



Description

Practices and procedures to manage the reuse of native topsoil and other selected materials during revegetation activities. Salvaging, stockpiling, and reapplication of native topsoil is integral to successful revegetation efforts, especially for the reestablishment of native vegetation.

Applications

- Reestablishment of areas where vegetation with native plant species is desirable.
- Appropriate for sensitive habitat areas, floodplains, wetlands, and stream banks.

Installation and Implementation Requirements

- Preserve native topsoil where practicable.
- Conduct a site-specific soil survey of the area prior to soil-disturbing activities to assess the location, depth, and amount of soils suitable for salvaging.
- Salvage and stockpile all suitable topsoil and other material for future use during revegetation of the area. *See* section SM-3 Stockpile Management for more information.
- Carefully remove shrubs suitable for revegetation and store with the roots covered with mulch or loose soil.
- Apply topsoil or growth medium directly to disturbed areas and seed once construction activity is complete. Water area daily until the area is stabilized. However, avoid over-watering which can create runoff and erosion.



Topsoil Management

Installation and Implementation Requirements *(continued)*

- Restrict vehicle/equipment use in areas where vegetative stabilization will occur to avoid soil compaction.
- Soil replacement depths are determined by factors such as soil depth prior to disturbance, type of vegetation, and physical and/or chemical properties of the material to be covered. A deeper soil layer is required for soils with poor physical and chemical properties. Testing (nutrients, pH, and toxicity factors) of replacement soils and material to be covered shall be completed prior to reapplication.

TOPSOIL MANAGEMENT CONSIDERATIONS

- Quality and amount of native topsoil or growth medium.
- Area of surface disturbance to which topsoil or growth medium will be applied and the required depth of application.
- Methodology for salvaging topsoil or growth medium.
- Stockpile location, duration of storage, and required erosion control measures to protect stockpile.
- Feasibility of direct application of salvaged soils.
- Availability of other growth media to supplement topsoil reclamation.

Considerations

- Stockpiles may limit the area available for construction activity.
- Runoff from stockpiles may adversely impact water quality.
- Topsoil is contaminated prior to the start of construction activity.
- Avoid placement of topsoil prior to expected rain events.

What to Inspect

- Is topsoil effectively stockpiled?
- Are BMPs maintained to effectively prevent contact with storm water?
- Is dust originating from stockpiles?

Maintenance

- Adequately water plantings until they are established.
- Replace/repair damaged stockpile cover, as needed.
- Ensure that the plastic cover is in contact with the ground around the entire pile and properly anchored.
- Replace/repair damaged temporary perimeter sediment barrier.
- After the stockpile has been removed, revegetate the disturbed area, if applicable. Reapply temporary stabilization (i.e., hydromulch, tackifier, etc.), if needed.



Topsoil stockpiles must be fully covered with an impermeable material and protected with a temporary perimeter sediment barrier.



Description

Natural or synthetic mats are roll-type materials used for temporary or permanent soil stabilization and protection from rain/wind erosion.

Applications

- Stabilize drainage ditches, channels, and stream banks.
- Stabilize steep slopes with high potential for erosion.
- Stabilize slope until vegetation is established.
- Hold water near surface to assist in vegetation growth.
- Protect stockpiles from wind erosion.
- Suppress weed growth.
- Provide temporary cover for bare areas that are idle.

Installation and Implementation Requirements

- Apply matting to disturbed soils and areas where vegetation has been removed.
- Install matting immediately after the area is seeded and fertilized.
- Minimize disturbance of slopes greater than 15% in grade.
- Phase disturbances and use stabilization techniques designed for steep grades if disturbance of steep slopes is unavoidable.

