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Module 2: Selection of Controls and Site Planning

Introduction

This chapter outlines some of the available guidance for selecting erosion controls for construction sites. There are many manuals available for throughout the US, some have been in use for more than 25 years. One example is the *Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas*, that was produced for the Alabama Soil and Water Conservation Committee in 1993 by the SCS (now the NRCS). This local manual was recently revised in 2003 as guidance for the Phase II regulations (http://swcc.state.al.us/erosion_handbook.htm). An earlier Alabama manual was prepared by the Birmingham Regional Planning Commission as part of their "208" project in 1980: *Best Management Practices for Controlling Sediment and Erosion from Construction Activities*.

This chapter organizes some of the major control categories by site erosion control issues that are listed in the Phase II stormwater NPDES regulations that will affect construction sites. In addition, steps are provided to guide a user in preparing an erosion control plan for local construction sites. Later chapters discuss how local rains, soils, and objectives need to be considered when designing the selected controls for site specific conditions.

Also included in this chapter is Appendix 2-A which lists some costs for on-site erosion and sediment controls, summarized from *Costs of Urban Nonpoint Source Water Pollution Control Measures* prepared by the Southeast Wisconsin Regional Planning Commission (June 1991).

Example Construction Site Control Requirements

Construction site control requirements can be divided into two major categories, primary controls and supporting controls. It is also possible to categorize the controls into preventative measures (much preferred), usually termed erosion control practices, and treatment measures (typically not as effective), usually termed sediment controls.

These requirement categories are summarized in the following sections, along with example controls that can be used to help meet each requirement, as referenced to the SCS (NRCS) standards (as modified for New Jersey or Alabama 1993) and selected Virginia standards (as modified by the Wisconsin Department of Natural Resources 1994). This list is not comprehensive, but does indicate the range of available tools to address these issues. Many of the Phase II NDPES requirements are similar to these categories.

Over the years, two general family "trees" of construction site erosion manuals have evolved. The State of Virginia produced one of the earliest manuals in 1980, and is widely copied by many states and local governments throughout the country. Another type of manual has been produced by the SCS, and has been modified by them for a number of states. In recent years, there also has been a number of independently produced local manuals that reflect local conditions and include some emerging procedures and techniques. The following list shows representative examples from both of these types of manuals. These design standards for the needed practices can obviously be supplemented and many need to be modified to reflect local conditions, based on site-specific hydrology and erosion conditions, as described in the earlier chapters.

Primary Construction Site Control Requirements

The following lists available construction site controls that can be applied to different categories of site issues. Obviously, these lists are not comprehensive, but do illustrate the diversity and number of practices that can be used. These practices are organized by the different site issues that should be addressed for all construction sites. Typical applications would require that each category be addressed for all construction sites, but that the specific controls selected are based on site specific conditions.

Minimize Upslope Water Contributions.

Upslope water must be diverted around disturbed areas, and existing large channels passing through the site must be protected from erosion runoff. These controls must be installed before any other site disturbance in order to minimize the amount of water flowing across disturbed areas that would contribute to site erosion and place a greater burden on sediment control practices. These controls are all preventative, erosion control, practices.

 SCS photo	
	

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This photo of U.S. Route 1 being relocated around Dover, Delaware shows pipe slope drains that carry sediment laden runoff downslope to a collector swale. Note that the side slopes are graded and seeded as the work progresses to keep soil from washing down.</td>
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IECA photo</td>
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Slope Diversions

General Diversion Structures:
• Diversions (Virginia standards III -51)
• Diversions (SCS/NJ standards 4.2.1)
• Level spreaders (Virginia standards III-161)
• Diversions (SCS/AL standards III-DV-1)
• Diversion design (SCS/AL standards III-DN-6)

Temporary Diversion Structures:
• Temporary diversion (WDNR standards 4-7)
• Temporary diversion dike (Virginia standards III-139)
• Temporary fill diversion (Virginia standards III-43)
• Temporary right-of-way diversion (Virginia standards III-47)

Permanent Diversion Structures:
• Permanent diversion (WDNR standards 4-4)

General Channel Stabilization:
• Permanent channel stabilization (WDNR standards 4-48)
• Structural streambank stabilization (Virginia standards III-175)
• Rock and concrete lined waterways (WDNR standards 4-59)
• Channel stabilization (SCS/NJ standards 4.6.1)
• Lined waterway (SCS/NJ standards 4.11.1)
• Channel stabilization (SCS/AL standards III-CS-1, III DV-6)
• Gabion (SCS/AL standards III-GB-1)

Check Dams:
• Check dams (Virginia standards III-151)
• Temporary sediment trap Virginia standards III-55)
• Sediment traps (WDNR standards 4-35)
• Check dams (SCS/AL standards III-CD-1)

Riprap:
• Riprap (SCS/NJ standards 4.12.1)
• Riprap (Virginia standards III-137)
• Riprap (SCS/AL standards III-RR-1)

Waterway Drops:
• Grade stabilization structure (SCS/NJ standards 4.17.1)
• Waterway drop structure (Virginia standards III-155)
• Drop structure (SCS/AL standards III-DS-1)

• Gabion (SCS/AL standards III-GB-1)

Stream Crossing:
• Temporary stream crossing (Virginia standards III-183)
• Stream crossing (SCS/AL standards III-SX-1)

Grassed Waterways:
• Vegetative streambank stabilization (Virginia standards III-165)
• Grassed waterways (SCS/NJ standards 4.3.1)
• Sodding (WDNR standards 4-52)
• Grassed waterway (WDNR standards 4-55)
• Geotextile reinforced grassed waterway (WDNR standards 4-57)
• Waterway or stormwater channels (SCS/AL standards III-WW-1)

Slope Protection:
• Slope protection strictures (SCS/NJ standards 4.5.1)
• Temporary slope drain Virginia standards III-89)
• Paved flume (Virginia standards III-95)
• Paved flume (SCS/AL standards III-PF-1)
• Retaining wall (SCS/AL standards III-RW-1)
• Down drain structure (SCS/AL standards III-DN-1)
• Gabion (SCS/AL standards III-GB-1)

Provide Downslope Controls
In general, wet detention (sediment) ponds are required to treat all runoff leaving construction sites for drainage areas greater than about 10 acres. If the drainage area is less than 10 acres, then filter fences, or equivalent perimeter sediment controls, should be used at all side slope and downslope edges of the construction site. These controls must also be installed before any other site disturbance. These controls are all treatment, or sediment control, practices, as they are intended to remove sediment from the flowing water before it leaves the construction site.

General Sediment Fence:
• Sediment barrier (SCS/NJ standards 4.13.1)
• Sediment barrier/fence (SCS/AL standards III-SF-1)
• Retrofitting (SCS/AL standards III-RT-1)

Filter Fabric Fences:
• Silt fence (Virginia standards III-17)
• Filter fabric fences (WDNR standards 4-11)
• Filter fabric barriers (WDNR standards 4-25)
• Temporary right-of-way diversion (Virginia standards III-47)
• Sediment barrier/fence (SCS/AL standards III-SF-1)

Straw Bale Fences:
• Straw bale fences (WDNR standards 4-15)
• Straw bale barriers (WDNR standards 4-30)
• Straw bale barriers (Virginia standards III-9)
• Brush barrier Virginia standards III-25)
• Sediment barrier/fence (SCS/AL standards III-SF-1)

Sediment Basins:
• Temporary sediment basin (Virginia standards III-59 and III-87)
• Sediment basins (SCS/NJ standards 4.4.1)
• Sediment basins (WDNR standards 4-39)
• Minimum area for sedimentation basins (SCS undated)
• Sediment basin (SCS/AL standards III-SB-1)
• Storm water retention structure (SCS/AL standards III-RS-1)

Outlet Protection:
• Outlet protection (Virginia standards III-127)
• Conduct outlet protection (SCS/NJ standards 4.14.1)
• Outlet protection (SCS/AL standards III-OP-1, III-DN-6)

Protect Disturbed Areas
Disturbed areas exposed for extended periods (14 days is a typical limit) without any activity must be stabilized with mulches, temporary vegetation, permanent vegetation, or by other equivalent control measures. Again, these controls would all be considered preventative, or erosion control, practices.

