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6.01

CONSTRUCTION SEQUENCE SCHEDULE

Definition A specified work schedule that coordinates the timing of land-disturbing activities and the installation of erosion and sedimentation control measures.

Purpose To reduce on-site erosion and off-site sedimentation by performing land-disturbing activities, and installing erosion and sedimentation control practices in accordance with a planned schedule.

Conditions Where Practice Applies All land-development projects that will disturb more than one contiguous acre.

Planning Considerations The removal of existing surface ground cover leaves a site vulnerable to accelerated erosion. Good planning will reduce land clearing, provide necessary controls, and restore protective cover in an efficient and effective manner. Appropriate sequencing of construction activities can be a cost-effective way to help accomplish this goal.

Scheduling considerations are summarized in Table 6.01a. The generalized construction activities shown in the table do not usually occur in a specified linear sequence, and schedules will vary due to weather and other unpredictable factors. However, the proposed construction sequence should be indicated clearly in the erosion and sedimentation control plan.

Construction access is normally the first land-disturbing activity. Exercise care not to damage valuable trees or disturb designated buffer zones.

Next, install **principal sediment basins** and traps before any major site grading takes place. Erect additional sediment traps and sediment fences as grading takes place to keep sediment contained on-site at appropriate locations.

Locate **key runoff-control measures** in conjunction with sediment traps to divert water from planned undisturbed areas out of the traps and sediment-laden water into the traps. Install diversions above areas to be disturbed prior to grading. Place necessary perimeter dikes with stable outlets before opening major areas for development. Install additional needed runoff-control measures as grading takes place.

Install the **main runoff conveyance system** with inlet and outlet protection devices early, and use it to convey storm runoff through the development site without creating gullies and washes. Install inlet protection for storm drains as soon as the drain is functional to trap sediment on-site in shallow pools and to allow flood flows to safely enter the storm drainage system. Install outlet protection at the same time as the conveyance system to prevent damage to the receiving stream.

Normally, install stream stabilization, including necessary stream crossings, independently and ahead of other construction activities. It is usually best to schedule this work as soon as weather conditions permit. Site clearing and

Table 6.01a
Considerations for Construction Scheduling

Construction Activity¹	Schedule Consideration
Construction access. Construction entrance, construction routes, equipment parking areas.	First land-disturbing activity—Stabilize bare areas immediately with gravel and temporary vegetation as construction takes place.
Sediment traps and barriers. Basin traps, sediment fences, and outlet protection.	Install principal basins after construction site is accessed. Install additional traps and barriers as needed during grading.
Runoff control. Diversions, perimeter dikes, water bars, and outlet protection.	Install key practices after principal sediment traps and before land grading. Install additional runoff-control measures during grading.
Runoff conveyance system. Stabilize streambanks, storm drains, channels, inlet and outlet protection, and slope drains.	Where necessary, stabilize streambanks as early as possible. Install principal runoff conveyance system with runoff-control measures. Install remainder of system after grading.
Landing clearing and grading. Site preparation—cutting, filling and grading, sediment traps, barriers, diversions, drains, and surface roughening.	Begin major clearing and grading after principal sediment and key runoff-control measures are installed. Clear borrow and disposal areas only as needed. Install additional control measures as grading progresses. Mark trees and buffer areas for preservation.
Surface stabilization. Temporary and permanent seeding, mulching, sodding, and riprap.	Apply temporary or permanent stabilization measures immediately on all disturbed areas where work is delayed or complete.
Building construction. Buildings, utilities, and paving.	Install necessary erosion and sedimentation control practices as work takes place.
Landscaping and final stabilization. Topsoiling, trees and shrubs, permanent seeding, mulching, sodding, and riprap.	Last construction phase—Stabilize all open areas, including borrow and spoil areas. Remove and stabilize all temporary control areas.
1 Maintenance, (1) maintenance inspections should be performed weekly, and (2) after periods of rainfall, maintenance repairs should be made immediately.	

project construction increases storm runoff, often making streambank stabilization work more difficult and costly.

Begin **land clearing and grading** as soon as key erosion and sediment control measures are in place. Once a scheduled development area is cleared, grading should follow immediately so that protective ground cover can be reestablished quickly. Do not leave any area bare and exposed for extended periods. Leave adjoining areas planned for development, or to be used for borrow and disposal, undisturbed as long as possible to serve as natural buffer zones.

Runoff control is essential during the grading operation. Temporary diversions, slope drains, and inlet and outlet protection installed in a timely manner can be very effective in controlling erosion during this critical period of development.

Immediately after land clearing and grading, apply **surface stabilization** on graded areas, channels, dikes, and other disturbed areas. Stabilize any graded slopes and fills where active construction will not take place for 21 calendar

days by temporary seeding and/or mulching or by other suitable means. Install permanent stabilization measures immediately after final grading, in accordance with the vegetative plan. Temporary seeding and/or mulching may be necessary during extreme weather conditions with permanent measures delayed for a more suitable time.

Coordinate **building construction** with other development activities so that all work can take place in an orderly manner and on schedule. Experience shows that careful project scheduling improves efficiency, reduces cost, and lowers the potential for erosion and sedimentation problems.

Landscaping and final stabilization is the last major construction phase, but the topsoil stockpiling, tree preservation, undisturbed buffer area, and well-planned road locations established earlier in the project may determine the ease or difficulty of this activity. All disturbed areas should have permanent stabilization practices applied. Unstable sediment should be removed from sediment basing and traps. All temporary structures should be removed after the area above has been properly stabilized. Borrow and disposal areas should be permanently vegetated or otherwise stabilized.

In planning construction work, it may be helpful to outline all land-disturbing activities necessary to complete the proposed project. Then list all practices needed to control erosion and sedimentation on the site. These two lists can then be combined in logical order to provide a practical and effective construction sequence schedule.

A construction sequence schedule is shown as part of the sample erosion plan (*Chapter 7, Sample Erosion and Sedimentation Control Plan*).

Design Criteria As a minimum, the construction sequence schedule should show the following:

- The erosion and sedimentation control practices to be installed,
- Principal development activities,
- What measures should be in place before other activities are begun, and
- Compatibility with the general construction schedule of the contract.

Construction Specifications Many timely construction techniques can reduce the erosion potential of a site, such as (1) shaping earthen fills daily to prevent overflows and (2) constructing temporary diversions ahead of anticipated storms. These types of activities cannot be put on the construction sequence schedule, but should be used whenever possible.

Following a planned construction sequence schedule to control erosion should help keep field personnel aware of the possibilities of erosion prevention through construction management.

Maintenance Follow the construction sequence throughout the project development. When changes in construction activities are needed, amend the sequence schedule in advance to maintain management control.

Orderly modification assures coordination of construction and erosion control practices to minimize erosion and sedimentation problems. When major changes are necessary, send a copy of the modified schedule to the local sediment control agency.