Installation and Implementation Requirements *(continued)*

- Grade and shape disturbed slopes prior to installing geotextiles and/or erosion control matting.
- Prepare area by removing rocks, vegetation and other obstructions that will inhibit direct contact with soil.
- Entrench or anchor material at the top and bottom of the slope in a 6-inch × 6-inch trench or per manufacturer’s specifications, whichever is more stringent. The trench should be placed a minimum of 12 inches from the top of the slope.
- Intermittent check slots can also be installed for large or long lengths of matted areas to increase stability of the area.
- Do not stretch matting. Maximize mat contact with soil by loosely laying blankets and securing to slope with stakes.
- Ensure matting maintains direct contact with soil to prevent rills, gullies, and undermining.
- Follow manufacturer’s specifications on overlapping and stake spacing requirements. Steep slopes may require additional staking requirements.
- If geotextile matting is to be installed on steep slopes greater than 15%, space stakes every 2 feet.
- Organic matting provides temporary protection until permanent vegetation has been established or construction activities recommence. Organic matting materials include the following:
 - Jute matting
 - Straw matting
- Synthetic matting provides temporary or post-construction soil stabilization in both vegetated and non-vegetated areas. Synthetic matting materials include the following:
 - Excelsior™ matting
 - Glass fiber matting
 - Stakes
 - Mulch netting
 - Plastic sheeting/covering



Check with manufacturer’s specifications for erosion control matting anchorage requirements.



Phase disturbances and use stabilization techniques designed for steep grades if disturbance of steep slopes is unavoidable.

Installation and Implementation Requirements *(continued)*

- Key in temporary plastic sheeting at top of slope and weigh down by gravel bags no more than 6 feet apart.
- Install erosion control measures or devices at the top and toe of the slope to filter sediment-laden runoff and decrease storm water velocity.
- Other proprietary devices may be used and shall be installed per manufacturer's recommendations.
- The contractor shall immediately initiate soil stabilization measures when earth-disturbing construction activities on exposed areas have been completed or will be temporarily inactive for 14 or more calendar days.

Considerations

- Minimize use of matting to areas where other erosion control measures are not applicable such as channels or steep slopes since matting is costly compared to other erosion control measures.
- Seed germination may be delayed due to decreased soil temperature.
- Extensive soil preparation is needed before installation for adequate contact with slope.
- Mats made of natural material have a limited life and low shear strength.
- High material cost and extensive manpower needed.
- Generally, the slope needs to be smooth and free of large rocks.
- Plastic sheeting results in 100% runoff and is easily torn/damaged.

What to Inspect

- Is there evidence of undercutting at the top of slope?
- Is the slope eroding beneath the blanket?
- Are blankets firmly anchored and trenched in at top and bottom of slope?
- Are blanket segments properly overlapped?
- Are stakes properly spaced and driven into the soil to prevent the blanket from lifting away from soil?
- Is matting free from any defects or tears?
- Are there areas not adequately growing vegetation?



