5.2.1 Protect Undisturbed and Healthy Soils

Description

Undisturbed soils are soils that have developed over long periods of time through the influence of climate (temperature, precipitation), landforms, and biological organisms on the original mineral substratum (bedrock). Found between vegetation and the bedrock, undisturbed soils generally consist of visually and texturally distinct parallel layers (soil horizons), which can range from a few inches to several feet in depth. Typical soil horizons consist of the following:

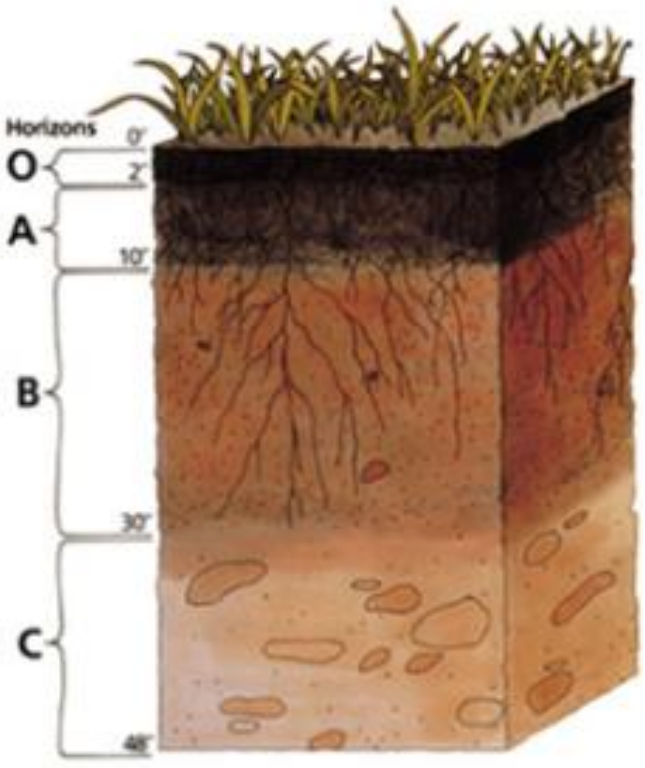

Figure 5.2.1-1. Soil horizons.

O - Organic matter: The uppermost layer on the surface of the ground composed mainly of relatively un-decomposed plant and animal residues (leaves, stems, fur, bones, etc.).

A - Topsoil: The top layer of soil. It has the highest concentration of organic matter and soil life, and is where most of the earth's biological soil activity occurs.

B - Subsoil: A layer of generally coarser mineral soil http://en.wikipedia.org/wiki/Soilunder the topsoil. This layer accumulates iron, clay, aluminum, and organic compounds.

C - Parent rock: Below the subsoil is a layer of residual, unbroken rocks or windblown or water-carried sediments. This layer often forms a major constituent of the other soil layers. Plant roots generally do not penetrate this layer.

Undisturbed soils are generally healthy soils that have the functions and characteristics (texture, structure, density, water holding capacity, etc.) of comparable, known, undisturbed soils in the region.

Soil Attributes:

Healthy soils have three key attributes. The following recommendations will help ensure that all three key soil characteristics are protected from damage during construction and maintenance.

