Sections 207 and 212 Landscape Plans and SWMP Design Guidance

207 Subsoil and Topsoil

Determine If Topsoil Should Be Salvaged

The CDPS General Permit states "*Unless infeasible, topsoil shall be preserved for those areas of a site that will utilize vegetative final stabilization*." Preserved topsoil must be stockpiled if construction activities are taking place in the area. Topsoil in areas that will not be disturbed can be left in place.

Salvaging topsoil is a cost-effective measure to reduce costs associated with removal and importation of topsoil. Topsoil contains valuable site organic matter including microbes and seeds and therefore, retaining existing topsoil can lead to higher vegetation success and increased diversity.

To determine if topsoil should be salvaged, the SWMP and/or landscape designer should coordinate with the Region's Permanent Stabilization Subject Matter Expert (PSSME) as well as the design team. Items to be reviewed by the team include: if noxious and invasive weeds are present, what is currently growing on site successfully, and any existing soils information, to determine if topsoil should be salvaged. Review of existing documents such as NEPA Biological Assessment, OTIS weed layers, and Geotechnical Reports as well as plan for a site visit can help determine if salvaging topsoil is right for your project. Work with the RWPCM and PSSME to determine if the site meets the following criteria:

- Existing native vegetation consists of less than 20 percent noxious and invasive weeds.
- There is sufficient area to store topsoil onsite or a nearby site and topsoil stockpiles can be placed a minimum of 50 horizontal feet away from State waters.

Other considerations:

- Rock cut slopes are not to be vegetated unless determined otherwise by the project team, including design project manager and the PSSME.

- Topsoil should not be placed on rock cut slopes, rock cut ditches, or on sandy and silty slopes[1] steeper than 3H:1V. Consult with the project team for slopes greater than 2.5H:1V. Alternatives include using permanent stabilization with concrete, retaining walls to reduce the slope, geogrid with rock or planted with natives.
- Topsoil containing rocks greater than or equal to 6 inches in diameter in any direction should specify the hydraulic seeding and hydro mulching methods for final landscape stabilization.
- Smaller disconnected sites should use the broadcast seeding method.

Topsoil should not be salvaged in the following site conditions or areas:

- Site conditions do not allow for stockpiling topsoil either onsite or offsite.
- Soil laboratory results discourage salvaging topsoil due to pH and salt content being out of range limits.
- Noxious weeds on the State or County A and B lists are present, (unless treated as part of the project before construction, see Section 217)
- Noxious weeds on the State C list or invasive weeds are present in amounts greater than 20%.
- Soil contamination is known to be present. i.e. mine tailings, radioactive soils, documented spills, or other soil contamination

If it is determined that onsite topsoil cannot be salvaged, then the SWMP Designer coordinating with the project design team needs to determine the best option for project topsoil. The options are:

- Importing topsoil
- Engineering topsoil from subsoils
- Salvaging topsoil from adjacent appropriate areas, or
- A combination of these techniques

Again, it is important to consider that salvaging topsoil is more cost effective than importing topsoil and the project team should take into consideration the cost of importing topsoil compared to engineering topsoil from existing subsoils.

[1] For vegetation plans and SWMP development, soils with an AASHTO M 145 or ASTM D3282 classification from A-3 to A-5 are considered sandy and/or silty soils.

Determine What Noxious and Invasive Weeds are present.

The most important thing to do is have a specialist conduct an environmental scoping field visit during the growing season to determine if and what type of weeds are present. The Colorado Department of Agriculture weeds list is available and many counties have weed lists specific to the county that may vary from the state.

Speaking to your region's maintenance staff can provide additional information on what weeds may be present on the project site.

OTIS weed layers is a resource for noxious weeds within CDOT right of way. This data may not be up to date and conducting a site visit is still the best way of determining if weeds are on site.

Obtain additional information on existing native species, invasive and noxious weeds from the region NEPA Specialist. If available, the project Biological Assessment, (or for Region 1 the Biological Resource Report) may provide more information to help make decisions. Knowledge of the existing vegetation can help in determining the seed mix, whether to salvage topsoil, and what Section 217 pay items to include in the plans for weed management. If noxious and invasive weeds are present at approximately less than 20% of the total plant cover and it is determined to salvage native topsoil, Section 217 Weed Management pay items should be included.

Determine Topsoil Quality and Quantity

Next, determine the quantity of topsoil available for the project site. This requires a site visit to determine the depth of topsoil and if determined to salvage topsoil, taking topsoil samples for analysis. The recommended minimum depth of topsoil is 6 inches, but the depth may vary based on project site conditions. Compare the quantity of onsite topsoil available with the quantity needed for the area to be vegetated. If additional topsoil is required, it will have to be imported from a local source or engineered from site subsoils. If more topsoil than is necessary is available, coordinate with the project team to determine if excess topsoil can be:

- reused on site to increase topsoil depth.
- used onsite for fill, or
- hauled offsite.