References

Chapter 4, Preparing the Erosion and Sedimentation Control Plan
Chapter 7, Sample Erosion and Sedimentation Control Plan

6.02



LAND GRADING

Definition Reshaping the ground surface to planned grades as determined by engineering survey evaluation and layout.

Purpose To provide more suitable topography for buildings, facilities, and other land uses, to control surface runoff, and to minimize soil erosion and sedimentation both during and after construction.

Conditions Where Practice Applies This practice is applicable where grading to a planned elevation is necessary and practical for the proposed development of a site, and for proper operation of sedimentation control practices.

Planning Considerations Fitting a proposed development to the natural configurations of an existing landscape reduces the erosion potential of the site and the cost of installing erosion and sedimentation control measures. It may also result in a more desirable and less costly development.

Before grading begins, decisions must be made on the steepness of cut-and-fill slopes, how they will be protected from runoff, how they will be stabilized, and how they will be maintained. The grading plan establishes drainage areas, directs drainage patterns, and affects runoff velocities.

The grading plan forms the basis of the erosion and sedimentation control plan. Key considerations that affect erosion and sedimentation include deciding which slopes are to be graded, when the work will start and stop, the degree and length of finished slopes, where and how excess material will be wasted, and where borrow is needed.

Leaving undisturbed temporary and permanent buffer zones in the grading operation may provide an effective and low-cost erosion control measure that will help reduce runoff velocity and volume and off-site sedimentation. In developing the grading plan, always consider how to take advantage of undisturbed water disposal outlets before storm drains or other constructed outlets are installed.

Design Criteria Base the grading plan and installation upon adequate surveys and soil investigations. In the plan, show disturbed areas, cuts, fills, and finished elevations of the surface to be graded. Include in the plan all practices necessary for controlling erosion on the graded site and minimizing sedimentation downstream. Such practices may include, but are not limited to, sediment basins, diversions, mulching, vegetation, vegetated and lined waterways, grade stabilization structures, and surface and subsurface drains. The practices may be temporary or permanent, depending upon the need after construction is completed.

In the grading plan consider the following as a minimum:

Make a provision to intercept and conduct all surface runoff to storm drains, protected outlets, or to stable watercourses to minimize erosion on newly graded slopes.

Use slope breaks, such as diversions or benches, as appropriate, to reduce the length of cut-and-fill slope to limit sheet and rill erosion and prevent gullyng. A spacing guide is shown in Table 6.02a.

Table 6.02a
Spacing Guide for Slope
Breaks

	Slope	Spacing (ft)
Steep Slopes	2:1	20
	3:1	35
	4:1	45
Long Slopes	15-25%	50
	10-15%	80
	6-10%	125
	3-6%	200
	<3%	300

Stabilize all graded areas with vegetation, crushed stone, riprap, or other ground cover as soon as grading is completed, or when work is interrupted for 30 working days or more. Use mulch to stabilize areas temporarily where final grading must be delayed. The finished cut-and-fill slopes, which are to be vegetated with grass and legumes, should not be steeper than 2:1. Slopes to be maintained by tractor or other equipment should not be steeper than 3:1. Slopes in excess of 2:1 may warrant vines, special vegetation, or retaining walls. Roughen the surface of all slopes during the construction operation to retain water, increase filtration, and facilitate vegetation. (Practice 6.03, *Surface Roughening*.)

Do not place cuts or fill so close to property lines as to endanger adjoining property without adequately protecting such properties from erosion, sedimentation, slippage, subsidence, or other damages.

Provide subsurface drainage to intercept seepage in areas with high water tables that would affect slope stability, bearing strength, or create undesirable wetness.

Do not place fill adjacent to a channel bank where it can create bank failure or result in deposition of sediment downstream.

Show all borrow and disposal areas in the grading plan, and ensure they are adequately drained and stabilized.

Provide stable channels and floodways to convey all runoff from the developed area to an adequate outlet without causing increased erosion or off-site sedimentation.

Construction Specifications

1. Construct and maintain all erosion and sedimentation control practices and measures in accordance with the approved sedimentation control plan and construction schedule.
2. Remove good topsoil from areas to be graded and filled, and preserve it for use in finishing the grading of all critical areas.
3. Scarify areas to be topsoiled to a minimum depth of 2 inches before placing topsoil (Practice 6.04, *Topsoiling*).
4. Clear and grub areas to be filled by removing trees, vegetation, roots, or other objectionable material that would affect the planned stability of the fill.
5. Ensure that fill material is free of brush, rubbish, rocks, logs, stumps, building debris, and other materials inappropriate for constructing stable fills.
6. Place all fill in layers not to exceed 9 inches in thickness, and compact the layers as required to reduce erosion, slippage, settlement, or other related problems.
7. Do not incorporate frozen, soft, mucky, or highly compressible materials into fill slopes.
8. Do not place fill on a frozen foundation, due to possible subsidence and slippage.
9. Keep diversions and other water conveyance measures free of sediment during all phases of development.
10. Handle seeps or springs encountered during construction in accordance with approved methods (Practice 6.81, *Subsurface Drain*).
11. Permanently stabilize all graded areas immediately after final grading is completed on each area in the grading plan. Apply temporary stabilization measures on all graded areas when work is to be interrupted or delayed for 30 working days or longer.
12. Show topsoil stockpiles, borrow areas, and spoil areas on the plans, and make sure they are adequately protected from erosion. Include final stabilization of these areas in the plan.

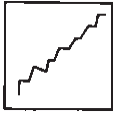
Maintenance

Periodically, check all graded areas and the supporting erosion and sedimentation control practices, especially after heavy rainfalls. Promptly remove all sediment from diversions and other water-disposal practices. If washouts or breaks occur, repair them immediately. Prompt maintenance of small eroded areas before they become significant gullies is an essential part of an effective erosion and sedimentation control plan.

References

Chapter 3, Vegetative Considerations
Chapter 5, Overview of Erosion and Sedimentation Control Practices

6.03



SURFACE ROUGHENING

Definition Roughening a bare soil surface with horizontal grooves running across the slope, stair stepping, or tracking with construction equipment.