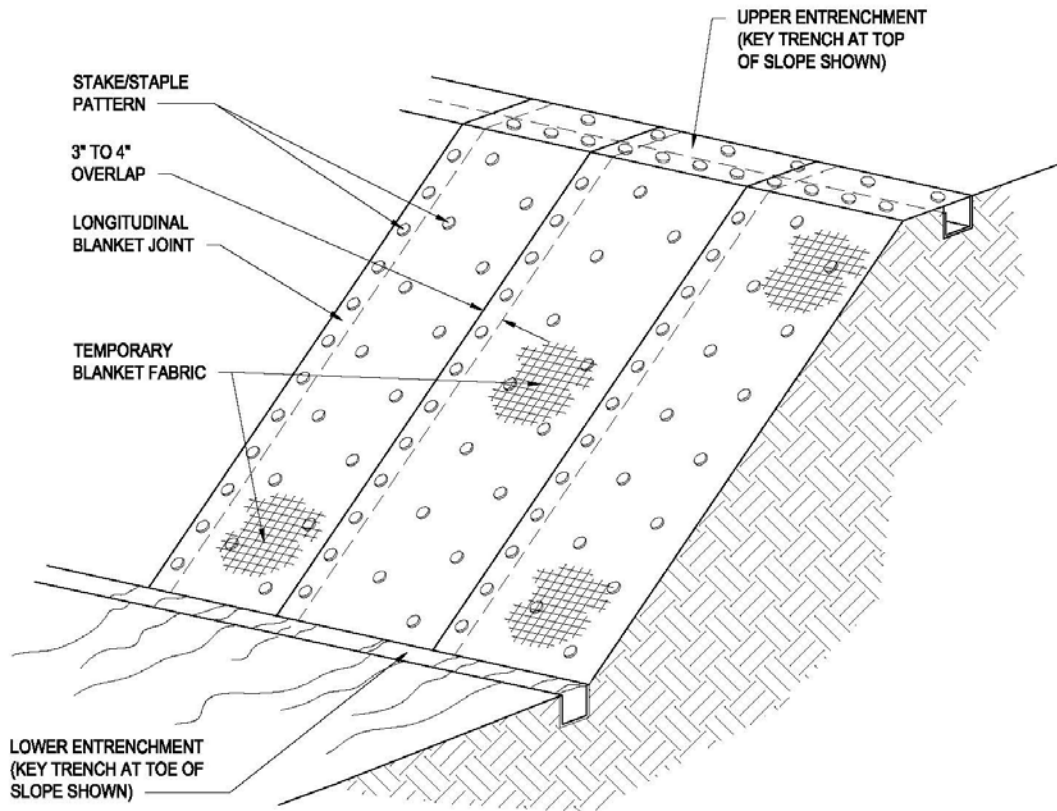
Matting must maintain direct contact with soil to prevent rills, gullies, and undermining.



Geotextiles and Mats

Maintenance

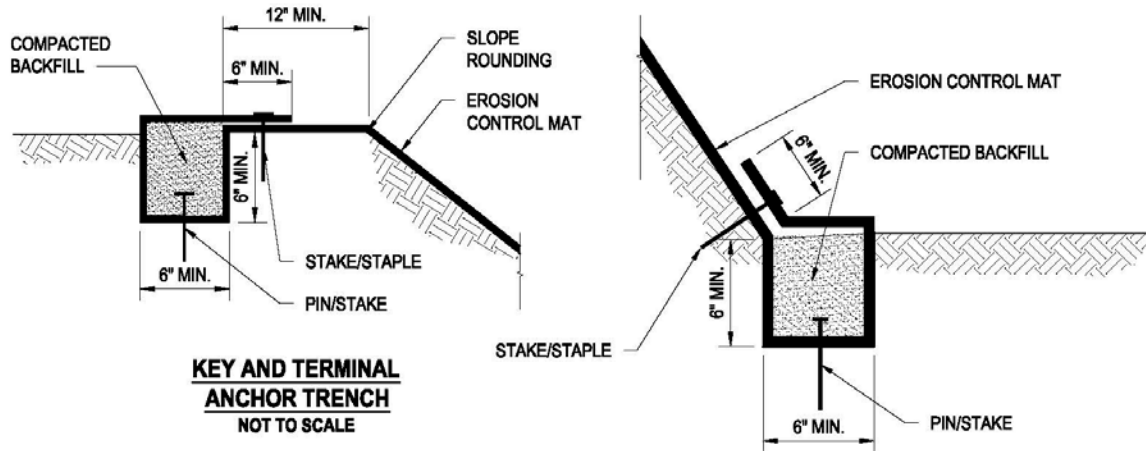
- Repair undermining or erosion.
- Repair/replace damaged blankets.
- Replace stakes and sandbags as needed.
- Reseed and fertilize areas not adequately growing vegetation.