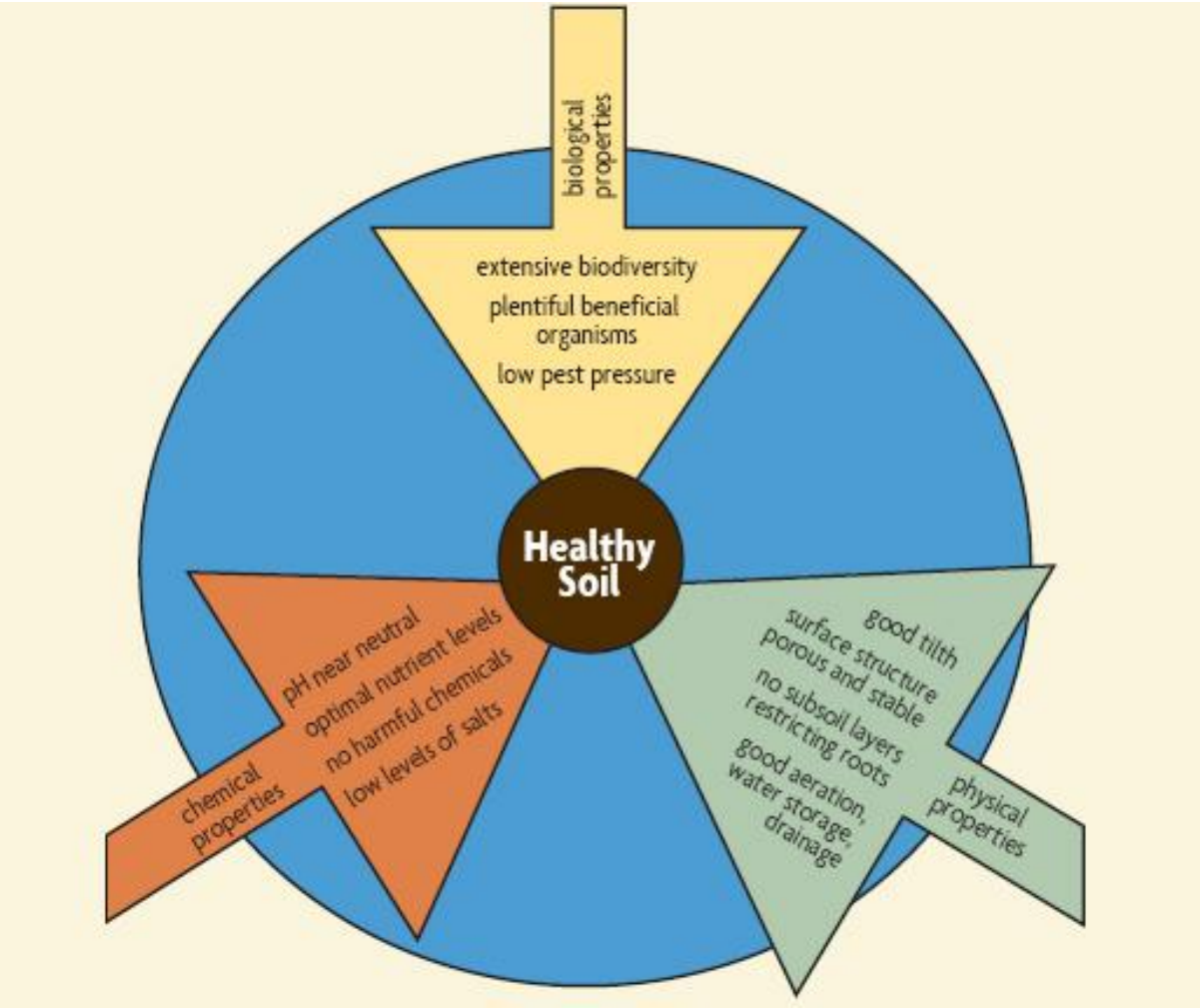

Figure 5.2.1-2. Optimal soil properties.

- Physical Structure – In all soil types, which consist of percentages of sand, silt, clay, and organic matter, it is the organic matter that helps form particle aggregates. These aggregates, called "peds," create pore spaces, which enable the soil to hold and clean water. Compaction increases "bulk density" as pore spaces are compressed. The result is poor root penetration and poor water absorption. Runoff increases, pollutants and sediments are carried into streams, and little water soaks into the ground to replenish the water table.

- Chemical Makeup – Certain chemicals such as salt, when added to the soil, cause aggregates to disintegrate and pore spaces to collapse. Conversely, some chemicals are required as key nutrients that support the life found in soil, which help create aggregations of particles.

- Biological Communities – A living, functioning soil biota influences both structure and chemistry. Biological processes are critical in stabilizing soil aggregates. Burrowing animals break up clods and push particles together, fine roots and fungi exude sticky substances, and microorganisms produce organic "glues."