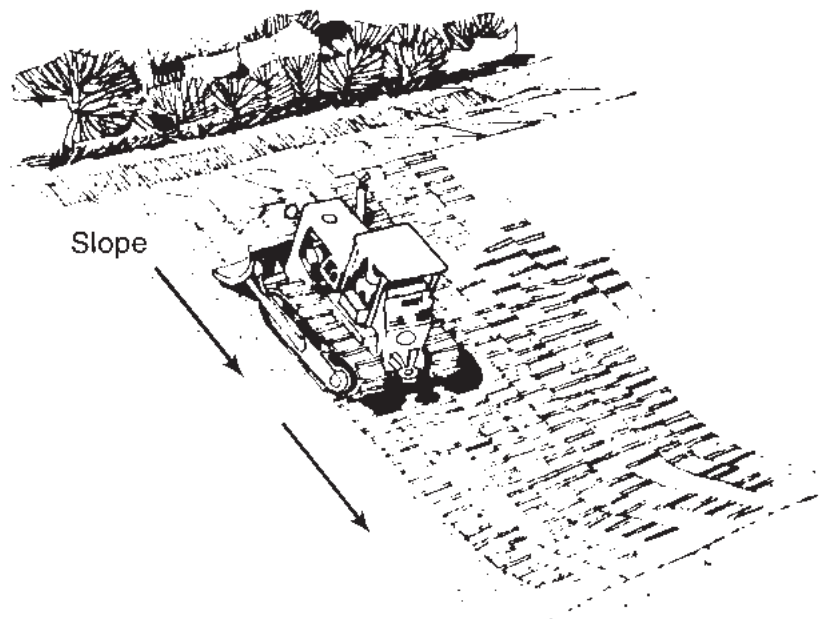
Purpose To aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for sediment trapping.

Conditions Where Practice Applies All construction slopes require surface roughening to facilitate stabilization with vegetation, particularly slopes steeper than 3:1.

Planning Considerations Rough slope surfaces are preferred because they aid the establishment of vegetation, improve water infiltration, and decrease runoff velocity. Graded areas with smooth, hard surfaces may be initially attractive, but such surfaces increase the potential for erosion. A rough, loose soil surface gives a mulching effect that protects lime, fertilizer, and seed. Nicks in the surface are cooler and provide more favorable moisture conditions than hard, smooth surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving (Figure 6.03a), and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

Figure 6.03a Bulldozer treads create grooves perpendicular to the slope. The slope face should not be back-bladed during the final grading operation (source: Va SWCC).



Design Criteria No formal design is required.

Construction Specifications

CUT SLOPE ROUGHENING FOR AREAS NOT TO BE MOWED

Stair-step grade or groove cut slopes with a gradient steeper than 3:1 (Figures 6.03b and 6.03c).

Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the “step” in toward the vertical wall.

Do not make individual vertical cuts more than 2 feet in soft materials or more than 3 feet in rocky materials.

Grooving uses machinery to create a series of ridges and depressions that run across the slope (on the contour).

Groove using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth on a front-end loader bucket. Do not make such grooves less than 3 inches deep nor more than 15 inches apart.

FILL SLOPE ROUGHENING FOR AREAS NOT TO BE MOWED

Place fill slopes with a gradient steeper than 3:1 in lifts not to exceed 9 inches, and make sure each lift is properly compacted. Ensure that the face of the slope consists of loose, uncompacted fill 4 to 6 inches deep. Use grooving, as described above, to roughen the face of the slopes, if necessary.

Do not blade or scrape the final slope face.

CUTS, FILLS, AND GRADED AREAS THAT WILL BE MOWED

Make mowed slopes **no steeper than 3:1**.

Roughen these areas to shallow grooves by normal tilling, disking, harrowing, or use of cultipacker-seeder. Make the final pass of any such tillage implement on the contour.

Make grooves, formed by such implements, close together (less than 10 inches) and not less than 1 inch deep.

Excessive roughness is undesirable where mowing is planned.

ROUGHENING WITH TRACKED MACHINERY

Limit roughening with tracked machinery to sandy soils to avoid undue compaction of the soil surface. Tracking is generally not as effective as the other roughening methods described.

Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

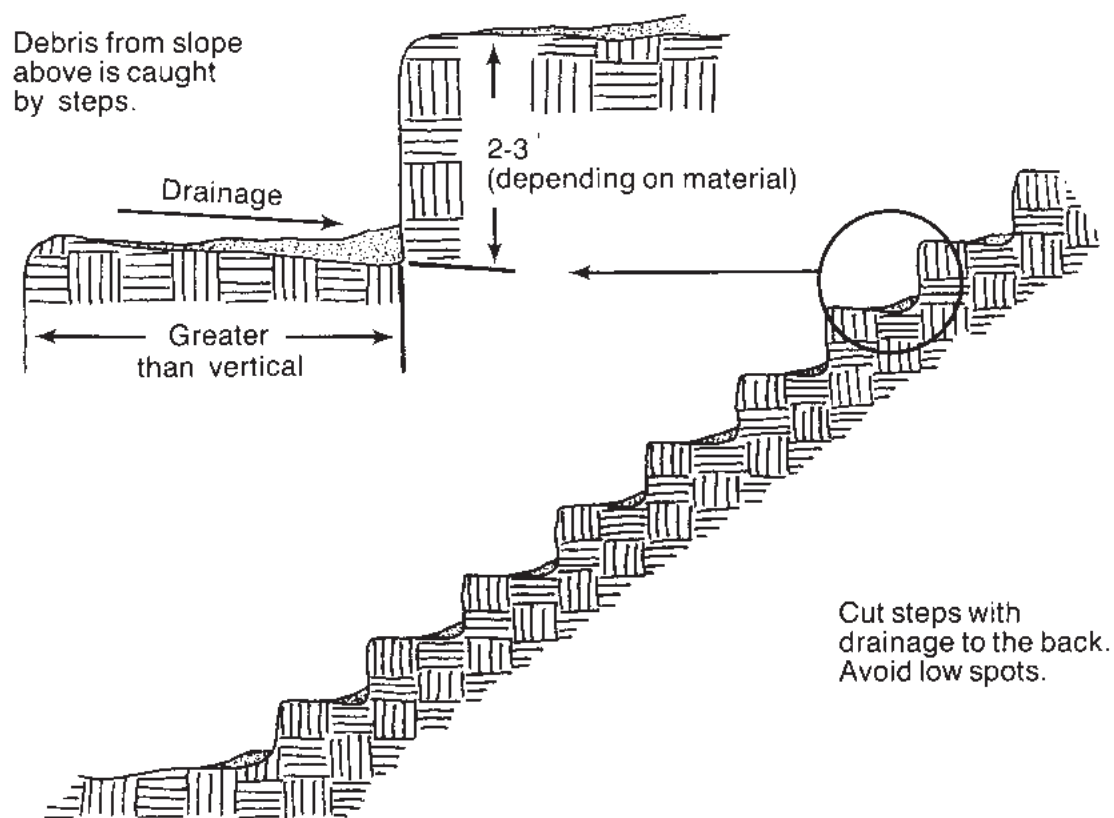


Figure 6.03b Stair stepping cut slopes (modified from Va SWCC).