Mulching:
• Mulching (Virginia standards M-247)
• Mulching (WDNR standards 4-19)
• Stabilization with mulch only (SCS/NJ standards 3.3.1)
• Guide to mulching materials (King Co. Wash. 1989)
• Mulching (SCS/AL standards IV-MU-1)

Local Vegetation Information:
• Vegetative BMPs to protect exposed surfaces (BRPC temporary and permanent covers)
• Lime and fertilizer requirements for plant growth (BRPC Appendix 1)
• Planting guide (SCS, Jefferson County, AL-6, 1975)
• Seed, fertilizer, and lime requirements for cost-share rates (SCS, Jeff. Co., Exhibit 1)
• Selection of vegetation (SCS/AL standards IV-7)
• Information on installing vegetative measures (SCS/AL standards Appendix A4)

General Seeding:
• Surface roughening (Virginia standards III-201)
• Topsoiling (Virginia standards III-207)
• Topsoiling (SCS/NJ standards 3.5.1)
• Seeding (WDNR standard 4-22)
• Topsoil (SCS/AL standards III-TS-1)
• Surface roughening (SCS/AL standards III-SR-1)

Temporary Seeding:
• Temporary seeding (Virginia standards M-211)
• Temporary vegetative cover for soil stabilization (SCS/NJ standards 3.1.1)
• Temporary vegetation-seeding (SCS/AL standards IV-TV-1)

Permanent Seeding..
• Permanent seeding (Virginia standards III-215)
• Permanent vegetative cover for soil stabilization (SCS/NJ standards 3.2.1)
• Permanent seeding (SCS/AL standards IV-PS-1)

Sodding.
• Sodding (Virginia standards M-231)
• Permanent stabilization with sod (SCS/NJ standards 3.4.1)
• Bermudagrass establishment Virginia standards III-241)
• Sodding (SCS/AL standards IV-SD-1)

Trees and Shrubs:
• Trees, shrubs, vines, and ground covers (Virginia standards III-257)
• Shrub, vine, and ground cover planting (SCS/AL standards IV-SVG-1)

Maintenance of Vegetation:
• Maintaining vegetation (SCS/NJ standards 3-6.1)
• Tree preservation and protection (Virginia standards III-279)
• Tree protection during construction (SCS/NJ standards 3.9.1)
• Tree preservation and protection (SCS/AL standards IV-TPP-1)
• Irrigation (SCS/AL standards IV-IR-1)

Supporting Construction Site Control Requirement
A number of construction site controls are also typically specified in local ordinances. The following are examples of some of these controls, some of which are preventative (represented by the “good-housekeeping” controls) while others are treatment (such

as inlet filters) practices.

Control Wastewater from Dewatering Operations
Wastewater from site dewatering operations should be controlled to limit the discharge of sediment. Typical criterion restricts particles greater than 50 micrometers from being discharged during dewatering operations. This level of control can be obtained by using simple sedimentation devices sized according to the maximum dewatering pumping rates.

• Dewatering settling basin (WDNR standards 4-72)
• Dewatering sediment basin (SCS/AL standards III-RS-5)

Properly Dispose of Construction Debris
All building material and other wastes needs to be removed from the site for disposal in licensed disposal facilities. No wastes or unused building materials can be buried, dumped, or discharged at construction sites.

Control Tracking of Sediment Off-Site
Each site needs to have graveled access drives and parking areas to reduce the tracking of sediment onto public or private roads. An example regulation would require that all unpaved roads on the site carrying more than 25 vehicles per day also be graveled. Any sediment or debris tracked onto public or private roads needs to be removed daily by street cleaners.

Entrance Controls:
• Temporary gravel construction entrance (Virginia standards III-1)
• Stabilized construction entrance (SCS/NJ standards 4.15.1)
• Construction exit (SCS/AL standards III-CE-1)

Site Road Controls:
• Construction road stabilization (Virginia standards III-5)
• Temporary graveled access roads and parking areas (WDNR standards 4-74)
• Traffic control (SCS/NJ standards 4.9.1)
• Construction exit (SCS/AL standards III-CE-1)

Dust Control:
• Dust control Virginia standards III-299)
• Dust control (SCS/NJ standards 4.10.1)
• Dust control (SCS/AL standards IV-DU-1)

Protect Storm Drain Inlets
All storm drain inlets need to be protected from erosion materials.

• Storm drain inlet protection (Virginia standards III-29)
• Inlet protection barriers (WDNR standards 4-64)
• Storm sewer inlet protection (SCS/NJ standards 4.16.1)
• Inlet insert baskets (WDNR standards 4-66)
• Inlet protection (SCS/AL standards III-NP-1)

Minimize Area Disturbed
One of the most effective erosion controls would require that all construction activities be conducted in a logical sequence to minimize the area of bare soil disturbed at any one time.

• Land grading (SCS/NJ standards 4.1.1)

Control Erosion Scour from Roof Runoff
Roof runoff must be directed to stabilized surfaces.

• Down drain structure (SCS/AL standards III-DN-1)

Control Erosion from Storage Piles
All uncovered soil or dirt storage piles also need to be controlled to prevent erosion. An example regulation may contain the following restrictions. An uncovered storage pile, containing more than 10 cubic yards of material, should be located more than 25 feet from a roadway or drainage channel. If these piles remain for 14 or more days, then their surfaces must be stabilized. If the piles will be in place for less than 14 days, then their perimeters must be surrounded by filter fencing or straw bales. Dirt or soil storage piles located less than 25 feet from the road, containing more than 10 cubic yards of material, and in place for 14 or more days must be covered with tarps or other control. If the piles will be in place for less than 14 days, then their perimeters must be surrounded by filter fencing or straw bales. Storm drain inlets must be protected from potential erosion from near street storage piles by filter fencing or other appropriate barriers.

Many of the above practices may be applicable for erosion control of storage piles, including filter fabric and straw bale fences for perimeter protection, plus temporary mulching and seeding practices to reduce direct erosion of material from the storage piles.

Planning Steps and Components for Construction Site Control
Most construction site control handbooks and design manuals include some information pertaining to the selection of controls needed for construction sites, and guidance on submitting acceptable control plans. As an example, the following discussion lists the minimum standards applicable for all construction sites in Virginia. Also included is planning guidance from the 1992 *Alabama Handbook* for erosion control.

Virginia Erosion and Sediment Control Regulations, Minimum Standards
The following is the list of the 19 “minimum standards” for erosion and sediment control as required in Section 4VAC50-30-40 of the Virginia Erosion and Sediment Control Regulations. This is a typical listing of most erosion and sediment control regulations and indicates which controls need to be considered for construction site activities.

(1) Soil Stabilization.
Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 30 days, but less than one year. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year

(2) Soil Stockpile Stabilization.
During construction, soil stockpiles and borrow areas shall be stabilized or protected with sediment trapping measures. Temporary protection and permanent stabilization shall be applied to all soil stockpiles on site and borrow areas or soil intentionally transferred off site.

(3) Permanent Stabilization.
Permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is: uniform, mature enough to survive, and will inhibit erosion.

Permanent Stabilization

(4) Sediment Basins & Traps.
Sediment basins, sediment traps, perimeter dikes, sediment barriers, and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

(5) Stabilization of Earthen Structures.
Stabilization measures shall be applied to earthen structures such as dams, dikes, and diversions immediately after installation.

(6) Sediment Traps and Sediment Basins.
Sediment traps and basins shall be designed and constructed based upon the total drainage area to be served by the trap or basin as follows:

> Sediment Traps: Only control drainage areas less than three acres. Minimum storage capacity of 134 cubic yards per acre of drainage area.
>
> Sediment Basins: Control drainage areas greater than or equal to three acres. Minimum storage capacity of 134 cubic yards per acre of drainage area. The outfall system shall, at a minimum, maintain the structural integrity of the basin during a 25 year storm of 24-hour duration

(7) Cut and Fill Slopes Design and Construction.
Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

(8) Concentrated Runoff Down Slopes.
Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume, or slope drain structure.

(9) Slope Maintenance.
Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

(10) Storm Sewer Inlet Protection.
All storm sewer inlets made operable during construction shall be protected so that sediment-laden water cannot enter the stormwater conveyance system without first being filtered/treated to remove sediment.

(11) Stormwater Conveyance Protection.
Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and the receiving channel.

(12) Work in Live Watercourse.
When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport, and stabilize the work area to the greatest extent possible during construction; nonerodible material shall be used for the construction of causeways and cofferdams; and earthen fill may be used for these structures if armored by nonerodible cover materials

Working in Streams

Sidebar Story:
The state power authority built a hydraulic turbine generating plant on the eastern shore of a pristine lake in 1918. After almost 80 years of operation a crack was noticed in the supporting structural carriage for one of the turbines at the plants outlet on the lake. In order to gain access to the turbine area the authority needed to construct a coffer dam out into the lake, then dewater the area, construct access and complete repairs.

The neighborhood along the shore and inhabitants of the area had changed dramatically in the decades since the plant was first built. There were many concerns about construction impacts such as noise, access and disruption of traffic as well as environmental impacts to the lake, even with the construction of a coffer dam to isolate the work area. The project engineer for the authority investigated constructing an earthen coffer dam with a rock riprapped face for wave protection. The length would be only 150 feet and the height needed about 4 feet. He found that this would take a week to construct at a cost of about $ 27,000 and then another week to remove after the turbine repairs were made. All this with disturbance to the lake bed.

After consulting with an erosion control expert, he decided to use a coffer dam of two poly-ethylene tubes filled with water and wrapped with a durable geo-textile. The system cost $ 2,100 and was installed in just four hours, including dewatering. At the completion of the work, the system was drained and removed in an hour and a half. This system was floated into position then filled with water and had essentially no disturbance to the lake bed. It’s height extended well above lake level to allow protection from wave action by wind or watercraft. Although this structure is not bullet proof and can freeze solid if used in cold climate applications, it is an excellent system for isolating work areas that require small depth control with low environmental impact.

These two photos at the New York State Electric & Gas Corporation hydro-electric plant on Keuka Lake demonstrate the use of water structures as cofferdams. Two tubes of polyethylene wrapped with a geo-textile, these are filled with water to act as a low ground pressure, environmentally friendly cofferdam. They can be installed and removed quickly.

This is another example of how utility line crossings can be accomplished without routing construction equipment through the stream. This Aqua-Barrier allows one side to be completed then the set up can be moved to the opposite bank for completion of the crossing.