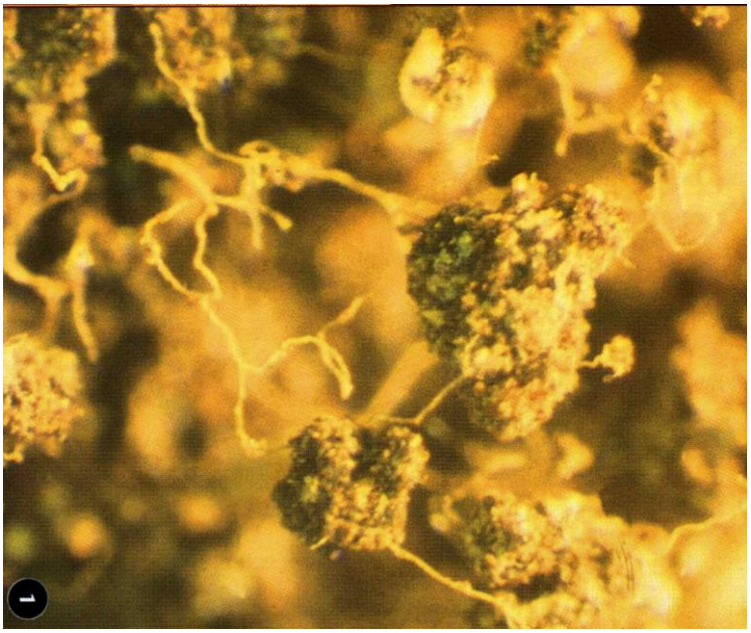

Figure 5.2.1-3. Soil Peds.

Protecting healthy/undisturbed soils, in order to maintain infiltration capacity, requires preservation of the above three main attributes. It also necessitates safeguarding site soils from the impacts of grading, compaction, and contamination before, during, and after construction.

General characteristics of healthy/undisturbed soils are as follows:

- Soil horizons similar to an undisturbed native soil within the Chattanooga region with native vegetation, unaltered topography, and soil characteristics similar to the site
- Bulk densities that do not exceed the value at which growth limitations are expected
- Organic matter content that is equal to or exceeds that of similar local undisturbed soils

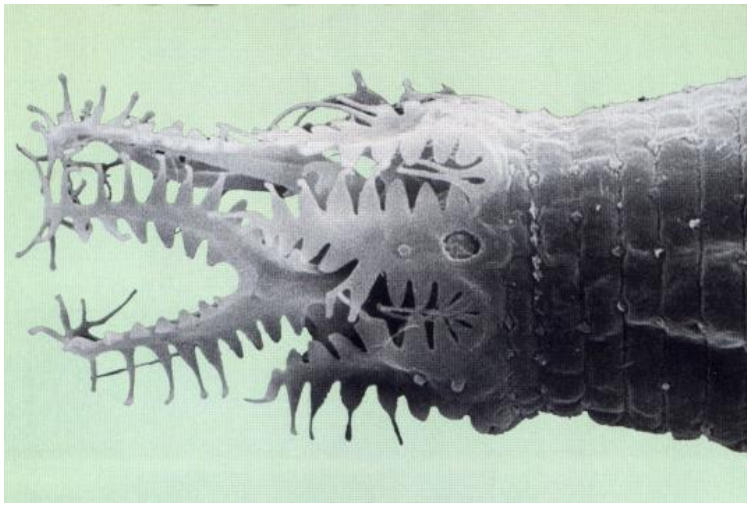

Figure 5.2.1-4. Nematode found in soil.

- Soil chemical characteristics (such as pH, salinity, cat-ion exchange capacity, and nutrient profiles) similar to local undisturbed soils
- Absence of construction debris and toxic compounds

When soils are compacted and permeability is drastically reduced, these critical characteristics of healthy soils are lost and with them the ability of the soil to absorb stormwater runoff (Hanks and Lewandowski 2003). The runoff response of areas with highly compacted soils closely resembles that of impervious areas, especially during large storms. Compacted soils have been shown to have runoff percentages as high as 95 percent (as high as some pavements), increasing stormwater flows (Schueler, undated). The purpose of this BMP is to prevent or at least minimize the degree and extent of compaction in areas that are to be considered "pervious" following development.