TEMPORARY EROSION CONTROL BLANKET ON SLOPE
NOT TO SCALE

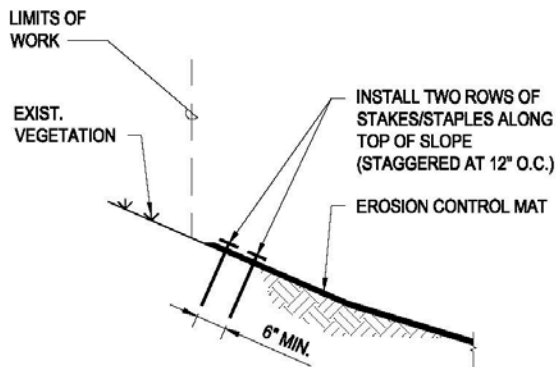
NOTES:

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS, AND GRASS. SOIL CONTACT SHALL BE MAXIMIZED.
2. LAY BLANKETS LOOSELY AND STAKE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
3. INSTALLATION MAY VARY ACCORDING TO MANUFACTURER'S RECOMMENDATIONS. APPLY THE MORE STRINGENT REQUIREMENT.

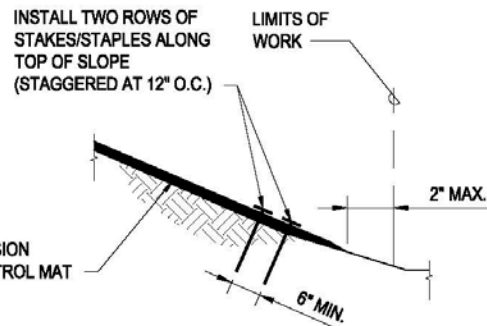


KEY AND TERMINAL ANCHOR TRENCH
NOT TO SCALE

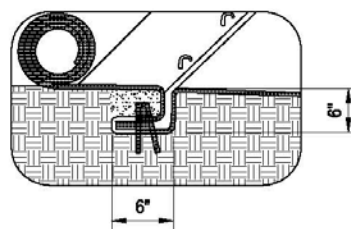
KEY TRENCH AT TOE OF SLOPE
NOT TO SCALE



MID-SLOPE
NOT TO SCALE

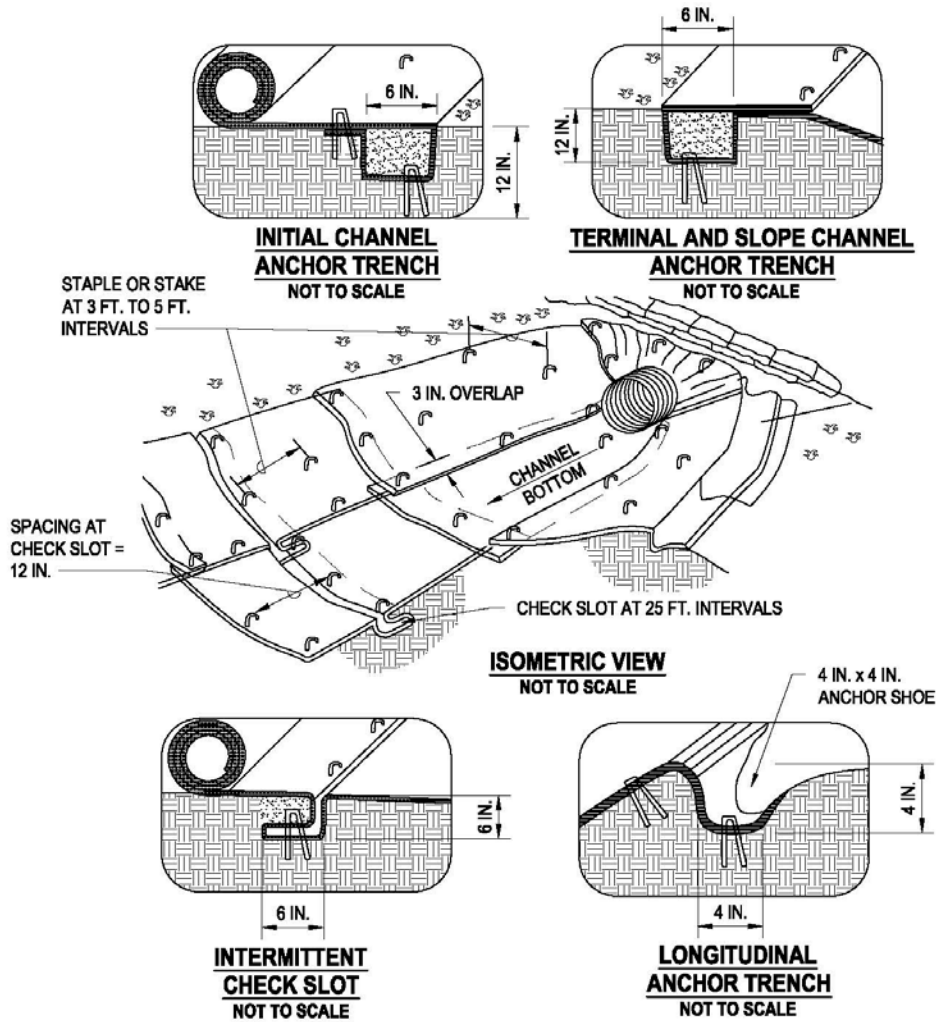


TOE OF SLOPE
NOT TO SCALE



INTERMITTENT CHECK SLOT
NOT TO SCALE

**GEOTEXTILES AND MATS INSTALLATION
DETAIL FOR SLOPES**



GEOTEXTILES AND MATS DETAIL FOR CHANNELS

NOTES:

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURER'S SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURER'S SPECIFICATIONS.



Description

Practices and procedures to provide ground cover for temporary or permanent stabilization of soil.

Applications

Soil stabilization during or after the construction phase applies to the following site conditions:

- Graded/cleared areas upon temporary or permanent cessation of earth-disturbing activities
- Open space and fill areas
- Steep slopes
- Spoil piles or temporary stockpile of fill material
- Vegetated swales
- Landscape corridors
- Stream banks

Installation and Implementation Requirements

- Coordinate temporary vegetative stabilization with permanent vegetative stabilization.
- Restrict vehicle/equipment use in areas where vegetative stabilization will be used to avoid soil compaction.

Installation and Implementation Requirements *(continued)*

- A licensed landscape architect should review the proposed vegetation to be used for the project.