Water-Filled Coffer Dams Allowing Near-Shore Work

Sidebar Story

Not 60 miles from a major U.S. City, a nuclear fuel processing facility was operating on this 54 acre lake from 1946-1972. Dam safety inspections statewide uncovered a number of dams that were below safety standards. This particular project required the installation of a reservoir drain system in the high hazard dam in order to assist in meeting current safety standards. Since the existing 100 foot long dam had a competent concrete core in the center of the dam beginning about four feet below the top of dam and extending down to the rock foundation, breaching the dam to install a conventional pipe/gate system was not feasible.

It was decided to install a siphon system for reservoir drawdown. To do this and maintain the integrity of the ecosystem of the lake, a coffer dam system was constructed of structural steel A-frames with a geo-membrane that was placed on the frame and extended out into the pool area. The entire system was put in place by divers and in this case this coffer dam was about 125 feet long and about 8 feet high. Once the dam is in place the work site is dewatered by pumps whose intakes are located well away from the base of the structural frame.

Once the construction was complete, the area cleaned up of excess materials and some fish habitat structures placed, the water was pumped back into the work area and the divers then removed the coffer dam with minimal disturbance to the lake bottom.

These photos show the use of a Port-A-Dam system in use at Nuclear Lake in Dutchess County, New York. This 54 acre lake is about 12 feet deep and would have had to be pumped dry to fix the dam. This system was installed by divers, then the interior pumped dry for working. This preserved the lake eco-system.

Near-Shore Barrier Dams

(13) Crossing Live Watercourse.
When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of nonerodible material shall be provided.

(14) Regulation of Watercourse Crossing.
All applicable federal, state and local regulations pertaining to working in or crossing live watercourses shall be met.

(15) Stabilization of Watercourse.
The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

(16) Underground Utility Line Installation.
Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria: no more than 500 linear feet of trench may be opened at one time; excavated material shall be placed on the uphill side of trenches; effluent from dewatering operations shall be filtered or passed through an approved sediment trapping device, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property; material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization; restabilization shall be accomplished in accordance with these regulations; and comply with applicable safety regulations.

(17) Vehicular Sediment Tracking.
Where construction vehicle access routes intersect paved or public roads: provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface; where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day; and sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner.

(18) Removal of Temporary Measures.
All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization, or after the temporary measures are no longer needed, unless otherwise authorized by the program authority. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

(19) Stormwater Management.
Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion, and damage due to increases in volume, velocity, and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration in accordance with the following standards and criteria:

- Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe, or storm sewer system. For those sites where runoff is discharged into a pipe or pipe system, downstream stability analyses at the outfall of the pipe or pipe system shall be performed.

- Adequacy of all channels and pipes shall be verified:

  - Natural Channels- use 2-year storm event
  - Manmade Channels- use 2- and 10-year storm events
  - Pipe and Pipe Systems-use 10-year storm event

- If existing natural receiving channels or previously constructed man-made channels or pipes are not adequate, the applicant shall provide channel, pipe, or pipe system improvement or provide a combination of channel improvement, site design, stormwater detention, or other measures that is satisfactory to the program authority to prevent downstream erosion.

- Provide evidence of permission to make the improvements

- If the applicant chooses an option that includes stormwater detention, he shall obtain approval from the locality of a plan for maintenance of the detention facilities. The plan shall set forth the maintenance requirements of the facility and the person responsible for performing the maintenance.

- Outfall from a detention facility shall be discharged to a receiving channel, and energy dissipators shall be placed at the outfall of all detention facilities as necessary to provide a stabilized transition from the facility to the receiving channel.

- Increased volumes of sheet flows that may cause erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.

- In applying these stormwater runoff criteria, individual lots or parcels in a residential, commercial or industrial development shall not be considered to be separate development projects. Instead, the development as a whole shall be considered to be a single development project.

- All measures used to protect properties and waterways shall be employed in a manner that minimizes impacts on the physical, chemical and biological integrity of rivers, streams and other waters of the state.

The complete, unedited version of the Virginia Erosion and Sediment Control Regulations (4VAC50-30) as codified in the Virginia Administrative Code is available through the Commonwealth of Virginia website at www.vipnet.org/vipnet/portal/government.

Alabama Procedures for Developing Plans for Erosion and Sediment Control

The following discussion is excerpted from the *Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas*, produced by the Alabama Soil and Water Conservation Committee Montgomery, AL, July 1993. This handbook was recently revised in 2003 (http://swcc.state.al.us/erosion_handbook.htm).

An erosion and sediment control plan is a working document which explains and stipulates the measures and actions which are to be taken to control potential erosion and sedimentation problems. The plan has a written narrative and a graphic portion known as a treatment map or site map. It contains specifications that describe how the measures are to be installed to meet the appropriate criteria. Also, it contains enough information to ensure that the party responsible for development of a site can install the measures in the correct sequence at the appropriate season of the year. The plan may contain a description of the potential erosion and sedimentation problems.

The purpose of an erosion and sediment control plan is to establish clearly which control measures are intended to prevent erosion and off-site sedimentation. The plan should serve as a blueprint for the location, installation, and maintenance of practices to control all anticipated erosion, and prevent sediment from leaving the site.

Developers and others can minimize erosion, sedimentation, and other construction problems by selecting areas appropriate for the intended use. Tracts of land vary in suitability for development. Knowing the soil type, topography, natural landscape values, drainage patterns, flooding potential, and other pertinent data helps identify both beneficial features and potential problems of a site.

The planner should have a sound understanding of the requirement of any state and/or local erosion and sediment control laws, erosion and sedimentation control principles, and vegetative, structural, and management type measures and their role in erosion and sediment control before preparing an erosion and sedimentation control plan on a selected site.

The erosion and sediment control plan should be a separate document. The plan should include, at a minimum, the erosion and sediment control layout, measure details and specifications. The approved plan should be included in the general construction contract.

An erosion and sediment control plan must contain sufficient information to describe the site development and the system intended to control erosion and off-site sedimentation. If regulations exist, the plan must satisfy the approving authority that the potential problems of erosion and sedimentation will be adequately addressed. The length and complexity of the plan should be commensurate with the size and importance of the project, severity of site conditions, and the potential for off-site damage.

Obviously, a plan for constructing a house on a single subdivision lot may not need to be as complex as a plan for a shopping center development. Plans for projects undertaken on flat terrain will generally be less complicated than plans for projects constructed on steep slopes with higher erosion potential. The greatest level of planning and detail should be evident on plans for projects which are adjacent to flowing streams, dense population centers, high value properties, etc., where damage may be particularly costly or detrimental to the environment.

The owner or lessee of the land being developed has the responsibility for plan preparation and submission. The owner or lessee may designate someone (i.e, an engineer, architect, contractor, etc.) to prepare and implement the plan, but the owner or lessee retains the ultimate responsibility. The following outline of the procedures can be used by planners and reviewers as a checklist for plan content and format.

Components of the Plan
As a minimum, include the following components in the plan:

• *a location or vicinity map, a narrative written in a clear, concise manner that describes the type of proposed development, existing conditions at the site and adjacent areas, proposed erosion and sediment control measures, and rationale or justification for those decisions*. Adequate information provided by the narrative is important for the plan reviewer who may not be familiar with the site and to the construction superintendent and inspector who are responsible for plan installation. Details of the narrative can save time and insure that erosion and sediment control measures are properly installed.

• *specifications for planned erosion and sediment control measures*. These should include standards and specifications for both vegetative and structural measures. The specific name and number of planned measures should be identified in the narrative and marked on the site plan or treatment map. By properly referencing the state *Handbook*, the planner could reduce the need for detailed drawings and lengthy conservation practice descriptions. New innovative conservation measures or modifications to the State standard measures may be used, but only after being thoroughly described, detailed designs developed, and concurred in by the approving authority.

• *site plan or treatment map*. This map may include a site development drawing and a site erosion and sediment control drawing depicting type and, to the extent possible, locations of planned conservation practices. Map scales and drawings should be appropriate for clear interpretation.

Site planners are urged to use the standard coding system for conservation practices contained in the *Alabama Handbook*. Use of the coding system will result in increased uniformity of plans and better readability for plan reviewers, job superintendents, and inspectors statewide.

The following components should be separate or included as applicable in the written narrative or site plan:
supporting material such as sketches and calculations for design of conservation practices, construction schedule, other maps (e.g., soils maps, charts, or other materials) as applicable.

Step-By-Step Procedures for Plan Development
Step 1 -Data Collection
Inventory the existing site conditions to gather information which will help the planner develop the most effective erosion and sediment control plan. The information obtained should be shown on a map and verbally explained in the narrative portion of the plan.

A. Topography - A small-scale topographic map of the site should be prepared to show the existing contour elevations. The suggested interval is usually 1 to 5 feet, depending upon the slope of the terrain. However, the contour interval may be increased on steep slopes.

B. Drainage Patterns - All existing drainage swales and patterns on the site should be located and clearly marked on the topographic map.

C. Soils - Major soil type(s) on the site should be determined and shown on the topographic map. Soils information can be obtained from the County Soil Survey, available from the local Soil Conservation District Office. Commercial soils evaluations are also available from consultants. For ease of interpretation, soils information should be plotted directly onto the map, or an overlay of the same scale.