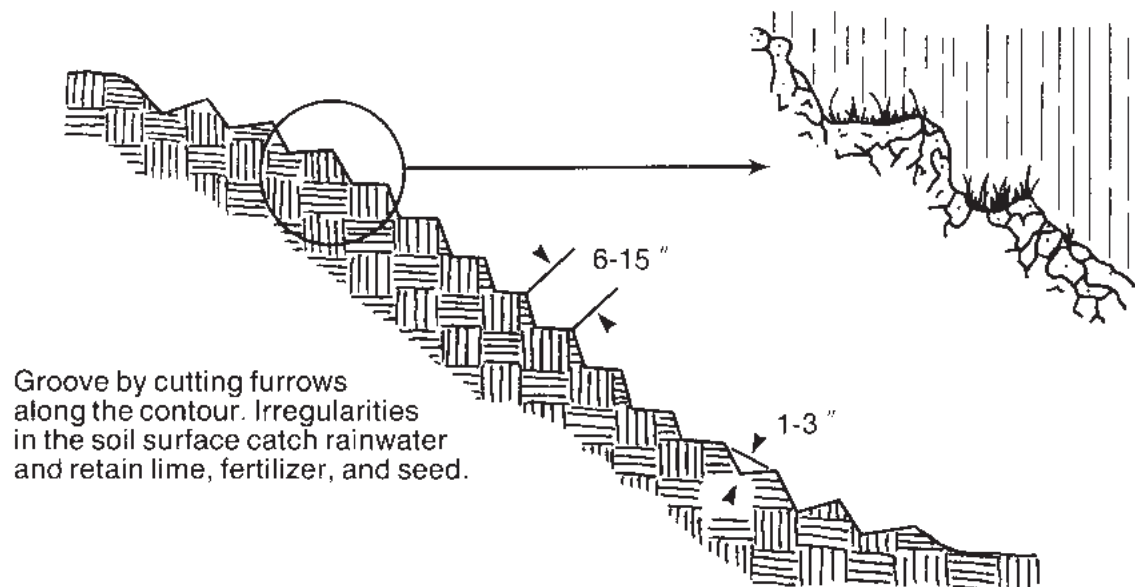


Figure 6.03c Grooving slopes (modified from Va SWCC).

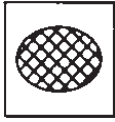
Seeding—Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.

Maintenance Periodically check the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

References *Surface Stabilization*
6.10, Temporary Seeding
6.11, Permanent Seeding
6.14, Mulching

Chapter 3, Vegetative Considerations

6.04



TOPSOILING

Definition Preserving and using topsoil to enhance final site stabilization with vegetation.

Purpose To provide a suitable growth medium for vegetation.

Conditions Where Practice Applies Where a sufficient supply of quality topsoil is available.
Where the subsoil or areas of existing surface soil present the following problems:

- The structure, pH, or nutrient balance of the available soil cannot be amended by reasonable means to provide an adequate growth medium for the desired vegetation,
- The soil is too shallow to provide adequate rooting depth or will not supply necessary moisture and nutrients for growth of desired vegetation, and
- The soil contains substances toxic to the desired vegetation.

Where high-quality turf or ornamental plants are desired.

Where slopes are 2:1 or flatter.

Planning Considerations

Topsoil is the surface layer of the soil profile, generally characterized as darker than the subsoil due to enrichment with organic matter. It is the major zone of root development and biological activity. Microorganisms that enhance plant growth thrive in this layer. Topsoil can usually be differentiated from subsoil by texture as well as color. Clay content usually increases in the subsoil. In North Carolina, where subsoils are often high in clay, the topsoil layer may be significantly coarser in texture. The depth of topsoil may be quite variable. On severely eroded sites it may be gone entirely.

Advantages of topsoil include its high organic-matter content and friable consistence (soil aggregates can be crushed with only moderate pressure), and its available water-holding capacity and nutrient content. Most often it is superior to subsoil in these characteristics. The texture and friability of topsoil are usually much more conducive to seedling emergence and root growth.

In addition to being a better growth medium, topsoil is often less erodible than subsoils, and the coarser texture of topsoil increases infiltration capacity and reduces runoff.

Although topsoil may provide improved growth medium, there may be disadvantages, too. Stripping, stockpiling, hauling, and spreading topsoil, or importing topsoil, may not be cost-effective. Handling may be difficult if large amounts of branches or rocks are present, or if the terrain is too rough. Most topsoil contains weed seeds, which compete with desirable species.

In site planning, compare the options of topsoiling with preparing a seedbed in the available subsoil. The clay content of many subsoils retains moisture. When properly limed and fertilized, subsoils may provide a satisfactory growth medium, which is generally free of weed seeds.

Topsoiling is normally recommended where ornamental plants or high-maintenance turf will be grown. It may also be required to establish vegetation on shallow soils, soils containing potentially toxic materials, stony soils, and soils of critically low pH (high acidity).

If topsoiling is to be used, consider the following:

- quality and amount of topsoil, and
- location for a stabilized stockpile that will not erode, block drainage, or interfere with work on the site.

Bonding—if topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly, and it will be difficult to establish vegetation.

Do not apply topsoil to slopes steeper than 2:1 to avoid slippage, nor to a subsoil of highly contrasting texture. Sandy topsoil over clay subsoil is a particularly poor combination especially on steep slopes. Water may creep along the junction between the soil layers and cause the topsoil to slough.

Construction Specifications

MATERIALS

Determine whether the quality and quantity of available topsoil justifies selective handling. Quality topsoil has the following characteristics:

Texture—loam, sandy loam, and silt loam are best; sandy clay loam, silty clay loam, clay loam, and loamy sand are fair. Do not use heavy clay and organic soils such as peat or muck as topsoil

Organic matter content—(sometimes referred to as “humic matter”) should be greater than 1.5% by weight.

Acidity—pH should be greater than 3.6 before liming, and liming is required if it is less than 6.0.

Soluble salts—should be less than 500 ppm.

Sodium—sodium adsorption ratio should be less than 12.

The depth of material meeting the above qualifications should be at least 2 inches. Soil factors such as rock fragments, slope, depth to water table, and layer thickness affect the ease of excavation and spreading of topsoil.

Generally, the upper part of the soil, which is richest in organic matter, is most desirable; however, material excavated from deeper layers may be worth storing if it meets the other criteria listed above.

Organic soils such as mucks and peats do not make good topsoil. They can be identified by their extremely light weight when dry.

STRIPPING

Strip topsoil only from those areas that will be disturbed by excavation, filling, roadbuilding, or compaction by equipment. A 4-6 inch stripping depth is common, but depth varies depending on the site. Determine depth of stripping

by taking soil cores at several locations within each area to be stripped. Topsoil depth generally varies along a gradient from hilltop to toe of the slope. Put sediment basins, diversions, and other controls into place before stripping.

STOCKPILING

Select stockpile location to avoid slopes, natural drainageways, and traffic routes. On large sites, respreading is easier and more economical when topsoil is stockpiled in small piles located near areas where they will be used.

Sediment barriers—Use sediment fences or other barriers where necessary to retain sediment.

Temporary seeding—Protect topsoil stockpiles by temporarily seeding as soon as possible, no more than 21 calendar days after the formation of the stockpile (Practice 6.10, *Temporary Seeding*).

Permanent vegetation—If stockpiles will not be used within 90 days they must be stabilized with permanent vegetation to control erosion and weed growth (Practice 6.11, *Permanent Seeding*).