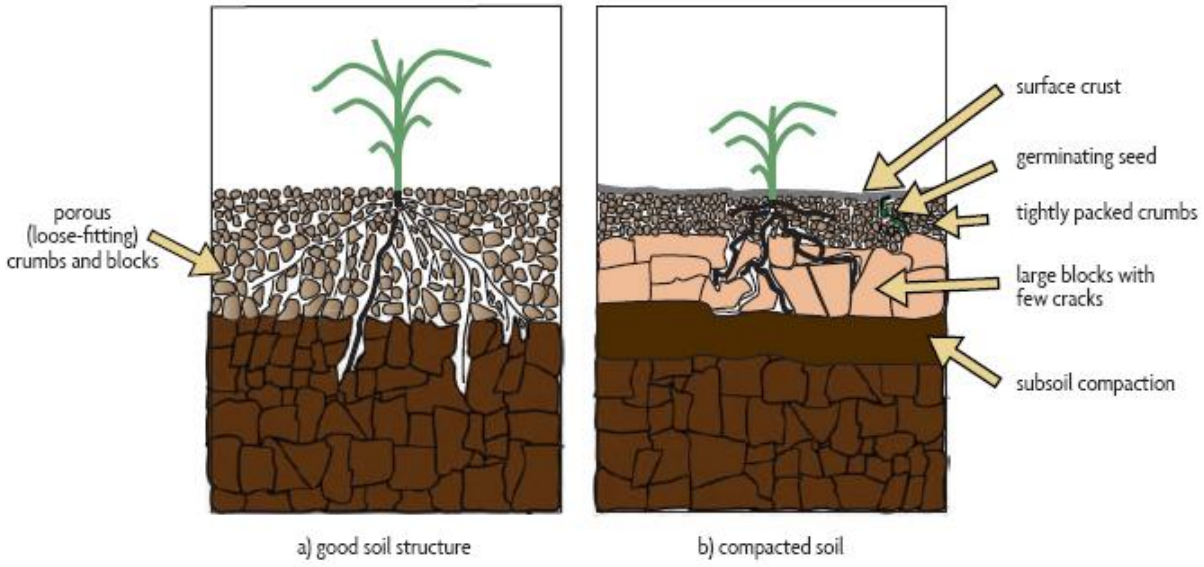

Figure 5.2.1-5. Soil compaction diagram (BSBC).

BMP Functions Table

Undisturbed, healthy soils are an important and low-cost BMP. Protecting site soils by minimizing damage from erosion and compaction, and preserving soil functions before, during, and after construction, is a very cost-effective stormwater management strategy, conserving infiltration capacity and reducing runoff.

BMP	Applicability	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation	Maintenance Burden	Cost
Undisturbed Soil	U/S/R	H	H	H	H	M	M	H	L	L

KEY: U = Urban; S = Suburban; R = Rural; H = High; M = Medium; L = Low

Key Design Guidelines

- Understand the importance of undisturbed soils as an irreplaceable resource. Once disturbed, soil can never be fully brought back to its original state.
- Identify soils to protect based on their functionality early in the design process.
- Where possible, preserve existing native plants, historical plant groups, and specimen trees, which often grow on less disturbed soils.
- Reduce impervious footprint.
- Minimize required grading.
- Designate "Protected Areas" and "Areas of Minimal Disturbance" on the Existing Conditions Assessment and Site Protection Plan, Grading and Soils Plan, Erosion and Sediment Control Plan, and Stormwater Plan.
- Designate construction activity and construction traffic routes on the Site Protection Plan and Stormwater Plan.
- Place, monitor, and enforce protection fencing.
- On protected soils, design for lower maintenance and restricted traffic and limited access.

Applications

- Any land with healthy, undisturbed soils that can be proposed for preservation.

Advantages

- Cost-effective:
  - Preserving soil horizons reduces the need for soil restoration and for additional stormwater management measures.
  - By limiting grading, costs can be reduced for construction machinery and purchase and transport of imported soils.
- Healthy soil:
  - Stores carbon as organic matter.
  - Minimizes runoff and maximizes soil water holding capacity.
  - Absorbs and removes nutrients, sediments, and pollutants.
  - Supports healthy plant roots.

Disadvantages

- Minimal site intervention during design and construction presents challenges to owner/developer and design team.
- Protection requires fencing that is kept standing and in good repair during construction.

Applications

This BMP can be applied to any development that has existing areas of relatively healthy soil proposed for preservation. Even abandoned properties/vacant lots, etc., may have areas of undisturbed soils.
Areas with damaged soils can be remediated (see Section 5.4.3, Restore and Amend Disturbed Soils, in this manual).

Figure 5.2.1-6. Construction site fencing protecting healthy soil under forest cover.

Figure 5.2.1-7. Soil samples taken with different devices.

Protocols and Specifications

Protocol 3 Soil Testing

Design Considerations

- Preserving healthy soils in place impacts both design and construction options. Successful soil preservation requires attention throughout the entire design, permitting, and construction process. **Non-disturbance is the most effective strategy for preserving soil functions.** Not only are soil functions maintained, but living organisms in undisturbed soil can colonize adjacent, disturbed soils after construction.
- There are a number of circumstances and BMP **requirements for soil compaction,**

for example, the cores of infiltration berms. These special situations are flagged in each BMP, and are **not restricted** by soil protection requirements.