D. Ground Cover - The existing vegetation on the site should be shown. Such features as trees and other woody vegetation, grassy areas, and unique vegetation should be shown on the map. In addition, existing bare or exposed soil areas should be indicated.

E. Adjacent Areas - Areas adjacent to the site should be delineated on the topographic map. Applicable features such as streams, roads, houses, and utilities or other buildings and wooded areas should be shown.

Step 2 - Data Analysis
When all of the data in Step 1 are considered together, a picture of the site potentials and limitations should begin to emerge. The site planner should be able to determine those areas which have potentially critical erosion hazards. The following are some important points to consider in site analysis:

A. Topography - The primary topographic considerations are slope steepness and slope length. The longer and steeper the slope, the greater the erosion potential from surface runoff. When the percent of slope has been determined, areas of similar steepness should be outlined. Slope gradients can be grouped into three general ranges of soil erodibility:

0-2% - Low erosion hazard potential
2-5% - Moderate erosion hazard potential
over 5% - High erosion hazard potential

Within these slope gradient ranges, longer slope lengths further increase the erosion hazard. Therefore, in determining potential critical areas, the site planner should be aware of excessively long slopes. As a general rule, the erosion hazard will become critical if slope lengths exceed these combined values:

0-2% - 300 feet
2-5% - 150 feet
over 5% - 75 feet

Figures 2-1 and 2-2 are examples of pre-development and final grading site topography evaluations for these slope erosion hazards. The pre-development topography shows much of the site having steep slopes and critical erosion hazards because many of the steep slopes were greater than 75 feet long. The site was originally heavily wooded, with little observed erosion problems. However, the site clearing operations left these soils exposed at these slopes while the site was slowly graded to the final site contours, as shown in Figure 2-2. Because the site was located at the top of the local drainage area and was surrounded by major roads on the upslope sides, little off-site drainage flowed across the site as it was being developed. Diversion structures were therefore not needed, and downslope controls were critical during the grading operation to minimize sediment transport off the site. Because the site was relatively small (between 5 and 10 acres), with concurrently small subdrainage areas, only filter fabric fences were used, and not a sediment pond. However, a pond would have been more suitable due to the most of the site draining towards one area. The final grading contours shown on Figure 2-2 show that most of the site was graded flat for building pads and therefore had low erosion hazards. The slopes on the bottom edges of the terraces however are quite steep and have high erosion hazard potential. The final slope lengths are all relatively short, so the only critical erosion hazard is near the bottom outlet area. These steep slopes require protection, as described in Chapter 5.

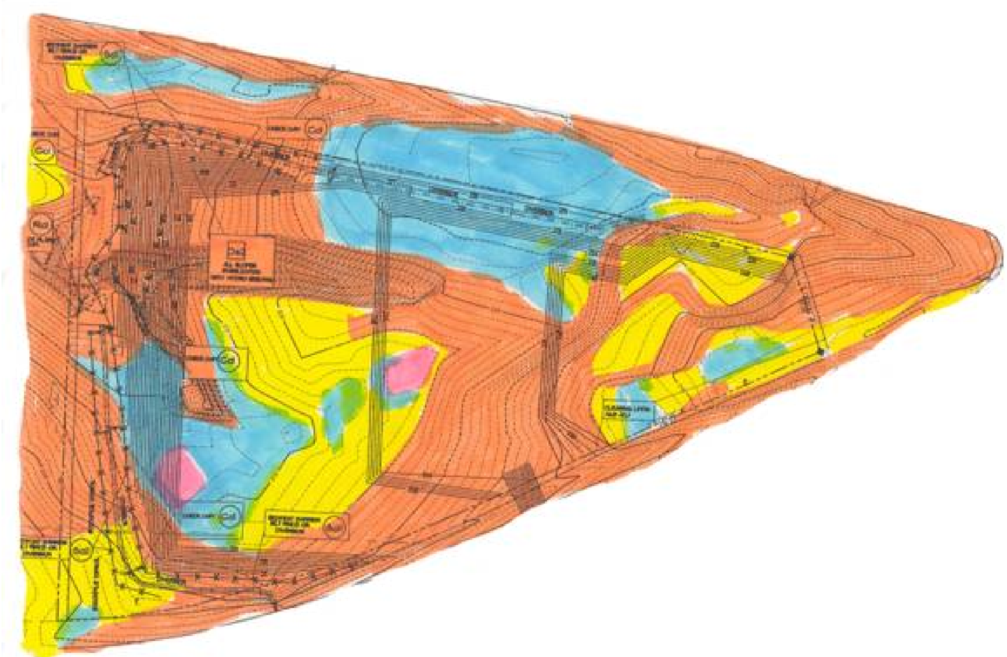

Figure 2-1. Evaluation of pre-development topography (dashed contour lines) for erosion hazards (orange: >10% slopes and high hazard; yellow: 5 to 10% slopes and high hazard; blue: 2 to 5% slopes and moderate hazard; pink: <2% slopes and low hazard).

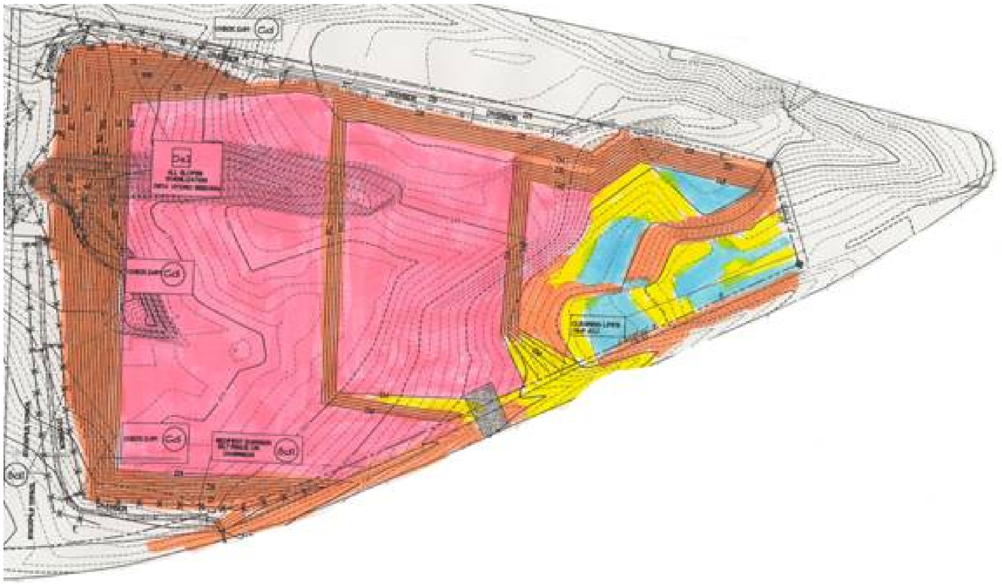

Figure 2-2. Evaluation of final grading plan topography (solid contour lines) for erosion hazards (orange: >10% slopes and high hazard; yellow: 5 to 10% slopes and high hazard; blue: 2 to 5% slopes and moderate hazard; pink: <2% slopes and low hazard).

B. Drainage Patterns - Natural drainage patterns exist on the land. These patterns, known as swales, depressions, and natural watercourses, should be identified in order to plan around critical areas where water will concentrate. Where it is possible, natural drainageways should be used to convey runoff over and off the site to avoid the expense and problems of constructing an artificial drainage system. Man-made ditches and waterways will become part of the erosion problem if they are not properly stabilized. Care should also be taken to be sure that increased runoff from the site will not erode or flood the existing natural drainage system; this includes locating possible sites for stormwater detention. Chapter 4 presents examples for determining site drainage evaluations.

C. Soils - Such soils properties as natural drainage, depth to bedrock, depth to seasonal water table, permeability, shrink-swell potential, texture, and erodibility should exert a strong influence on land development decisions. Also, the flood hazard related to the soils can be determined based on the relationship between soils and flooding. A discussion of soils, along with interpretations for developmental uses, is included in the County Soil Maps, from the local NRCS (SCS) offices. Chapters 3 and 4 both discuss important soil considerations.

D. Ground Cover - Ground cover is the most important factor in terms of preventing erosion. Any existing vegetation which can be saved will help prevent erosion. Trees and other vegetation protect the soil as well as beautify the site after construction. If the existing vegetation cannot be saved, the planner should consider staging construction, temporary mulching and/or vegetation. Staging of construction involves stabilizing one part of the site before disturbing another. In this way, the entire site is not disturbed at once, minimizing the time ground is left bare. Temporary mulching and/or vegetation involves seeding or mulching areas which would otherwise be left bare for long periods of time; therefore, time of exposure is limited and the erosion hazard is reduced.

E. Adjacent Areas - Generally, the analysis of adjacent properties should focus on areas downslope or downstream from the construction project. Watercourses which will receive direct runoff from the site should be of major concern; these streams should be analyzed to determine their carrying capacity. The potential for sediment pollution of these watercourses should be considered as well as the potential for downstream channel erosion due to increased velocity and peak flow rate of storm water runoff from the site. The potential for sediment deposition on adjacent properties due to sheet and rill erosion should also be analyzed so that appropriate sediment retention measures can be planned.