- Condition the soil to promote vegetative growth prior to planting in areas where vehicle/equipment use cannot be avoided.
- Contractor shall keep records of application dates, type(s), amount of fertilizer used, and the areas covered.
- Plant vegetation immediately after Engineer approval.
- Minimize the amount of exposed soil during construction activity by phasing disturbances.
- Preserve native topsoil and vegetation where practicable.
- Use of invasive species is prohibited.

SEEDING AND PLANTING APPLICATION CONSIDERATIONS

- Type of vegetation
- Site and seedbed preparation
- Seasonal planting times
- Fertilizers
- Water

GRASSES

- Ground preparation requires fertilization, scarification, and mechanical stabilization of the soil.
- Can tolerate short-term temperature extremes and waterlogged soil conditions.
- Appropriate soil conditions include a shallow soil base, good drainage, and 2:1 (H:V) or flatter slope.
- Quickly develops from seeds.
- Vigorous grass growth depended on mowing, irrigating, and fertilizing.
- Immediately after seeding or planting the area to be vegetatively stabilized, to the extent necessary to prevent erosion on the seeded or planted area, install non-vegetative erosion controls that provide cover (e.g., mulch, rolled erosion control products) to the area while vegetation is becoming established.

TREES AND SHRUBS

- Selection dependent on vigor, species, size, shape, and potential wildlife food source.
- Consider wind/exposure and irrigation requirements.
- Plant indigenous species where possible.

Installation and Implementation Requirements *(continued)*

VINES AND GROUND COVER

- Lime and fertilizer required for ground preparation.
- Use appropriate seeding rates.
- Consider requirements for drainage, acidity, and ground slope.
- Plant indigenous species where possible.
- Avoid species that require irrigation.