SITE PREPARATION

Before spreading topsoil, establish erosion and sedimentation control practices such as diversions, berms, dikes, waterways, and sediment basins.

Grading—Maintain grades on the areas to be topsoiled according to the approved plan and do not alter them by adding topsoil.

Limit of subsoil—Where the pH of the existing subsoil is 6.0 or less, or the soil is composed of heavy clays, incorporate agricultural limestone in amounts recommended by soil tests or specified for the seeding mixture to be used (Practice 6.11, *Permanent Seeding*). Incorporate lime to a depth of at least 2 inches by disking.

Roughening—Immediately prior to spreading the topsoil, loosen the subgrade by disking or scarifying to a depth of at least 4 inches, to ensure bonding of the topsoil and subsoil. If no amendments have been incorporated, loosen the soil to a depth of at least 6 inches before spreading topsoil.

SPREADING TOPSOIL

Uniformly distribute topsoil to a minimum compacted depth of 2 inches on 3:1 slopes and 4 inches on flatter slopes. To determine the volume of topsoil required for application to various depths, use Table 6.04a. Do not spread topsoil while it is frozen or muddy or when the subgrade is wet or frozen. Correct any irregularities in the surface that result from topsoiling or other operations to prevent the formation of depressions or water pockets.

Compact the topsoil enough to ensure good contact with the underlying soil, but avoid excessive compaction, as it increases runoff and inhibits seed germination. Light packing with a roller is recommended where high-maintenance turf is to be established.

Table 6.04a
Cubic Yards of Topsoil
Required for Application to
Various Depths

Depth (Inches)	Per 1,000 Sq. ft.	Per Acre
1	3.1	134
2	6.2	268
3	9.3	403
4	12.4	536
5	15.5	670
6	18.6	804

On slopes and areas that will not be mowed, the surface may be left rough after spreading topsoil. A disk may be used to promote bonding at the interface between the topsoil and subsoil.

After topsoil application, follow procedures for seedbed preparation, taking care to avoid excessive mixing of topsoil into the subsoil.

References

Site Preparation

6.03, Surface Roughening

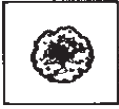
Surface Stabilization

6.10, Temporary Seeding

6.11, Permanent Seeding

Chapter 3, *Vegetative Considerations*

6.05



TREE PROTECTION

Definition Practices to preserve and protect desirable trees from damage during project development.

Purpose To preserve and protect trees that have present or future value for their use in protection from erosion, for their landscape and aesthetic value, or for other environmental benefits.



Figure 6.05a Tree protection zone. A protected zone preserves roots and soil and keeps branches clear of contact with construction equipment and materials.

Conditions Where Practice Applies On development sites containing trees or stands of trees.

Planning Considerations Conserving the right trees can reap rewards for developers, homeowners, and communities. Healthy trees enhance property values and community development by providing shade, wildlife habitat, and beauty. Sickly, stressed trees reduce property values, discourage potential buyers and detract from a community. Post-construction maintenance and removal of trees is difficult and expensive. Replacing trees after construction can also be costly and time consuming.

Preserving and protecting trees and other natural plant groups often results in a more stable and aesthetically pleasing development. During site evaluation, note where valuable trees and other natural landscape features should be preserved, then consider these trees and plants when determining the location of roads, buildings, or other structures.

Trees that are near construction zones should be either protected or removed because damage during construction activities may cause the death of the tree at a later time.

Trees should be considered for preservation for the following benefits:

- They stabilize the soil and prevent erosion.
- They reduce stormwater runoff by intercepting rainfall, promote infiltration, and lower the water table through transpiration.
- They moderate temperature changes, promote shade, and reduce the force of wind.
- They provide buffers and screens against noise and visual disturbance, providing a degree of privacy.
- They filter pollutants from the air, remove carbon dioxide from the air, and produce oxygen.
- They provide a habitat for animals and birds.
- **They increase property values and improve site aesthetics.**

Consider the following characteristics when selecting trees to be protected and saved:

Tree vigor—Preserve healthy trees. A tree of low vigor is susceptible to damage by environmental changes that occur during site development. Healthy trees are less susceptible to insects and disease. Indications of poor vigor include dead tips of branches, small annual twig growth, stunted leaf size, sparse foliage, and pale foliage color. Hollow or rotten trees, cracked, split, or leaning trees, or trees with broken tips also have less chance for survival.

Tree age—Old, picturesque trees may be more aesthetically valuable than smaller, younger trees, but they may require more extensive protection.

Tree species—Preserve those species that are most suitable for site conditions and landscape design. Trees that are short-lived or brittle or are susceptible to attack by insects and disease may be poor choices for preservation.

Tree aesthetics—Choose trees that are aesthetically pleasing, shapely, large, or colorful. Avoid trees that are leaning or in danger of falling. Occasionally, an odd-shaped tree or one of unusual form may add interest to the landscape if strategically located. However, be sure the tree is healthy.

Wildlife benefits—Choose trees that are preferred by wildlife for food, cover, or nesting. A mixture of evergreens and hardwoods may be beneficial. Evergreen trees are important for cover during the winter months, whereas hardwoods are more valuable for food.

Construction activities can significantly injure or kill trees unless protective measures are taken. Although direct contact by equipment is an obvious means of damaging trees, most serious damage is caused by root zone stress from compacting, filling, or excavating too close to the tree. Clearly mark boundaries to maintain sufficient undisturbed area around the trees.

Design Criteria

1. Take stock of trees on the site. Hire a professional arborist or urban forester to inventory existing trees. An inventory records the variety, location, size, and health of each tree. A proper tree inventory creates the foundation for a successful tree protection plan. A professional can identify valuable trees and those that need attention or removal. Identify any stressed trees that need removal. Stressed, unhealthy trees have wilting leaves, dying limbs, thinning crowns or other signs of declining health. Always remove insect-, disease-, or storm-damaged trees prior to construction. This is fast, efficient, and saves resources.

2. Draw a base map. Include all the important site features such as existing vegetation, property lines, utility connections, slopes, and required setback distances before drawing in the proposed building(s):

- Map grading and drainage.
- Identify priority trees for protection. Mark their locations on the base map and sketch in approximate tree protection zones where temporary fences should be located around priority trees.
- Locate the building footprints: the areas where structures and their amenities will affect the landscape. Draw in the driveways, parking areas, and decks.
- Mark trees that need to be removed or pruned to make room for future structures and construction equipment.

3. Prepare a tree protection plan. A tree protection plan designates the valuable trees that must be protected during the construction process. Assemble a team to write a tree protection plan before ground is broken. The team should include the site managers as well as professionals who can provide tree protection advice (Table 1). Do not leave anyone out who should be involved. By working together, the team can identify potential conflicts between construction needs and tree protection, and identify compromise solutions.