Step 3 - Facility Plan Development
This step does not apply to established developments. On the other hand, this step is relevant to those situations where facilities are being planned and there is flexibility in their extent and location. After analyzing the data about the site and determining any site limitations, the planner can then develop a site plan that is in harmony with the landscape. An attempt should be made to locate the buildings, roads, and parking lots and develop landscaping plans to exploit the strengths and overcome the limitations of the site. The following are some points to consider in making these decisions:

A. Fit development to terrain. The development of an area should be tailored, as much as possible, to existing site conditions. This will avoid unnecessary land disturbance, while minimizing the erosion hazards and development costs.

B. Confine construction activities to the least critical areas. Any land disturbance in the critically erodible areas will necessitate the installation of more costly erosion and sediment control measures.

C. Cluster buildings together. This minimizes the amount of disturbed area, concentrates utility lines and connections in one area while leaving more open natural space. The cluster concept not only lessens the erodible area, but it generally reduces runoff and development costs.

D. Minimize impervious areas. Keep paved areas, such as parking lots and roads, to a minimum. This goes hand in hand with cluster developments in eliminating the need for duplicating parking areas, access roads, etc. The more land that is kept in vegetative cover, the more water will infiltrate, thus minimizing runoff and erosion. Consider the use of special pavements which will allow water to infiltrate, or cellular blocks which have soil and vegetation components.

E. Utilize the natural drainage system. If the natural drainage system of a site can be preserved instead of being replaced with storm sewers or concrete channels, the potential for downstream damages due to increased runoff can be minimized, making compliance with stormwater management criteria much easier.

Step 4 – Planning for Erosion and Sediment Control
When the site facility plan layout has been developed, a plan to control erosion and sedimentation from the disturbed areas is then formulated. The following general procedure is recommended for erosion and sediment control planning:

A. Divide the site into drainage areas. Determine how runoff will travel over the site. Consider how erosion and sedimentation can be controlled in each small drainage area before looking at the entire site. Remember, it is easier to control erosion than to contend with sediment after it has been carried downstream.

B. Determine the limits of clearing and grading. Decide exactly which areas must be disturbed in order to accommodate the proposed construction. Pay special attention to critical areas which must be disturbed. The important point in this activity is to minimize the areas to be disturbed.

C. Select erosion and sediment control measures. Erosion and sediment control practices can be divided into 3 broad categories: vegetative measures, structural measures, and management measures. The *Alabama Handbook* should be used for the selection and design of vegetative and structural measures. Management measures include items such as construction management techniques which, if properly utilized, can minimize the need for more costly vegetative/structural erosion and sediment control measures.

1. Vegetative Controls - Vegetative controls should generally be considered first, because of economics. Usually, vegetation should be established on a temporary basis to minimize offsite impacts at the beginning of land disturbances. Vegetation protects the soil surface from raindrop impact and overland flow of runoff water. Vegetative measures should be maximized to provide as much erosion and sediment control as possible, with a minimum of structural measures. One of the simplest ways to protect the soil surface is by preserving existing ground cover where protective cover already exists. Where existing ground cover must be removed and land disturbance is necessary, temporary seeding or mulching can be used on areas that are to be exposed for long periods. Erosion and sediment control plans must contain provisions for permanent stabilization of disturbed areas. Selection of permanent vegetation should include the following considerations:

a. adaptability to site conditions
b. establishment requirements
c. aesthetics
d. maintenance requirements

2. Structural Controls - Structural measures are generally more costly than vegetative controls. However, they are necessary on areas where vegetation alone will not control erosion. In addition, structural measures are often needed in combination with vegetative measures as a second or third line of defense to capture sediment before it leaves the site. It is very important that structural measures be selected, designed, constructed, and maintained according to the standards and specifications in the *Alabama Handbook*. Poorly planned or constructed structural measures can increase development costs and create maintenance problems. Structural measures that fail may increase erosion and sedimentation. Therefore, it is very important that structural measures be designed and installed properly.

3. Management Measures - Good construction management is as important as physical measures for erosion and sediment control and there is generally little or no cost involved. Following are some management considerations which should be included in the erosion and sediment control plan:

a. Sequence construction so that no area remains exposed for unnecessarily long periods of time.

b. When possible, avoid grading activities during months such as July and November through February, because these months are unsuitable for seeding and the potential for erosion and sedimentation is high.

c. Temporary seedings should be done immediately after grading.

d. On large projects, stage the construction if possible, so that one area can be stabilized before another is disturbed.

e. Develop and carry out a regular maintenance schedule for erosion and sediment, control measures.

f. Physically mark off limits of land-disturbance on the site with tape, signs or other methods, so the workers can see areas to be protected.

g. Make sure that all workers understand the major provisions of the erosion and sediment control plan.

h. Responsibility for implementing the erosion and sediment control plan should be designated to one individual (preferably the job superintendent or foreman).

D. Plan for stormwater management. Where increased runoff will cause the carrying capacity of a receiving channel to be exceeded (for a 2-year storm), the site planner must select appropriate stormwater management measures.

Step 5 - Plan Assembly
The necessary planning work was done in steps 1through 4; therefore, this final step consists of consolidating the pertinent information and developing it into a specific erosion and sediment control plan for the project. The two major plan components are a narrative and a site plan. The narrative verbally explains the problems and their solutions with all necessary documentation. The site plan is one, or a series, of maps or drawings pictorially explaining information contained in the narrative. The following checklists may be used in completing the narrative and site plan. These checklists can be used as a guide by the site planner as a ready reference to be sure all major items are included in the erosion and sediment control plan.

Checklist for Erosion and Sediment Control Plans
Narrative
• project description. Briefly describe the nature and purpose of the land disturbing activity and the amount of grading involved.

• existing site conditions. A description of the existing topography, vegetation, and drainage.

• adjacent areas. A description of neighboring areas such as streams, lakes, residential areas, roads, etc., which might be affected by the land disturbance.

• soils. A brief description of the soils on the site giving such information as soil names, mapping unit, erodibility, permeability, depth, texture, soil structure, and any other limitations.

• critical areas. A description of areas on the site which have potential serious erosion problems.

• erosion and sediment control measures. A description of the methods which will be used to control erosion and sedimentation on the site.

• permanent stabilization. A brief description, including specifications, of how the site will be stabilized after construction is completed.

• stormwater management considerations. Will the development of the site result in increased peak rates of runoff? Will this result in flooding or channel degradation downstream? If so, considerations should be given to stormwater control structures on the site. Local ordinances must be considered and met.

• maintenance. A schedule of regular inspections and repair of erosion and sediment control measures should be set forth.

Site Plan

• vicinity map. A small map locating the site in relation to the surrounding area.

• existing contours. The existing contours of the site should be shown on a map.

• existing vegetation. The existing tree lines, grassy areas, or unique vegetation should be shown on a map.

• soils. The boundaries of the different soil types should be shown on a map.

• indicate north. The direction of north in relation to the site should be shown. The top of all maps should be north, if possible and practical.

• critical erosion areas. Areas with potentially serious erosion problems should be shown on a map.

• existing drainage patterns. The dividing lines and the direction of flow for the different drainage areas should be shown on a map.

• final contours. Changes to the existing contour should be shown on a map.

• development features. The outline of buildings, roads, drainage appurtenances, utilities, landscaping features, parking areas, improvements, impervious areas, topographic features, and similar man-made installations should be shown to scale and relative location.

• limits of clearing and grading. Areas which are to be cleared and graded should be outlined on a map.

• location of measures. The locations of the erosion and sediment control and stormwater management practices used on the site should be shown on a map, using the notation shown on Table 2-1.

• detail drawings. Any structural measures used that are not referenced to the manual or other local manuals should be explained and illustrated with detail drawings.

Table 2-1. Legend of Measures for Erosion and Sediment Control Plans (Alabama 1993)

Vegetative Measures		**Structural Measures**	
BZ	Buffer Zone	CD	Check Dam
DU	Dust Control	CS	Channel Stabilization
IR	Irrigation	CE	Construction Exit
MU	Mulching	DV	Diversion
PS	Permanent Seeding	DN	Downdrain Structure
TP	Tree Planting on Disturbed Sites	DS	Drop Structure
SD	Sodding	GB	Gabion
SVG	Shrub, Vine and Groundcover Planting	NP	Inlet Protection
TV	Temporary Vegetation - Seeding	OP	Outlet Protection
TPP	Tree Preservation and Protection	PF	Paved Flume
		RW	Retaining Wall
Coastal Dune Measures		RT	Retrofitting
DC	Dune Crosswalk	RR	Riprap
DSF	Dune Sand Fence	SF	Sediment Barrier/Fence
DV	Dune Vegetation	SB	Sediment Basin
		RS	Storm Water Retention Structure
		SX	Stream Crossing
		SR	Surface Roughening
		TS	Topsoil
		WW	Waterway or Storm Water Conveyance Channel

References

Alabama. *Alabama Handbook For Erosion Control, Sediment Control, And Stormwater Management On Construction Sites And Urban Areas*, produced by the Alabama Soil And Water Conservation Committee Montgomery, AL, July 1993.

BRPC (Birmingham Regional Planning Commission). *Best Management Practices for Controlling Sediment and Erosion from Construction Activities*. Birmingham, Alabama. 1980.

SEWRPC (Southeast Wisconsin Regional Planning Commission). *Costs of Urban Nonpoint Source Water Pollution Control Measures,* Technical Report #31. Waukesha, WI. June 1991.