FERTILIZER USE

- Do not apply fertilizers or pesticides during or just before a rain event.
- Do not apply to storm water conveyance channels with flowing water.
- Comply with fertilizer and pesticide manufacturer's recommended usage and disposal instructions. Do not over apply.
- Apply fertilizers at the appropriate time of year for the location, and preferably as closely as possible to the period of maximum vegetation uptake and growth.
- Where possible, till fertilizer into soil rather than surface spreading or spraying on steep slopes.
- Minimize discharges of fertilizers containing nitrogen or phosphorus.
- Store fertilizer in original container with proper labeling, sealed, and under cover or covered with secondary containment.
- Follow federal, state, and local laws regarding fertilizer application.

WATERING

- Quantity and frequency of watering may vary depending on type of vegetation, type of soil, location, frequency of rainfall, and slope.
- Regulate quantity of water to prevent erosion and formation of gullies.
- Temporary irrigation may be required for initial establishment of vegetation and sustained growth.
- Permanent water supply source may be required for certain types of vegetation.



Temporary irrigation may be required for initial establishment of vegetation and sustained growth.

STABILIZATION

- Initiate soil stabilization measures immediately whenever earth-disturbing activities have permanently or will/has temporarily ceased for 14 or more calendar days on any portion of the site to prevent erosion.

Installation and Implementation Requirements *(continued)*

- Types of activities that constitute initiation of stabilization include the following:
 - Prepping the soil for vegetative or non-vegetative stabilization.
 - Applying mulch or other non-vegetative product to the exposed area.
 - Seeding or planting the exposed area.
 - Starting any activities listed above on a portion of the area to be stabilized, but not on the entire area.
 - Finalizing arrangements to have stabilization product fully installed in compliance with the deadline for completing initial stabilization activities.
- Stabilization activities must be completed as soon as practicable, but no later than 14 days after the initiation of soil stabilization measures. If area drains to impaired waters, stabilization activities must be completed as soon as practicable, but no later than 7 days after the initiation of soil stabilization measures. Refer to the Hawaii Administrative Rules (HAR) Title 11, Chapter 55, Appendix C for more information.
- Types of activities that constitute completion of initial stabilization activities include the following:
 - For vegetative stabilization, all activities necessary to initially seed or plant the area to be stabilized.
 - For non-vegetative stabilization, the installation or application of all such non-vegetative measures.
- Vegetative coverage must be perennial.
- Establish uniform vegetation, which provides 70% of coverage that was provided by vegetation prior to commencing earth-disturbing activities.
- The contractor should take pictures of the area being used prior to installing BMPs. This will provide evidence of the amount of vegetation in the area prior to commencing earth-disturbing activities.
- Immediately after seeding the area the contractor shall install non-vegetative erosion controls, to the extent necessary, to provide cover to the area while vegetation is becoming established.
- Install perimeter controls around exposed areas where vegetation is becoming established to prevent sediment-laden runoff from entering storm drain systems and open waterbodies.
- Remove non-vegetative erosion controls once the area is deemed stabilized by the Engineer.



Install non-vegetative erosion controls, to the extent necessary, to provide cover to areas where vegetation is becoming established.

Considerations

- During dry periods without irrigation, permanent and temporary vegetation may not grow.
- Improper application of fertilizer may contribute to storm water pollution.
- Vegetative coverage must be perennial for final stabilization.
- Lack of dedicated water supply may require a temporary water source.
- Rainwater can wash away seeds and fertilizer from areas being restabilized.
- It is common for topsoil to be lost from grading, which causes the soil to lack nutrients for seeds to germinate.
- Disturbed areas may be difficult to stabilize if soil has been compacted.

What to Inspect

- Is vegetation growing?
- Is there evidence of erosion?
- Are fertilizers being properly stored and handled?
- Are fertilizers being over applied or applied in an improper area?
- Is there at least 70% vegetative coverage?
- Are temporary non-vegetative stabilization devices installed?
- Has soil been conditioned?
- Are native plants being used?
- Has the contractor initiated vegetative stabilization within the required timeframe?