Planning takes time, but it pays off during and after construction. Using the base map, the team can plan for tree protection, foresee problems, and solve them. Early planning helps to keep construction on schedule, reduce costs, and avoid conflicts:

- Locate construction activities after considering the priority trees and the development requirements.
- Look for potential conflicts, and explore alternate solutions.
- Consider grading and stormwater drainage. Remember that cutting or filling around roots will weaken and eventually kill valuable trees. Weigh alternatives such as retaining walls to protect priority trees.
- Designate **tree protection zones (TPZs)**. The protection plan should specify the location of temporary tree protection fences to protect trees and their root zones during construction. TPZ fences identify “exclusion zones” where construction and equipment use is prohibited. Effective TPZs maintain a radius of at least 1.25 feet of protected area for each inch of trunk diameter (Table 6.05a).

Table 6.05a Mature Tree Protection Zone Guidelines

Mature Tree Protection Zone Radius			
Trunk Diameter	Good Protection	Better Protection	Best Protection
8 inches	10 feet	12 feet	20 feet
12 inches	15 feet	18 feet	30 feet
16 inches	20 feet	24 feet	40 feet
20 inches	25 feet	30 feet	50 feet

- Identify techniques that will protect valuable trees. A tree professional can develop a schedule of tree maintenance activities, including watering, mulching, and fertilization. Stay committed to this plan throughout the project.

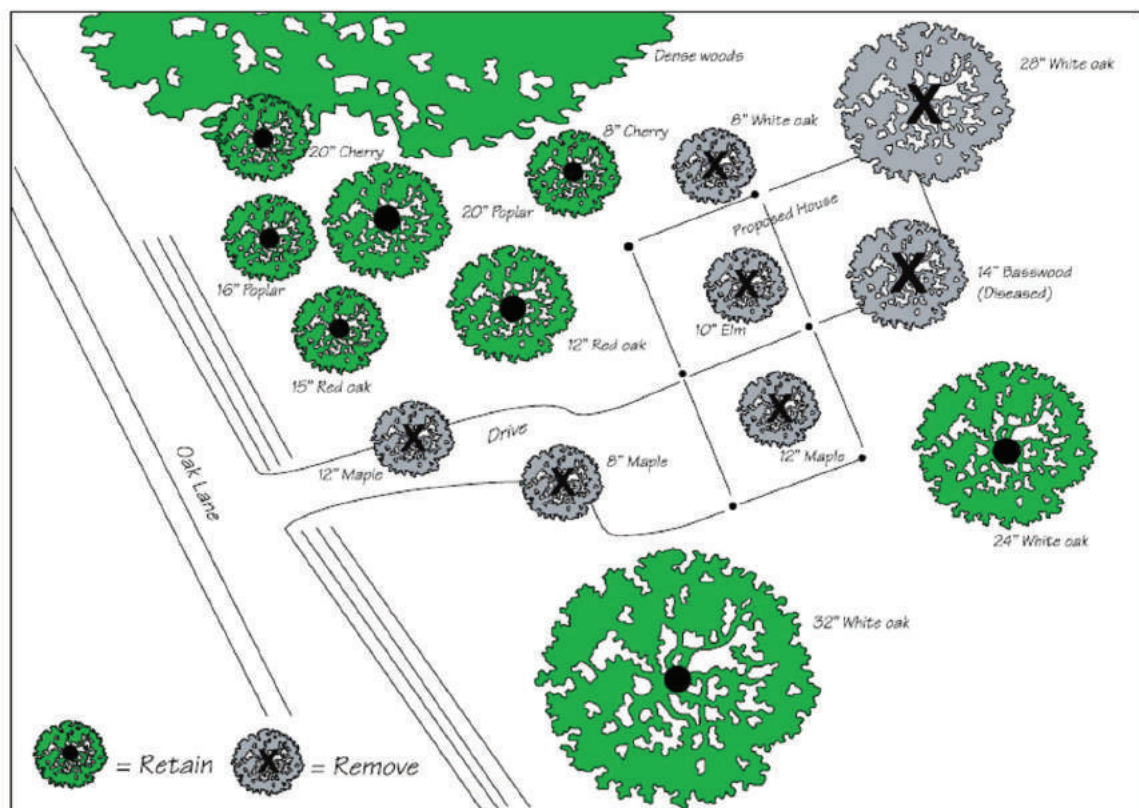


Figure 6.05b Simple tree protection plan. A plan identifies the size and species of existing trees, designates trees that must be protected, and marks trees to be removed. It also indicates planned structures, vehicle access, and excavation areas.

Design Criteria The following general criteria should be considered when developing sites in wooded areas:

- Leave critical areas (such as flood plains, steep slopes and wetlands) with desirable trees in their natural condition or only partially cleared.
- Locate roadways, storage areas, and parking pads away from valuable tree stands. Follow natural contours, where feasible, to minimize cutting and filling in the vicinity of trees.
- Select trees to be preserved before siting roads, buildings, or other structures.
- Minimize trenching in areas with trees. Place several utilities in the same trench.
- Designate groups of trees and individual trees to be saved on the erosion and sedimentation control plan.
- **Do not excavate, traverse, or fill closer than the drip line, or perimeter of the canopy, of trees to be saved.**

Construction Specifications

1. Erect TPZ fences. Restrict access to TPZs, with tall, bright, protective fencing. Most fencing is inexpensive and durable enough to last throughout most construction projects. Temporary tree protection fencing should be erected before clearing, deliveries and other construction activities begin on the site.

2. Prohibit or restrict access to TPZs. All on-site workers should be aware of the TPZs and the restrictions on activities within the zones. Use these TPZ guidelines for the best effect:

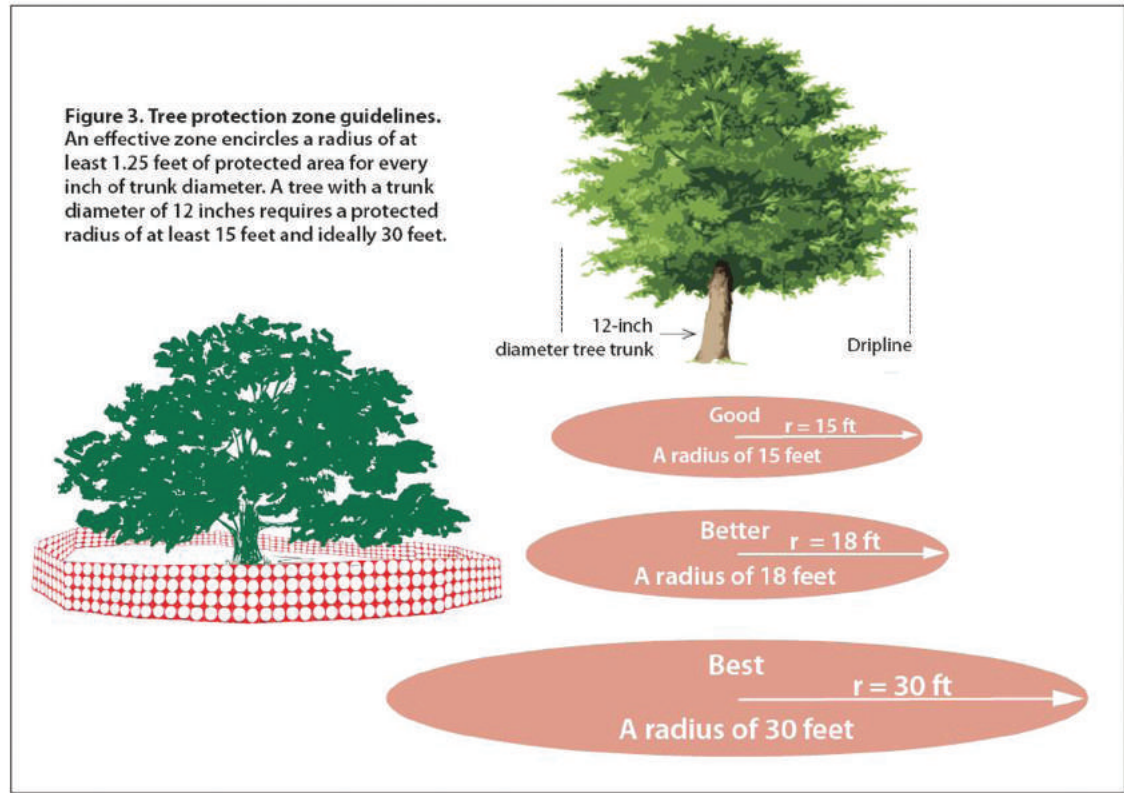
- Post “keep out” signs on all sides of fencing. Do not store construction equipment or materials in TPZs.
- Prohibit construction activities near the most valuable trees, and restrict activities around others.
- Assess crew and contractor penalties, if necessary, to keep the TPZs intact.

3. Monitor trees. Vigilance is required to protect trees on construction sites. Use a tree professional or train your staff to monitor tree health during and after construction on a regular, frequent basis. Watch for signs of tree stress, such as dieback, leaf loss, or general decline in tree health or appearance.

4. Monitor TPZ fences. Assign a crewmember the weekly responsibility of checking the integrity of TPZ fences. Repair and replace TPZ fencing as needed.

5. Optimize tree health. Assign a trained crewmember or hire a professional to complete regular tree maintenance tasks, including watering, fertilization, and mulching to protect tree roots. Consult a tree professional for advice on these practices if needed. Survival of protected trees will increase if these practices continue during construction. Healthy trees require undisturbed healthy soils. Do not cause injuries to trees and roots. Do not change the soil, grade, drainage, or aeration without protecting priority trees

Figure 6.05c Tree protection zone guidelines.



Maintenance Continue to care for the site until the new owner takes possession. Take these steps after all materials and equipment have been removed from the site:

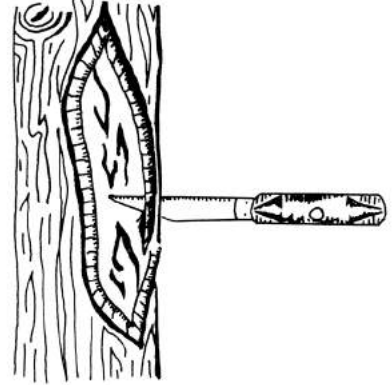
- Remove tree protection zone fences.
- Prune any damaged trees. In spite of precautions, some damage to protected trees may occur. In such cases, repair any damage to the crown, trunk, or root system immediately.
- Repair roots by cutting off the damaged areas and painting them with tree paint. Spread peat moss or moist topsoil over exposed roots.
- Repair damage to bark by trimming around the damaged area as shown in Figure 6.05d, taper the cut to provide drainage, and paint with tree paint.
- Cut off all damaged tree limbs above the tree collar at the trunk or main branch. Use three separate cuts as shown in Figure 6.05d to avoid peeling bark from healthy areas of the tree.
- Continue maintenance care. Pay special attention to any stressed, diseased, or insect-infested trees. Reduce tree stress caused by unintended construction damage by optimizing plant care with water, mulch, and fertilizer where appropriate. Consult your tree expert if needed.
- Inform the property owner about the measures employed during construction, why those measures were taken, and how the effort can be continued.

Figure 6.05d Wound repair and pruning of damaged trees.

Trim bark wounds with a tapered cut, then apply tree paint.

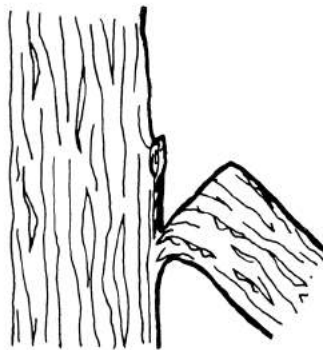


Tree wound

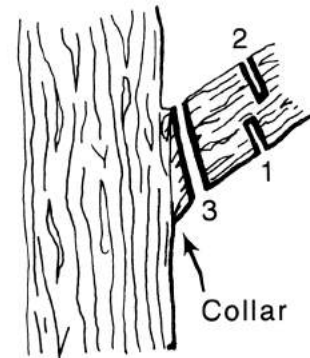


Trim and taper

Prune damaged branches with three cuts to avoid peeling bark from the trunk when limb falls.



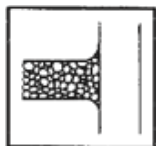
Incorrect



Correct

References

Construction and Tree Protection, AG-685 (Revised) North Carolina Cooperative Extension Service



6.06 Temporary Construction Entrance/Exit

Definition

An area or pad located at points where vehicles enter and leave a construction site typically surfaced with stone, riprap, coarse ground wood mulch, wooden logging mats, synthetic/composite products, or other ground stabilizing materials.

Purpose

To provide an area where mud, soil, and debris can be removed from equipment and vehicle tires to avoid deposition on the public road, where it can be a safety hazard and create muddy runoff and dust. Except for wheel washes, the removal of mud, soil, and debris occurs as a result of abrasion and wheel shaking as the vehicles drive over the right surfaces.

Conditions Where Practice Applies

Wherever vehicles and equipment will be entering and leaving a construction site and moving directly onto a public road or other paved off-site area. Construction plans should limit traffic to properly constructed entrances and exits.

Design Criteria

Construction entrances should be 12-ft minimum per lane of traffic. Non-synthetic construction entrance/exits should have geotextile underlayment.

Aggregate or mulch thickness should be a minimum of 6-in. A dedicated stockpile of clean material should be available on-site for immediate use to maintain the measure.

Location – Locate construction entrances and exits to limit sediment from leaving the site and to provide for maximum utility by all construction vehicles. Avoid steep grades and entrances at curves in public roads.

Dimensions of Entrance/Exit Pad -

Width – A 12ft-minimum or full width at all points of the vehicular entrance and exit area, whichever is greater.