Virginia. *Erosion and Sediment Control Handbook.* Second Edition. Division of Soil and Water Conservation. Virginia Dept. of Conservation and Historic Resources. Richmond, Virginia. 1980.
Virginia. *Erosion and Sediment Control Handbook.* Third Edition. Division of Soil and Water Conservation. Virginia Dept. of Conservation and Historic Resources. Richmond, Virginia. 1992.
WI DNR. *Wisconsin Construction Site Best Management Practice Handbook, revised.*. Wisconsin Department of Natural Resources. Madison, WI. 1994.

Important Internet Links

Alabama Department of Environmental Management (ADEM), Nonpoint Program
http://www.adem.state.al.us/Education%20Div/Nonpoint%20Program/WSNPSProgram.htm

Jefferson County Stormwater Management, Inc.
http://www.swma.com/

Alabama Soil and Water Conservation Committee
http://www.swcc.state.al.us/

Alabama Soil and Water Conservation Committee (Sediment and Erosion Control Handbook):
http://swcc.state.al.us/erosion_handbook.htm

Geological Survey of Alabama
http://www.gsa.state.al.us/

Natural Resources Conservation Service, USDA
http://www.nrcs.usda.gov/

Alabama on-line soil surveys available to download (only a few counties):
http://soils.usda.gov/survey/online_surveys/alabama/

EPA Region 4 Nonpoint Source Information
http://www.epa.gov/region4/water/nps/

EPA "Surf you Watershed" (compiled water and watershed information for your watershed)
http://www.epa.gov/surf/

USGS "Science in your Watershed" (additional water and watershed information)
http://water.usgs.gov/wsc/index.html

Microsoft TerraServer maps (maps and aerial photographs for most of US)
http://terraserver.microsoft.com/

NOAA Data and Information Server (many linked environmental databases)
http://www.esdim.noaa.gov/NOAAServer/

Code of Federal Regulations, Title 40 (environmental regulations)
http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=199840

Appendix 2-A. Costs of Control Options at Construction Sites

The following tables are from Technical Report #31, *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Southeast Wisconsin Regional Planning Commission, Waukesha, WI. June 1991. The costs reported in the tables in this appendix are mostly from the 1988 and 1989 construction period. To adjust for 2002 costs, multiply by approximately 1.5 (based on long-term inflation factors, but not different locations).

Reported Costs of Selected Construction Erosion Control Measures (SEWRPC 1991; multiply by 1.5 for 2002 costs)

Measure	Unit	Number of Reported Costs	Minimum	Maximum	Mean
Temporary Seeding	Square yard	8	$0.08	$ 0.12	$0.10
Mulching	Square yard	91	0.10	1.00	0.30
Sodding	Square yard	117	1.40	10.10	2.40
Filter Fabric Fence	Lineal foot	290	0.60	8.00	3.40
Straw Bale Barrier	Bale	136	5.00	12.00	9.20

Source: City of Madison, Wisconsin; City of West Bend, Wisconsin, Crispell-Snyder Consulting Engineers; GeoSynthetics, Inc.; Hornburg Contractors; Ruekert & Mielke, Inc; Terra Engineering; Wisconsin Department of Transportation; and SEWRPC.

Unit Capital Costs for Selected Construction Erosion Control Measures (SEWRPC 1991; multiply by 1.5 for 2002 costs)

		Unit Cost		
Component	**Unit**	**Low**	**Moderate**	**High**
Temporary Seeding	Square yard	$ 0.05	$ 0.10	$ 0.20
Temporary Seeding	Pound	1.80	4.60	7.40
Mulching	Square yard	0.10	0.30	0.50
Sodding	Square yard	1.20	2.40	3.60
Filter Fabric Fence	Lineal foot	2.30	3.40	4.50
Straw Bale Barrier	Bale	7.80	9.20	10.60
Inlet Protection Device	Inlet	106.00	130.00	154.00

Estimated Capital Cost of a 1.5-Foot-Deep Diversion Swale (SEWRPC 1991; multiply by 1.5 for 2002 costs)

			Unit Cost			Total Cost		
Component	**Unit**	**Extent**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Site Preparation								
Excavation	Cubic yard	11.81	$2.10	$3.70	$5.30	$ 24.80	$ 43.70	$ 62.59
Place and Compact Fill	Cubic yard	11.81	0.60	1.10	1.60	7.09	12.99	18.90
Grading	Square yard	144.4	0.10	0.20	0.30	14.44	28.88	43.32
Site Development								
Salvaged Topsoil Seed, and Mulch	Square yard	72.2	$0.40	$1.00	$1.60	$ 28.88	$ 72.20	$115.52
Sod	Square yard	72.2	1.20	240	3.60	86.64	173.28	259.92
Subtotal	--	--	--	--	--	$162.00	$331.00	$500.00
Contingencies	Swale	1	25 percent	25 percent	25 percent	$ 41.00	$ 83.00	$125.00
Total	- -	- -	- -	- -	- -	$202.00	$414.00	$625.00

NOTE: Swale height is from top of dike to bottom of channel. Dike top width equals channel bottom width of two feet. Swale has an assumed length of 100 feet with 3:1 side slopes.

Estimated Capital Cost of a 3.0-Foot-Deep Diversion Swale (SEWRPC 1991; multiply by 1.5 for 2002 costs)

			Unit Cost			Total Cost		
Component	Unit	Extent	Low	Moderate	High	Low	Moderate	High
Site Preparation								
Excavation	Cubic yard	36.11	$2.10	$3.70	$5.30	$ 75.83	$133.61	$ 191.38
Place and Compact Fill	Cubic yard	36.11	0.60	1.10	1.60	21.67	39.72	57.78
Grading	Square yard	244.4	0.10	0.20	0.30	24.44	48.88	73.32
Site Development								
Salvaged Topsoil Seed, and Mulch	Square yard	122.2	$0.40	$1.00	$1.60	$ 48.88	$122.20	$ 195.52
Sod	Square yard	122.2	1.20	2.40	3.60	146.64	293.28	439.92
Subtotal	--	--	--	--	--	$162.00	$331.00	$ 500.00
Contingencies	Swale	1	25 percent	25 percent	25 percent	$ 79.00	$159.00	$ 240.00
Total	- -	- -	- -	- -	- -	$397.00	$797.00	$1,198.00

NOTE: Swale height is from top of dike to bottom of channel. Dike top width equals channel bottom width of two feet. Swale has an assumed length of 100 feet with 3:1 side slopes.

Estimated Capital Cost of a 3.0-Foot-Deep Sediment Trap (SEWRPC 1991; multiply by 1.5 for 2002 costs)

			Unit Cost			Total Cost		
Component	**Unit**	**Extent**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Site Preparation								
Excavation	Cubic yard	117	$ 2.10	6 3.70	$ 5.30	$246.00	$433.00	$620.00
Site Development								
Outlet								
Crushed Stone Fill	Cubic yard	1.8	$14.80	$19.40	$24.00	$ 26.60	$ 34.90	$ 43.20
Filter Fabric	Square yard	6.7	1.00	2.00	3.00	6.70	13.40	20.10
Subtotal	- -	- -	- -	- -	- -	$279.00	$481.00	$683.00
Contingencies	Sediment trap	1	25 percent	25 percent	25 percent	$ 70.00	$121.00	$171.00
Total	- -	- -	- -	- -	- -	$349.00	$602.00	$854.00

NOTE: Trap has an assumed surface area of 1,000 square feet.

Estimated Capital Cost of a 5.0-Foot-Deep Sediment Trap (SEWRPC 1991; multiply by 1.5 for 2002 costs)

			Unit Cost			Total Cost		
Component	**Unit**	**Extent**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Site Preparation								
Excavation	Cubic yard	926	$ 2.10	$ 3.70	$ 5.30	$1,945.00	$3,426.00	$4,908.00
Site Development								
Outlet								
Crushed Stone Fill	Cubic yard	3	$14.80	$19.40	$24.00	$ 44.40	$ 58.20	$ 7200
Filter Fabric	Square yard	11	1.00	2.00	3.00	11.00	22.00	33.00
Subtotal	- -	- -	- -	- -	- -	$2,400.00	$4,383.00	$5,013.00
Contingencies	Sediment trap	1	25 percent	25 percent	25 percent	$600.00	$877.00	$1,253.00
Total						$3,000.00	$4,383.001	$6,266.00

NOTE: Trap has an assumed surface area of 5,000 square feet.

Estimated Capital Cost of a 0.1-Acre Sedimentation Basin (SEWRPC 1991; multiply by 1.5 for 2002 costs)

			Unit Cost			Total Cost		
Component	**Unit**	**Extent**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Site Preparation								
Excavation	Cubic yard	462	$ 2.10	$ 3.70	$ 5.30	$ 970.00	$ 1,709.00	$ 2,449.00
Place and Compact Fill	Cubic yard	310	0.60	1.10	1.60	186.00	341.00	496.00
Site Development								
Basin Inlet	Basin	1	$1,310.00	$2,870.00	$4,430.00	$1,310.00	$ 2,870.00	$ 4,430.00
Basin Outlet	Basin	1	1,320.00	3,380.00	5,440.00	1,320.00	3,380.00	5,440.00
Riprap	Cubic yard	2.42	16.40	29.60	42.80	39.70	71.60	104.00
Subtotal	- -	- -	- -	- -	- -	$3,826.00	$ 8,372.00	$12,919.00
Contingencies	Basin	1	25 percent	25 percent	25 percent	$ 956.00	$ 2,093.00	$ 3,230.00
Total	- -	- -	- -	- -	- -	$4,782.00	$10,465.00	$16,149.00

NOTE: Basin has side slopes of 3:1 and a depth of five feet.