- Determine areas of high-value soils and identify areas of undisturbed soil. Delineate these soils clearly on the Existing Conditions Assessment and Site Protection Plan, Grading and Soils Plan, Erosion and Sediment Control Plan, and Stormwater Plan. Where possible, integrate these soil areas into the proposed open space plan and/or into the stormwater design.
  - Look for soils that have the following characteristics:
    - Clearly visible soil horizons that are similar to an undisturbed native soil within the Chattanooga region with native vegetation, unaltered topography, and soil characteristics similar to the site
    - Sites with mature vegetation, which are less likely to be disturbed and are a good indicator of undisturbed soils
    - Bulk densities that do not exceed the value at which growth limitations are expected, see Protocol 3, Soil Testing
    - Organic matter content that is equal to or exceeds that of similar local undisturbed soils
    - Soil chemical characteristics (such as pH, salinity, cat-ion exchange capacity, and nutrient profiles) similar to local undisturbed soils
    - Absence of construction debris and toxic compounds
- Identify easily damaged soils and soils on sensitive areas, especially on steep slopes. For example, deep, spongy soils underneath relatively undisturbed, mature forests typically have a high infiltration capacity and can be destroyed easily. These soils are a priority for protection. Excessive stormwater should not be directed onto these soils.
- Take soil samples from representative areas on the site. Do not mix these soils together, rather, test each individual sample separately. Send samples to the University of Tennessee Extension for analysis (Hamilton County, 6183 Adamson Circle, Chattanooga, TN 37416-3648). Laboratory tests often include professional interpretation of results and recommendations.

Figure 5.2.1-8. Soil protection at woodland edge.

Website:
https://utextension.tennessee.edu/hamilton/Pages/Soil-Testing.aspx

Recommended Soil Tests:

Texture Class
Organic Matter
Bulk Density

- Identify "Protected Areas" and "Areas of Minimal Disturbance"

  "Protected Areas" are those areas where there will be no construction disturbance by machinery, dumping or other means. Protected Areas must be clearly delineated on the Existing Conditions Assessment and Site Protection Plan, Grading and Soils Plan, Erosion and Sediment Control Plan, and Stormwater Plan. This includes areas intended for suggested BMPs.
  - Include in the specifications that the contractor is responsible for maintaining the protection fencing.
  - Where appropriate, explore the use of conservation easements, deed restrictions, or other legal measures for protected areas on private property. Legal status can help ensure lasting protection. In addition, the owner can be rewarded with a tax write-off.

  "Minimal Disturbance Areas" are protected areas where limited construction will temporarily take place because of site constraints. These areas are to be restored at the end of construction to be considered fully pervious after development. Indicate on plans areas of soil remediation, amendments, etc. (where such areas are to be considered permeable after construction). Minimal Disturbance Areas must be clearly delineated on the Existing Conditions Assessment and Site Protection Plan, Site Design, Erosion and Sediment Control Plan, and Construction Plan.

  These **temporary** areas include:
  - Areas where vegetation needs to be removed for equipment access. Where possible, do not remove stumps to leave root systems to hold soil and possibly regenerate.
  - Areas that require small amounts of grading (including excavating, filling, moving, and dumping) for utilities, etc.
  - Area of remediation such as erosion and/or gully repair.

  These areas should use:
  - The lightest equipment possible to do the job.
  - Protection measures discussed below.
  - The smallest possible construction space.

- Provide durable protection fencing.
- During the site design process, make every effort to avoid placing buildings and roads on Protected Areas and Areas of Minimal Disturbance. During concept and preliminary stormwater management plan phases, reexamine proposed site plans to reduce site disturbance. Revisions should include minimizing impervious

surfaces of all kinds, including circulation and building footprints, and wherever possible, minimizing land disturbance. (See Section 5.2.1.1, Preserving Landforms, in this manual.)

- Design to protect designated areas. Rogue trails are created and site resources are damaged where circulation is poorly planned. Buffer areas of healthy and undisturbed soils by maintaining existing strips or creating new strips of vegetation that people would not care to walk through. These buffers will safeguard from damage by runoff and also help to direct users to designated access routes after the project is implemented. Soil degradation can also result from trampling and extensive maintenance activities. (See Structural BMP 5.3.6 Vegetated Filter Strips, in this manual.)