Length – Apply stabilization techniques at lengths necessary to keep mud and debris from entering the paved roadway (Figure 6.06a). Lengths of stabilized roadway entrances and exits may vary by size of the construction site, percent

cover applied to the site access roadway, stabilization material selected, weight and frequency of traffic, and soil types.

Riprap and Stone Pads, Wood Fiber, Wooden Mats, and Synthetic Mats - Each option should achieve the purpose of this standard. Some standard starting points include:

Riprap Pads:

Aggregate Size – Use 2 - 3 inch stone. NCDOT Class A may be suitable for finer textured soils

Length – 50-ft minimum. More stone may be required to minimize trackout on paved surfaces.

Stone Pads:

Aggregate Size – Use NCDOT #5 or #57 stone.

Length – 25-ft minimum for residential or small linear utility sites.

Wood chips:

Material sizes may vary, but 3-inches or larger is preferred.

Wood Mats:

A minimum of ¼ inch construction, but various thicknesses may be appropriate.

Synthetic Mats:

Various thicknesses may be appropriate.

Wash Racks and Wheel Washes - If two instances of debris deposited onto the roadway are cited as a safety concern, a wash rack or wheel wash may be required. Otherwise, if conditions at the site are such that soil and other debris are not removed from exiting vehicles, the vehicles should be washed prior to accessing the public roadway. Soil and debris removal by washing should be conducted in a stabilized area that drains into a sediment trap or other suitable collection area or self-contained to filter water for reuse. A pressure washer and wash rack may be used to make washing more convenient and effective. A manufactured wheel wash installed and operated according to manufacturer's specifications is also an acceptable alternative. The roadway leading to and from wash racks or wheel washes shall be stabilized with appropriate materials. Drain space under wash rack shall be kept open. Damage to wash racks or wheel washes shall be repaired prior to further use.

Prefabricated Pad - Prefabricated pads may be used instead of or in conjunction with stone construction entrances provided they are installed according to manufacturer's recommendations and a sufficient number of pads or stone are installed to provide for a minimum of four tire revolutions while on the pad. More pads may be needed depending

on site conditions. Accumulated materials should be cleaned from the pads daily (more often if necessary) and disposed in the manner specified by the erosion and sediment control plan.

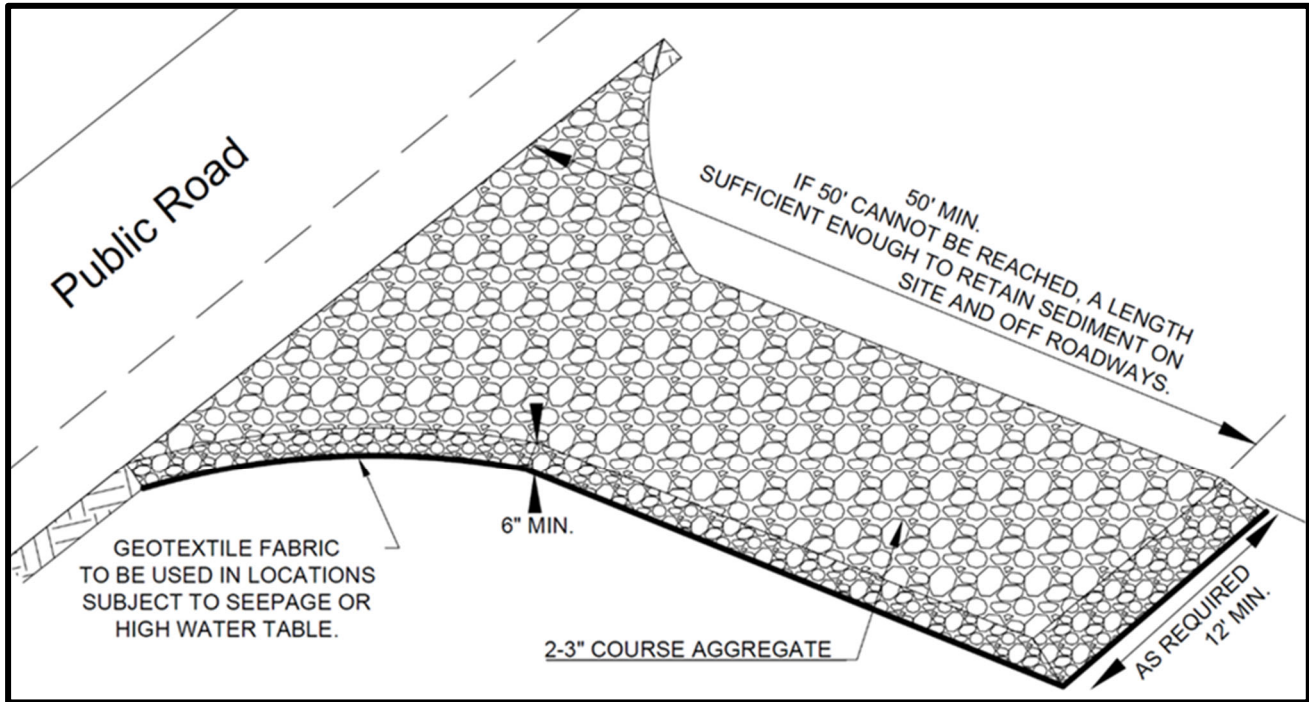


Figure 6.06a, Typical stone entrance/exit pad (modified from VA SWCC)



Figure 6.06b, Stone Entrance/Exit keeps sediment from leaving the construction site

Construction Specifications

1. Clear the entrance and exit area of all vegetation, roots, and other objectionable material and properly grade it.

2. Place the stone or other stabilizing material to the specific grade and dimensions shown on the plans, and smooth it.
3. Provide drainage from construction entrance area to carry runoff to a sediment trap or other suitable collection area.
4. Divert construction site runoff away from the construction entrance area to nearby erosion and sediment control measures. Do not allow construction sites to outlet runoff through entrances/exits.
5. When appropriate to do so, use geotextile fabrics underneath construction entrance material to improve stability of the foundation, especially in locations subject to seepage or a high-water table.

Maintenance

Maintain the pad or entrance in a condition to prevent mud or sediment from leaving the construction site. If any objectionable material—including sediment—is deposited onto paved roadways from the construction site, remove by manual or mechanical means and return the deposits back to the construction site immediately. Periodic topdressing with stone or coarse ground wood mulch may be needed to prevent debris deposits onto the road, a stockpile shall be maintained on site to quickly address compromised entrances/exits. After each rainfall, inspect any structure used to trap sediment and clean it out as necessary. In circumstances of high-traffic and/or wet conditions, routinely inspect the entrance/exit for sediment and debris removal effectiveness as needed.

References

Runoff Conveyance Measures

6.30, Grass-lined Channels

Sediment Traps and Barriers

6.60, Temporary Sediment Trap

Pennsylvania Erosion and Sediment Pollution Control Program Manual. March 2012.

Technical Guidance Number 363-2134-008. pp.13-18