32-8	330
Benzo[b]fluoranthene	205-99-2	330
Benzo[ghi]perylene	191-24-2	330
Benzo[k]fluoranthene	207-08-9	330
Chrysene	218-01-9	330
Dibenz[a,h]anthracene	53-70-3	330
Fluoranthene	206-44-0	330
Fluorene	86-73-7	330
Indeno(1,2,3 cd)pyrene	193-39-5	330

TABLE H.1

TARGET QUANTITATION LIMITS
INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
ATKEMIX TEN INC.
LOUISVILLE, KENTUCKY

	CAS Number	*Targeted Quantitation Limits (µg/Kg)*
Naphthalene	91-20-3	330
Phenanthrene	85-01-8	330
Pyrene	129-00-0	330
2-Chloronaphthalene	91-58-7	330
Hexachlorobenzene	118-74-1	330
Hexachlorobutadiene	87-68-3	330
2,4,5-Trichlorophenol	95-95-4	830
2-Methylnaphthalene	91-57-6	330
3,3'-Dichlorobenzidine	91-94-1	330
4-Chlorophenyl phenyl ether	7005-72-3	330
Bis(2-chloroethoxy)methane	111-91-1	330
Bis(2-chloroethyl)ether	111-44-4	330
Dibenzofuran	132-64-9	330
m-Nitroaniline	99-09-2	830
N-Nitrosodiphenylamine	86-30-6	330
N-Nitrosodipropylamine	621-64-7 1	330
o-Cresol	95-48-7	330
o-Nitroaniline	88-74-4	830
p-Chloroaniline	106-47-8	330
p-Cresol	106-44-5	330
p-Nitroaniline	100-01-6	830
Benzaldehyde	100-52-7	330
2,2'-oxybis(1-Chloropropane)	108-60-1	330
Acetophenone	98-86-2	330
Caprolactam	105-60-2	330
1,1'-Biphenyl	92-52-4	330
4-Bromophenyl-phenylether	101-55-3	330
Atrazine	1912-24-9	330
Carbazole	86-74-8	330

Note:

CAS - Chemical Abstract System.

TABLE H.2

SAMPLING AND ANALYSIS SUMMARY
INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
ATKEMIX TEN INC.
LOUISVILLE, KENTUCKY

Sample Matrix	*Analytical Parameters*	*Analytical Method*	*Estimated No. of Samples*	*Field Duplicates*	*MS/MSD*
Soil	Semi-Volatiles	SW-846 8270	TBD	1/20	1/20

Notes:

MS - Matrix Spike.
MSD - Matrix Spike Duplicate.

TABLE H.3

SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME PERIODS
INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
ATKEMIX TEN INC.
LOUISVILLE, KENTUCKY

Analyses	*Sample Containers*	*Preservation*	*Maximum Holding Time*	*Notes*
Soil				
Semi-Volatile Organic Compounds (SVOCs)	8-ounce glass jar	Cool 4°C	14 days from collection to extraction, 40 days from extraction to analysis.	Fill completely

TABLE H.4

LABORATORY REPORTING DELIVERABLES - STANDARD DATA PACKAGE
INTERIM CORRECTIVE MEASURE
SOUTH LANDFILL AND CURTAIN AREA
ATKEMIX TEN INC.
LOUISVILLE, KENTUCKY

A detailed report narrative should accompany each submission, summarizing the contents, and results.

A. Chain of Custody Documentation and Detailed Narrative[1]

B. Sample Information
- i) date collected
- ii) date extracted or digested
- iii) date analyzed
- iv) analytical method and reference

C. Final Results
- i) samples
- ii) laboratory duplicates [2]
- iii) method blanks
- iv) spikes, spike duplicates [2], [3]
- v) surrogate recoveries [2]
- vi) internal standard recoveries
- vii) TICs (if applicable)

D. Miscellaneous
- i) method detection limits and/or instrument detection limits
- ii) percent solids (where applicable)
- iii) metals run logs
- iv) dates of extraction or digestion and analysis for method blanks and blank spikes

All sample data and its corresponding (QA/QC) data shall be maintained accessible to CRA either in hard copy or on magnetic tape or disc (computer data files). All solid sample results must be reported on a dry-weight basis.

Notes:

(1) Any quality control outliers must be addressed and corrective action taken must be specified.
(2) Laboratory must specify applicable control limits for all quality control sample results.
(3) A blank spike must be prepared and analyzed with each sample batch.
TICs Tentatively Identified Compounds.