Imported and Engineered Topsoil

Where topsoil is unavailable, the project team must specify an imported or engineered topsoil. Imported topsoil should be obtained from a local source, meet the requirements of Table 207-1, and be placed on a prepared subsoil surface. The topsoil depth should be 6 inches or as determined by the project team. Any depth other than 6 inches will have to be documented in the plans. Work with your project team to determine what is the correct course of action for your project conditions.

Engineered Topsoil

When imported topsoil meeting the requirements of Tables 207-1 and 207-2 in Section 207 Subsoil and Topsoil is unavailable locally, topsoil can be engineered on site using existing subsoils. The subsoils should be sent for laboratory testing to determine if they are suitable and what amendment quantities are necessary. The subsoils for use should be stockpiled, amended to a homogenous mixture to create the engineered topsoil before placement, and then placed on the prepared surface.

Litter and Duff

Litter and duff are removed during clearing and grubbing. Litter and duff are the layer of fresh and decomposed plant materials such as needles and leaves covering the ground surface. Litter and duff can be a valuable source of nutrients, seeds, and mycorrhizae, vital to plant growth. Based on the site assessment of desirable or problematic pre-existing plant species, direction should be given to either dispose of litter and duff with topsoil or stockpile litter and duff with topsoil as part of clearing and grubbing. Retaining litter and duff will require a PSP 202.

For wetland soils, work with the Region Wetland Specialist to determine the course of action to salvage and store litter and duff.

Saline Soils

Where topsoil laboratory results discourage salvaging topsoil due to pH and salt content being out of range limits. Here are recommendations:

- SAR values above 3.9 mmhos/cm include saline tolerant grasses.
- SAR values above 13.0 mmhos/cm consult with an expert to develop a strategy for the topsoils and amendments.

Documenting Topsoil Quantities, Stockpile Locations, and Stockpile Control Measures

The SWMP Designer documents the topsoil management strategies in either the SMWP Site Maps for projects over an acre, or for projects under an acre, include in the SWMP Template for easy interpretation by the Contractor for bidding. The Site Maps should also propose locations of topsoil stockpiling along with the appropriate control measures. Stockpiling can be phased as an alternative for projects with tighter working spaces and phased seeding schedules. However, keep in mind the Contractor will ultimately determine where to locate stockpiles.

When salvaging topsoil in windrows or stockpiles the designer must include initial and interim control measures per 208 for protecting the stockpiles from run-on and as a downgradient perimeter control. Document the control measures on the appropriate Site Maps and include the quantities in the SWMP.

Document the topsoil quantities, including amount of native topsoil supplemented by imported or engineered soils, in the Tabulations of Stormwater Quantities in the SWMP Plan.

Coordinate with the Region Wetland Specialist to determine the best course of action for stockpiling wetland topsoil, required maintenance, and length of storage and phasing.

Collect Topsoil Sample

In addition, when collecting a topsoil sample(s) determine the depth of topsoil.

If it is determined that the project will salvage topsoil, topsoil testing should be conducted, generally in the early design phase (prior to FIR) by the SWMP Designer, Region Environmental or Consultant to determine if soil pH and salts are within an acceptable range and to determine site specific amendment quantities. The topsoil testing procedure outlines the steps to determine vegetation units, collect topsoil sample(s), and send the sample(s) to a laboratory for analysis.

If it is determined that subsoils may be used to generate engineered topsoil, send a sample of the subsoil. Do not mix topsoil and subsoil samples, they should be sent as separate samples.

Note: For smaller projects, or as determined by the project team, it is unnecessary to perform a soil analysis. Use the recommended soil amendment rates in Section 212.

Subsoil Considerations

Heavily compacted soils do not support healthy plant growth; therefore, subsoil preparation is important to increase planting and seeding success. Plants help slow stormwater, allowing more water to infiltrate into the soil which prevents erosion and helps protect CDOT infrastructure such as roads, bridges, and walls.

Coordinate with the project design team to identify the disturbed areas to be revegetated, the final stabilization methods to recommend, and where subsoil preparation is or is not appropriate. The SWMP or landscape designer should collaborate with the roadway designer to determine how far off the roadway shoulder to decompact the subsoil and ensure this coordination is reflected on plans.

Site locations that Benefit from Subsoil Preparation:

- Disturbed areas that will need to be vegetated. These include, but not limited to, temporary haul and abandoned roads, staging areas, and batch plant areas.
- Bioretention areas
- Fill slopes that conform to the Section 203.03 material requirements for soil and rock embankment material with particle sizes less than 6 inches.