Estimated Capital Cost of a 0.25-Acre Sedimentation Basin (SEWRPC 1991; Multiply By 1.5 For 2002 Costs)

			Unit Cost			Total Cost		
Component	**Unit**	**Extent**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Site Preparation								
Excavation	Cubic yard	1,509	$ 2.10	$ 3.70	$ 5.30	$3,169	$ 5,583	$ 7,998
Place and Compact Fill	Cubic yard	1,011	0.60	1.10	1.60	607	1,112	1,618
Site Development								
Basin Inlet	Basin	1	$1,310.00	$2,870.00	$4,430.00	$1,310	$ 2,870	$ 4,430
Basin Outlet	Basin	1	1,320.00	3.380.00	5,440.00	1,320	3,380	5,440
Riprap	Cubic yard	6.1	16.40	29.60	42.80	100	181	261
Subtotal	--	--	--	--	--	$6,506	$13,126	$19,747
Contingencies	Basin	1	25 percent	25 percent	25 percent	$1,627	$ 3,282	$ 4,937
Total	- -	- -	- -	- -	- -	$8,133	$16,408	$24,684

NOTE: Basin has side slopes of 3:1 and a depth of five feet.

Estimated Capital Cost of a 1.0-Acre Sedimentation Basin (SEWRPC 1991; multiply by 1.5 for 2002 costs)

			Unit Cost			Total Cost		
Component	**Unit**	**Extent**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Site Preparation								
Excavation	Cubic yard	7,252	$ 2.10	$ 3.70	$ 5.30	$15,229	$26,832	$38,436
Place and Compact Fill	Cubic yard	4,859	0.60	1.10	1.60	2,915	5,345	7,774

Site Development								
Basin Inlet	Basin	1	$1,310.00	$2,870.00	$4,430.00	$ 1,310	$ 2,870	$ 4,430
Basin Outlet	Basin	1	1,320.00	3,380.00	5,440.00	1,320	3,380	5,440
Riprap	Cubic yard	24.2	16.40	29.60	42.80	397	716	1,036
Subtotal	- -	- -	- -	- -	- -	$26,464	$48,929	$71,395
Contingencies	Basin	1	25 percent	25 percent	25 percent	$ 5,293	$ 9,786	$14,279
Total	- -	- -			- -	$26,464	$48,929	$71,395

NOTE: Basin has side slopes of 3:1 and a depth of five feet.

Annual Maintenance Unit Costs for Construction Erosion Control Measures (SEWRPC 1991; multiply by 1.5 for 2002 costs)

Measure	Annual Maintenance Cost Expressed As Percentage of Capital Cost	Unit Annual Maintenance Cost
Temporary Seeding and Mulching	25	$0.12/square yard
Sodding	5	$0.12/square yard
Filter Fabric Fence	100	$3.40/lineal foot
Straw Bale Barrier	100	$9.20/bale
Inlet Protection Device	100	$123/inlet
Diversion Swale	20	$1.50-5.20/lineal foot
Sediment Trap	20	$1.00-1.80/lineal foot
Sedimentation Basin	25	$1.50-3.25/cubic yard

Construction Component Unit Costs for Urban Nonpoint Pollution Control Measures (SEWRPC 1991; multiply by 1.5 for 2002 costs)

Description	**Unit**	**Installation Costs**			**Indirect Cost**	**Total Cost**	**Year of Cost**	**Comments**
Site Clearing								
Clear and Grub								
Light	Acre	- -	$ 865.00	$ 850.00	$ 510.00	$ 2,225.00	January 1989	All trees are cut and chipped
Medium	Acre	--	1,225.00	1,225.00	750.00	3,200.00		
Heavy	Acre	--	2,875.00	2,850.00	1,725.00	7,450.00		
Clear and Grub								
Light	Acre	- -	$ 283.12	$ 365.00	$ 256.01	$ 904.13	Mid-1988	- -
Medium	Acre	--	943.73	1,216.67	853.36	3,013.76		
Heavy	Acre	--	3,147.20	4,144.00	2,863.99	10,155.19		
Clear Brush								
By Hand	Acre	--	$1,125.00	$ 430.00	$ 620.00	$ 2,175.00	January 1989	
With Brush Saw	Acre	--	540.00	205.00	305.00	1,050.00		
Clear Trees								
< 241nches	Each	- -	$ 118.87	$ 52.17	$ 86.25	$ 257.29	Mid-1988	- -
> 241nches	Each	- -	178.30	78.25	129.39	385.94		
Earthwork								
Grading								
By Hand	Cubic yard	- -	$ 40.64	- -	$ 30.66	$ 71.30	Mid-1988	- -
Dozer	Cubic yard	- -	0.46	$0.91	0.53	1.90		
Scraper								
_< 1,000 Foot Haul	Cubic yard	--	0.30	0.82	0.41	1.53		
> 1,000 Foot Haul	Cubic yard	--	0.30	0.88	0.41	1.59		
Excavating								
To Five-Foot Depth	Cubic yard	$ 0.50	$ 5.33	$ 2.77	$ 4.70	$ 13.30	Mid-1988	- -
To 10-Foot Depth	Cubic yard	0.50	3.04	1.58	2.74	7.86		
By Hand	Cubic yard	- -	- -	40.64	30.66	71.30	Mid-1988	- -
Common Excavation	Cubic yard	- -	- -	- -	- -	$ 2.82 2.00-5.00	1983	Average Typical range
Excavation								
Loam, Sand, and Gravel	Cubic yard	- -	$ 0.24	$ 0.30	$ 0.24	$ 0.78	Mid-1988	Two-and-one-half cubic yard power shovel
Compacted Gravel and Till	Cubic yard	- -	0.26	0.33	0.27	0.86		
Hard Clay and Shale	Cubic yard	- -	0.32	0.40	0.33	1.05		
Excavation								
Loam, Sand, and Gravel	Cubic yard	- -	$ 0.17	$ 0.07	$ 0.07	$ 0.38	Mid-1988	Two-cubic-yard front end loader
Compacted Gravel and Till	Cubic yard	- -	0.18	0.07	0.16	0.41		
Hard Clay and Shale	Cubic yard	- -	0.23	0.09	0.19	0.51		
Excavation: Structure								
Backhoe								
Common Earth	Cubic yard	- -	$ 3.63	$ 4.78	$ 2.24	$ .10.65	January 1989	3/4 Cubic Yard Bucket
Common Earth	Cubic yard	- -	3.03	4.97	1.95	9.95		One-Cubic-Yard Bucket
Common Earth	Cubic yard	- -	2.27	4.44	1.54	8.25		1-1/2-Cubic-Yard Bucket
Common Earth	Cubic yard	- -	1.63	4.46	1.26	7.35		Two-Cubic-Yard Bucket

Construction Component Unit Costs for Urban Nonpoint Pollution Control Measures (continued) (SEWRPC 1991; multiply by 1.5 for 2002 costs)

Description	Unit	Installation Costs			Indirect Cost	Total Cost	Year of Cost	Comments
		Material	Labor	Equipment				
Backfill By Hand								
Light Soil	Cubic yard	- -	$ 9.65	- -	$	14.50	January	No compaction
Heavy Soil	Cubic yard	- -	12.25	- -	6.20 4.8513	18.45	1989	
Backfill: Compaction								
Light Soil Six Inches Deep								
Hand Tamp	Cubic yard	- -	$ 16.20	- -	$ 8.15	$ 24.35	January	- -
Roller Compaction	Cubic yard	- -	12.06	$ 0.67	6.10	18.83	1989	
Light Soil 12 Inches Deep								
Hand Tamp	Cubic yard	- -	13.61	- -	6.84	20.45		
Roller Compaction	Cubic yard	- -	11.25	0.45	5.68	17.38		
Heavy Soil Six Inches Deep								
Hand Tamp	Cubic yard	- -	18.80	- -	9.50	28.45		
Roller Compaction	Cubic yard	- -	14.66	0.67	7.45	22.78		
Heavy Soil 12 Inches Deep								
Hand Tamp	Cubic yard	- -	16.21	- -	8.19	24.40		
Roller Compaction	Cubic yard	- -	13.85	0.45	7.03	21.33		
Earth Fill								
Borrow Fill								
One Mile Haul	Cubic yard	$ 3.67	$ 0.44	$ 1.17	$ 0.72	$ 6.00	January	Compact and
Select Fill							1989	shape
One Mile Haul	Cubic yard	5.75	0.44	1.17	0.89	8.25		
> One Mile Haul	Mile	- -	- -	- -	- -	0.60		
Compacted Gravel Fill								
Four Inches Deep	Square feet	$ 0.11	S 0.09	$ 0.01	$ 0.05	$ 0.26	January	-
Six Inches Deep	Square feet	0.17	0.10	0.01	0.07	0.35	1989	
Nine Inches Deep	Square feet	0.25	0.12	0.02	0.09	0.48		
12 Inches Deep	Square feet	0.33	0.14	0.02	0.10	0.59		
Crushed Stone Fill								
1-1/21nches	Cubic yard	$ 14.00	$ 0.87	$ 2.34	$ 2.04	$ 19.25	January	-
3/4 Inches to							1989	
1-1 /2 Inches	Ton	9.10	- -	- -	0.90	10.00		
Stone Fill								
One to Two Inches Deep	Cubic yard	- -	- -	- -	- -	$ 22.50	1983	Average
						15.00-25.00		Typical range
Stone Tamping	Cubic yard	- -	- -	- -	- -	$ 2.00	1983	Average
Pea Gravel Fill	Cubic yard	$ 14.40	$ 16.00	- -	$ 8.60	$ 38.00	January	- -
							1989	
	Cubic yard	- -	- -	- -	- -	7.50	1983	Average
Clean Washed Sand Fill	Square feet	$ 12.95	$ 0.87	$ 2.34	$ 1.94	$ 18.10	January	- -
							1989	
	Square feet	- -	- -	- -	- -	14.00	1983	Average
Hauling								
Off-Road								
1,000 Feet One Way	Cubic yard	- -	$ 0.23	$ 0.52	$ 0.29	$ 1.04	Mid-1988	- -
2,000 Feet One Way	Cubic yard	- -	0.27	0.67	0.54	1.28		
Over-Road								
1,000 Feet One Way	Cubic yard	--	0.44	0.74	0.49	1.67		
2,000 Feet One Way	Cubic yard	- -	0.47	0.82	0.52	1.81		
Six Cubic Yard Dump Truck								
1/4 Mile Round Trip	Cubic yard	- -	0.59	1.12	0.04	2.11	January	- -
1/2 Mile Round Trip	Cubic yard	- -	0.71	1.37	0.49	2.57	1989	