Construction Strategies

- The best way to preserve topsoil is to leave it in place. Where high-value soils must be disturbed, topsoil should be separated from the subsoil and stockpiled for reuse. While this is the easiest and most familiar method, a less conventional but more effective way to preserve soil structure, microorganisms, and seed reservoirs, etc., is to cut and stockpile the upper soil layers as a "sod" (See Restorative BMP 5.2.4.2 Soil and Plant Salvage, in this manual.)
- Designate undisturbed soils as "Protected Areas" or as "Areas of Minimal Disturbance" onsite.
- Consider preserving a buffer strip of existing vegetation between "Construction Areas," "Protected Areas," and "Areas of Minimal Disturbance." See Structural BMP 5.3.6 Vegetated Filter Strips, in this manual.
- Preserve existing vegetated areas for as long as possible during construction (even if they are to be removed eventually). Existing vegetation acts as a barrier, making it less likely for an area to be suddenly usurped for construction activities.
- Safeguard protected areas from sediment and stormwater loads from disturbed, upgradient parts of the site.
- Restrict access through protection and minimal disturbance areas. If access by construction equipment through a minimal disturbance area is required, or if it is necessary to work in sensitive areas:
  - Avoid grading and allowing access over any soil under extreme conditions—when soil is either extremely wet or extremely dry. Most critically, do not cross or work soil in wet weather. This should be noted on the Erosion and Sediment Control Plan.
  - Use small equipment and always use the lightest machinery available. Consider alternatives for moving materials, including the use of planks and rollers, pole slings, dollies, etc.
  - If storage or access is unavoidable in areas designated as "Areas of Minimal Disturbance", the contractor should lay down a thick, protective layer over the soil to absorb and spread compressive forces.

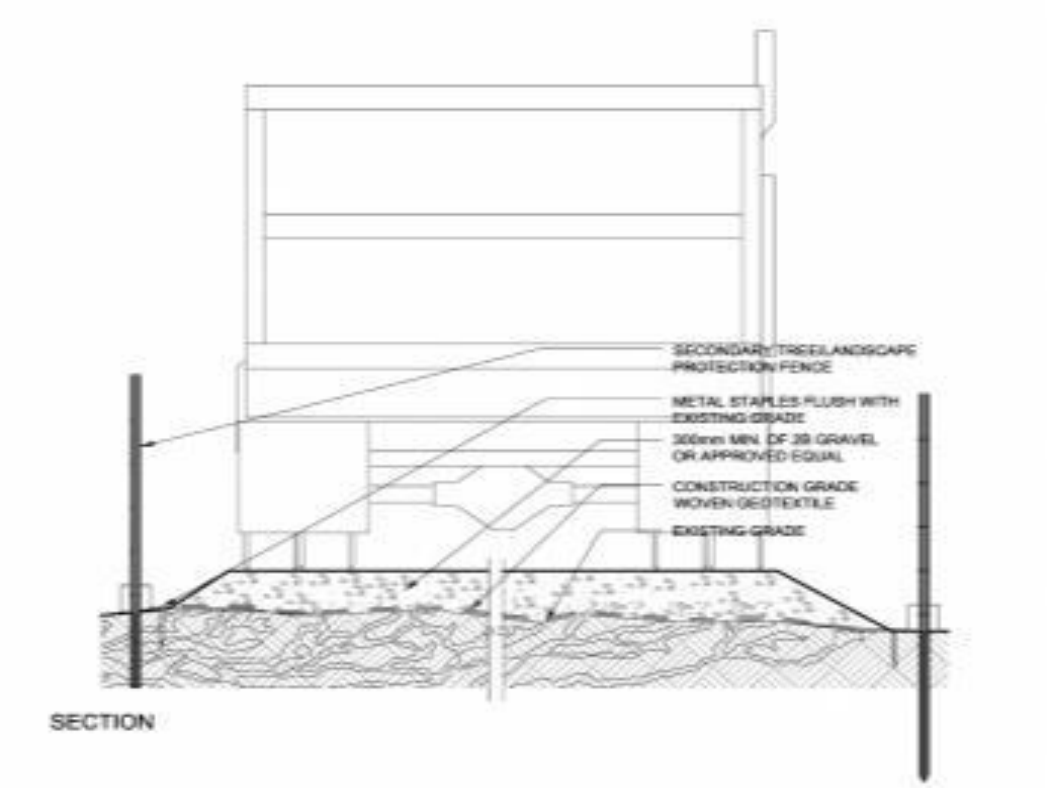

Figure 5.2.1-9. Gravel mat – large vehicle access.