Subsoil Preparation is Not Appropriate Where (In consultation with Design Project Manager and PSSME prior to any decisions being made):

- Earthwork activities are not required for the project (no dozers or graders mobilized).
- Small disturbances where subsoil preparation equipment would create a larger disturbance.
- Subsoil contains a significant quantity of large rocks or is sandy or gravelly[1].
- In drainage swales with slopes less than 2% (due to ponding potential).
- Subsurface utilities prohibit ripping operations.
- Cut slope/embankments are steeper than 2.5:1.
- Subsoils have a high moisture content such as in wetland and riparian areas.
- The area under the drip lines or root zones of existing trees and shrubs are to remain undisturbed (Protect with tree protection fencing).
- Areas to be irrigated and sodded. These areas should not use Section 207, but instead follow Sections 219 Sodding or 220 for Lawn Seeding.

[1] For landscape plans and SWMP development, soils with an AASHTO M 145 or ASTM D3282 classification from A-3 to A-5 are considered sandy and/or silty soils.

Subsoil Preparation for Shallow Depths or Smaller Project Areas

For sites where subsoil preparation is not appropriate at a depth of 14 inches, evaluate if shallower decompaction would be appropriate. If yes, indicate quantities and include quantities on the SWMP template or site maps for easy interpretation by the Contractor for bidding. If rototilling is to be conducted for smaller project areas, use a project special provision.

Coordinate Earthwork Tabulations.

List the topsoil strategies and earthwork quantities in the SWMP and Earthwork Quantities Worksheet of the Plan Set. Potential options that may affect quantities:

- Salvaging and redistributing native topsoil, with 6-inch depth average or as determined for your project.
- Importing off site topsoil for areas being landscaped for final stabilization.
- Exporting excessive, existing topsoil from the project site.
- Salvaging topsoil using Section 207 pay items, which would no longer be paid for as clearing and grubbing.

212 Topsoil Amendments and Native Seeding

Develop Vegetation Plan (Landscape Plan or SWMP Plan)

Getting vegetation to grow is not a one size fits all process; therefore, a site-specific landscape plan is necessary to identify site constraints, types of soils, and type of vegetation. The landscape pan should include:

- show areas where topsoil will be salvaged, to what depth, and where to potentially stockpile the topsoil. Note the Contractor will determine the final locations where topsoil will be stored during construction.
- address if the project will need to import or engineer additional topsoil.
- based on the results of the topsoil testing procedure if adjustments to the seed mix should be made for salinity and what amendments and in what quantities are necessary to achieve successful site vegetation.

Landscape Plan, Tools, and Options

Landscape design starts with the SWMP Plan Sheets and Site Maps (vegetation plan). Early coordination of the topsoil, weeds, and existing vegetation is crucial for successfully reestablishing roadside vegetation establishment. The vegetation plan includes:

- noxious and invasive weeds inventory.
- topsoil inventory including depth and where to salvage.
- topsoil lab analysis.
- seeding method(s).
- topsoil amendment quantities.

Several tools are available to assist the SWMP Designer with final stabilization strategies. These include the following:

- Vegetation Transect.
- Topsoil Testing Procedure.
- Topsoil Amendment Calculator.
- SWMP Templates.

Determine Amendment Quantities

Enter the results from the laboratory analysis into the Topsoil Amendment Calculator. The results of the Topsoil Amendment Calculator provide the types and quantities of soil amendments specific to the needs of your project. These results are then transferred into the SWMP Plan Sheets (SWMP Template).

The limiting factor(s) for vegetation establishment might be a nutrient, high pH value, low organic matter, soil instability, high nitrogen to carbon ratios, high salts, or other soil properties. The Landscape Architecture Section is available to assist with developing or reviewing the topsoil amendment strategies for the project.

No amendments are to be added to wetland soils unless determined by the Region Wetland Specialist.

Topsoil Amendments:

Organic Fertilizer provides the essential nutrients for existing plant growth. Fertilizer should not be used in and around permanent water quality ponds and water conveyance swales. High nitrogen should be used as an amendment for sod installation.

Compost improves soil physical properties, including increasing the water infiltration and the water holding capacity of soil. Prior to specifying compost as an amendment, the SWMP designer should determine if Certified and Tested Compost is locally available and if the manufacturing facility can provide the amount of compost required for your project when it is likely to be required, as determined by the Topsoil Amendment Calculator.