Construction Component Unit Costs for Urban Nonpoint Pollution Control Measures (continued) (SEWRPC 1991; multiply by 1.5 for 2002 costs)

Description	Unit	Installation Costs			Indirect Cost	Total Cost	Year of Cost	Comments
		Material	Labor	Equipment				
Mobilization/Demobilization								
Shovel. Backhoe. or Dragline								
3/4 Cubic Yard	Each	- -	$ 39.00	$ 175.00	$ 41.00	$ 255.00	January	- -
1-1 /2 Cubic Yard	Each	- -	47.00	210.00	48.00	305.00	1989	
Construction								
Pond Linings								
Plain PVC Sheets								
10 mils Thick	Square feet	$ 0.10	$ 0.54	- -	$ 0.35	$ 0.99	January	- -
20 mils Thick	Square feet	0.21	0.55	- -	0.37	1.13	1989	
30 mils Thick	Square feet	0.32	0.56	- -	0.39	1.27		

PVC Mineral Fiberback								
45 mils Thick	Square feet	$ 0.70	$ 0.57	- -	$ 0.43	$ 1.70	January 1989	- -
Waterproof Membrane								
Two-Ply	Square yard	$ 5.41	$ 10.16	- -	$ 8.80	$ 24.37	Mid-1988	- -
Three-Ply	Square yard	5.82	12.70	--	10.80	29.32		
Filter Fabric								
Minimum	Square feet	$ 0.26	- -	--	$ 0.03	$ 0.29	January	- -
Maximum	Square feet	0.30	--	--	0.03	0.33	1989	
Filter Cloth	Square feet	- -	- -	- -	- -	$ 2.71	1983	Average
						2.00-5.00		Typical range
PVC Pipe								
10-Foot Length								
Six-Inch Diameter	Lineal foot	$ 1.22	S 1.32	--	$ 0.79	$ 3.33	January	
Eight-inch Diameter	Lineal foot	1.75	1.38	--	0.87	4.00	1989	
10-Inch Diameter	Lineal toot	2.80	1.67	8 0.26	1.12	5.85		
Six-Inch Diameter	Lineal foot	--	--	--	--	8 10.00	1983	Average
						8.00-12.00		Typical range
Eight-inch Diameter	Lineal foot	- -	- -	- -	- -	10.50		Average
10-Inch Diameter	Lineal foot	--	--	--	--	15.00		Average
Six-Inch Diameter	Lineal foot	$ 2.65	S 0.79	--	$ 1.15	$ 4.59	Mid-1988	
Eight-inch Diameter	Lineal foot	4.48	0.83	--	1.57	6.88		
10-Inch Diameter	Lineal foot	7.19	0.89	--	217	10.25		
Perforated PVC Pipe								
10 Foot Length								
Four-Inch Diameter	Lineal foot	$ .0.57	$ 1.23	--	$ 0.68	$ 2.48	January	-
Six-inch Diameter	Lineal foot	1.22	1.32	--	0.79	3.33	1989	
Eight-inch Diameter	Lineal foot	1.75	1.38	--	0.87	4.00		
10-Inch Diameter	Lineal foot	2.80	1.67	$ 0.26	1.12	5.85		
Six-Inch Diameter	Lineal foot	$ 2.65	8 0.79	--	$ 1.15	8 4.59	Mid-1988	
Eight-inch Diameter	Lineal foot	4.48	0.83	--	1.57	6.88		
10-Inch Diameter	Lineal foot	7.19	0.89	--	2.17	10.25		
Six-Inch Diameter	Lineal foot	--	--	--	--	$ 10.00	1983	Average
						8.00-12.00		Typical range
Eight-inch Diameter	Lineal foot	- -	- -	- -	- -	10.50		Average
10-Inch Diameter	Lineal foot	- -	- -	- -	- -	15.00		Average

Construction Component Unit Costs for Urban Nonpoint Pollution Control Measures (continued) (SEWRPC 1991; multiply by 1.5 for 2002 costs)

		Installation Costs			Indirect	Total	Year of	
Description	Unit	Material	Labor	Equipment	Cost	Cost	Cost	Comments
Reinforced Concrete								
Pipe (Class 111)								
15-Inch Diameter	Lineal foot	$ 7.31	$ 2.06	$ 1.17	$ 3.32	$ 13.86	Mid-1988	Gasket joints
18-Inch Diameter	Lineal foot	9.08	3.31	1.88	4.81	19.08		eight-foot
21-Inch Diameter	Lineal foot	10.73	3.42	1.95	5.24	21.34		lengths
24-Inch Diameter	Lineal foot	15.20	4.14	2.36	6.81	28.51		
Reinforced Concrete								
Pipe (Class 111)								
15-Inch Diameter	Lineal foot	$ 7.50	$ 3.15	$ 0.48	$ 2.37	$ 13.50	January	Gasket joints
1 B-Inch Diameter	Lineal foot	9.45	3.67	0.56	2.87	16.55	1989	
24-Inch Diameter	Lineal foot	14.80	5.50	0.85	3.85	25.00		
Riprap								
Broken Stone,								
Random Placement	Cubic yard	$ 9.20	$ 5.25	$ 6.35	$ 4.20	$ 25.00	January	Machine placed
							1989	for protection
3/8-1/4 Cubic Yard Pieces	Square yard	16.10	12.70	5.75	8.45	43.00		Grouted
18-Inch Minimum								
Thickness	Square yard	11.50	19.20	8.70	11.60	51.00		Not grouted
Porous Pavement								
Two-Inch-Thick Surface	Square yard	- -	- -	- -	- -	$ 6.60	1976	12-inch sub-base
Two to Four Inches Thick	Square yard	$ 1.58	- -	- -	- -	- -	1983	
Grassed Driveways								
(porous surfaces)	Cubic yard	- -	- -	- -	- -	$ 70.00	1976	Brick lattices, gravel filled, cov ered with top soil
Landscaping								
Sodding								
Level								
> 400 Square Yards	Square yard	$ 0.98	$ 0.85	$ 0.17	$ 0.56	S 2.56	January	- -
100 Square Yards	Square yard	1.36	1.07	0.22	0.70	3.35	1989	
50 Square Yards	Square yard	1.95	1.14	0.23	0.80	4.12		
Slopes								
400 Square Yards	Square yard	1.03	1.19	0.24	0.72	3.18		
Seeding								

Mechanical Seeding	Acre Square yard	$410.00 0.08	$ 435.00 0.09	$ 165.00 0.03	$ 290.00 0.06	$ 1,300.00 0.26	January 1989	-
Fine Grade/Seed	Square yard	0.15	0.85	0.17	0.48	1.65		Includes ferti lizer and lime
Push Spreader								
Grass Seed	1,000 square feet	$ 8.60	$ 0.67	$ 0.26	$ 1.22	$ 10.75	January 1989	- -
Limestone	1.000 square feet	2.05	0.67	0.26	0.58	3.56		
Fertilizer	1,000 square feet	5.40	0.67	0.26	0.92	7.25		
Level Areas	Acre	578.21	149.30	80.63	251.00	1,059.14	Mid-1988	- -
Sloped Areas	Acre	578.21	238.88	129.00	328.75	1,274.84		
Mulching								
Hay	Acre Square yard	$255.76 - -	$ 74.65 - -	$ 40.31 - -	$ 118.50 - -	$ 489.22 0.58 0.25-1.00	Mid-1988 1983	- - Average Typical range

NOTE: Total cost includes operation and maintenance, taxes, insurance, and other contingencies.