Choices for this layer include:

- 10 inches of woodchips.
- Wood planks, plywood, or metal mats.
- Pre-engineered systems, designed for this purpose.
- A layer of geotextile fabric should be laid under the other suggested protective layers when using very heavy construction equipment.

– When the protective layer/layers are removed at the end of construction, a light tilling of the soil may be necessary to prevent surface crusting.

– If areas impacted by construction activities are to be

Figure 5.2.1-10. Using wood mats to protect soil from compaction.

counted as permeable at the completion of the project, soil restoration (including compost tea and other amendments) will be required (see Section 5.4.3, Amend and Restore Disturbed Soils, in this manual).

Operations and Maintenance

Sites with minimal soil disturbance require less maintenance. Minimizing the compaction of soils that will later be planted or used as part of a recommended BMP will save time, money, and materials. Vegetation will be healthier, have a higher survival rate, and look more attractive. BMPs will be less expensive.

Soil health and stormwater management potential can also be damaged by end users and by conventional maintenance techniques, especially for turf areas. Soil compaction after construction can be reduced in a number of ways:

- Reduce mowing frequencies. Let turf grasses grow to a height of 3 to 4 inches before mowing. (This approach will also allow the grass to shade itself, which, in turn, reduces evapotranspiration losses and the need for irrigation.)
- Use specialized grass seed mixes, such as "No-Mow" mix.
- Amend topsoil with organic matter and compost teas.
- Aerate turf on a regular basis.
- Keep users out of sensitive areas or restrict users to routes that encourage them to remain on designated paths.

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5.2.1 Protect Undisturbed and Healthy Soils Criteria Checklist

ITEM DESCRIPTION	YES	N/A
The following checklist provides a summary of design guidance by the owner/applicant for successful implementation.		
• Soil samples are taken from representative areas onsite and tested separately. Tests show: – Soil bulk density does not exceed the value at which growth limitations are expected. – Organic content is equal to or exceeds that of similar, local undisturbed soils. – Soil chemical characteristics (such as pH, salinity, cat-ion exchange capacity, nutrient profiles) are similar to local undisturbed soils.	☐ ☐ ☐	☐ ☐ ☐
• Absence of construction debris and toxic compounds in soil preservation areas. Provide photo documentation.	☐	☐
• Soil horizon similar to undisturbed native soil with native vegetation and unaltered topography. Provide photo documentation of soil pits showing distinctive horizons.	☐	☐
• Where possible, existing native plants and specimen trees are preserved.	☐	☐
• Areas of high-value soils, including soils on sensitive areas, especially on steep slopes, have been designated "Protected Areas" and/or "Areas of Minimal Disturbance" and are delineated clearly on the Existing Conditions Assessment, Site Protection Plan, Grading and Soils Plan, Erosion and Sediment Control Plan, and Stormwater Plan.	☐	☐
• "Protected Areas" and/or "Areas of Minimal Disturbance" are safeguarded from sediment and stormwater loads.	☐	☐
• Protections fencing details and associated signage details for "Protected Areas" and/or "Areas of Minimal Disturbance" have been provided.	☐	☐
• Protected soil areas have been designed for end-user avoidance. (Existing strips of vegetation are maintained or created to discourage pedestrian circulation over disturbed soils.)	☐	☐
• Areas for site access, storage, and equipment use the smallest possible construction space, and minimize impervious surfaces, building footprints, and site disturbance.	☐	☐
• Where high-value soil must be disturbed, it is separated from the subsoil and stockpiled appropriately for reuse.	☐	☐
• Notes on Existing Conditions Assessment, Site Protection Plan, Grading and Soils Plan, Erosion and Sediment Control Plan, and Stormwater Plan state: Grading in extreme wet or dry conditions is avoided entirely.	☐	☐
• Provide written description of any work that may need to be performed within "Areas of Minimal Disturbance."	☐	☐
• Smallest and lightest machinery is to be used in "Areas of Minimal Disturbance."	☐	☐
• Details provided for protective layer on soil to absorb and spread compressive forces for work done in "Areas of Minimal Disturbance."	☐	☐
• Notes on drawing clearly provide sequence for removal of protective layers and soil restoration if required in "Areas of Minimal Disturbance." (Once removed, contractor performs a light tilling of soil to prevent surface crusting, including compost tea and other amendments.)	☐	☐