Facilities can be found on the following STA Certified Compost website. If compost is not available from a certified provider within a 50-mile radius or less (economic haul distance perimeter), utilize a Biotic Soil Amendment (Hydraulic). If referring to soil testing results, use the Topsoil Amendment Calculator and the worksheet tab *Lab R. & No Compost Avail*.

Biotic Soil Amendment (BSA) increases water and nutrient holding capacity of soils. It is used to amend poor quality soils which lack organic matter and have little to no bioactivity. Biotic Soil Amendments are used to facilitate faster plant growth and long-term growth. Since BSAs are applied with hydro equipment, hydraulic seeding and hydro mulching should be specified in the plans. This requires less mobilization and is cost effective.

Mycorrhizae is a symbiotic fungus that increases plant access to soil moisture and nutrients, which is beneficial during periods of drought.

Landscape Stabilization Methods

Native Seed Mix – According to CDOT's Procedural Directive 503.1, use Colorado's native grasses and pollinating species specific to the ecoregion. Native seed mixes should be developed for site specific conditions. Plants along the right of way should be low growing, adapted to the site-specific soil conditions, slope, elevation, precipitation requirements, and aspect. Additionally, the seed mix should include three or more diverse pollinator species with a mix of species blooming throughout the season to increase habitat.

A project biologist, restoration ecologist, botanist, horticulturist, or landscape architect with knowledge of Colorado native plants should develop the seed mix. For assistance in developing or reviewing seed mixes, contact the Region or Headquarters Landscape Architect. Please refer to the local jurisdiction for recommended seed mixes.

If the topsoil analysis results have high salinity or pH, contact the HQ or region Landscape Architect for assistance with adding salt tolerant species to seed mixes.

Specifying the Seeding Method(s)

To determine the best method for seeding, it is important to consider access to these areas and the type of equipment to be used. This is done by evaluating slope lengths, gradients, and if rocky conditions will need to be negotiated by drill seeders.

Drill seeding is CDOT's preferred method due to improved seed to soil contact. However, some areas are not suitable for drill seeding. Refer to the table below. It is important to note that any seeding method can be used with any mulching or blanketing method. However, the cost of mobilizations can go up. Hydroseeding should be used with hydro mulching to use the same equipment mobilized on site. Drill and broadcast seeding methods should use blanketing for mulching.

Seeding Methods

Seeding Method	Suggested Amendment	Slope	Suitability	Limitations	Minimum Area
Drill	Compost	flat to 3:1	Preferred seeding method for fill slopes. Use when certified compost is locally available.	Cut slopes, rocky soils, steep slopes, small areas, and sites with limited access.	> 0.5 acres
Hydraulic*	Biotic Soil Amendment	Flat to steep slopes and difficult to access areas	Alternative seeding method for where drill seeding is not feasible such as cut slopes, rocky soils, steep slopes, and smaller constrained sites.	Water availability in remote areas	Use for sites > 0.5 acres

Seeding Method	Suggested Amendment	Slope	Suitability	Limitations	Minimum Area
Broadcast*	Compost	Flat to steep slopes, and difficult to access areas	Hard to access areas. Areas not suitable for drill or hydraulic seeding methods	Generally, not applicable to large areas. Seed must be raked in to ensure seed is in contact with soil.	Small sites < 0.5 acres and/or steep slopes or hard to reach areas

***** Increase the drill seeding rate by 1.5 times for broadcast and hydraulic seeding methods.

Temporary Seed, Application Season and Rate

Temporary Seed for interim seeding or seeding topsoil stockpiles. Select one seed for the most appropriate site conditions.

Common Name	**Botanical Name**	**Application Time**	**Drill Rate** (lb PLS /Acre)	**Broadcast / Hydraulic Rate** (lb PLS/Acre)	**Planting Depth** (inches)
Oats	*Avena sativa*	Spring thaw to May 1	35	53	1 - 2
Foxtail Millet	*Setaria italica*	May 2 to September 30	30	45	1/2 - 3/4
Triticum	*Triticum aestivum* x *Secale cereale*	October 1 to May 1	32	48	1/2 - 3/4

A project special provision for (Temporary Seeding) Pneumatic is available on the landscape architecture website for temporary seeding. This seeding method is for short-term stabilization.

Additional references

Roadside Revegetation - An Integrated Approach to Establishing Native Plants and Pollinator Habitat, Chapter 6 Chapter 6 | Monitoring (nativerevegetation.org)

NRCS Soil Health Assessment protocol Soil Health Assessment | NRCS Soils (usda.gov)

USFS Monitoring Manual MonitoringManualVolume_II.pdf (fs.fed.us)

CDOT Report No. CDOT-DTD-R-2005-12 Factors Impacting the Health of Roadside Vegetation including impacts of deicing salt contamination on vegetation is available.