Maintenance

- Water, fertilize, mow, weed, and/or prune the grasses/plants as needed.
- Repair broken or leaking water lines, sprinklers, or valves used for irrigation.
- Mow temporary plantings as needed to prevent signage/site obstructions, fire hazards, or nuisances to the public.
- Replace plants that fail to develop healthy growth, become injured, or die.
- Remove invasive species.
- Reseed areas where the grass did not grow and/or any areas affected by erosion.



Description

Application of a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydromulch equipment to temporarily protect exposed soils from wind and water erosion.

Applications

- Temporary ground cover until permanent vegetation has been established.
- Suitable for disturbed areas that will be redisturbed following an extended period of inactivity.

Installation and Implementation Requirements

- Seed type must be carefully selected based upon anticipated soil type and future irrigation. All seeds must be in conformance with the State of Hawaii Department of Agriculture (HDOA). For information on appropriate seed mixes, visit the Hawaii office of the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) website.
- Avoid use of hydroseeding in areas where future earthwork activities will commence.



Apply hydroseed to moderate soil moisture and temperature until seeds germinate and grow.

Installation and Implementation Requirements *(continued)*

- Roughen the slope, fill area, or area to be seeded with the furrow trending along the contours prior to application of hydroseed. Rolling with a crimping or punching type roller or track walking is required on all slopes prior to hydroseeding. *See* EC-4 Slope Roughening, Terracing, and Rounding for more information.
- Apply mulch to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- Avoid spraying hydroseed onto sidewalks, lined drainage channels, roads, and existing vegetation.

EVALUATION OF SITE CONDITIONS CONSIDERATIONS TO SELECT APPROPRIATE HYDROSEEDING MIXTURES

- Soil conditions
- Site topography
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

Considerations

- Steep slopes are difficult to protect with temporary seeding.
- Hydroseeding shall only be used when there is sufficient time to ensure adequate vegetation establishment and provide adequate erosion control.
- Temporary seeding may not be appropriate without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Hydroseeding shall not be used in areas subject to heavy traffic.
- To ensure complete coverage over roughen terrain, hydroseeding may have to be applied from multiple angles and sides.

What to Inspect

- Is there evidence of erosion?
- Are there bare areas that need to be reseeded?
- Is an irrigation system installed?
- Does the irrigation system apply complete coverage to the desired areas?
- Is the irrigation system working?
- Are there any areas of exposed soil showing?

Maintenance

- Mulches applied to seeded areas may be disturbed due to wind or runoff. Recover exposed areas until permanent vegetation has been established.
- Replace ornamental and landscape mulches of bark or wood chips if soil is visible in more than 75% of the designated area.
- Follow-up applications must be made as needed to cover weak spots and to maintain adequate soil protection.
- If erosion has occurred, additional mulch may be required. Eroded areas need to be repaired prior to additional mulch being added.



Additional mulch may be needed if erosion of hydroseeded area has occurred.



Description

Application of loose bulk material to stabilize disturbed soil by protecting bare soil, increasing infiltration, and reducing runoff. Materials suitable for mulching include green material, vegetable fibers (hay or straw), and wood/bark chips.

Applications

- Temporary ground cover until permanent vegetation has been established.
- Method may be used in combination with temporary or permanent seeding to enhance plant growth.
- Areas requiring soil moisture retention to prevent cracking of the soil.
- Ground cover for exposed soil between trees or shrubs.
- Mulch should be used in conjunction with other BMPs for optimal erosion control, especially on slopes.

Installation and Implementation Requirements

VEGETABLE FIBERS (HAY OR STRAW)

- Loose hay or straw which may be used in combination with seeding. Mulching usually follows seeding and the process is described in the following:
 - Apply seed and fertilizer to bare soil.
 - Apply loose hay or straw over top of seed and fertilizer prior to seed germination. Apply at a rate of 2,000 pounds per acre by machine or hand distribution.
 - Evenly distribute mulch on the soil surface to cover 80% to 90% of the ground.

Installation and Implementation Requirements *(continued)*

- Maintain maximum fiber length. Average fiber length shall be greater than 6 inches.
- Use a tackifier, netting, or mechanical “punching” method to anchor mulch. “Punching” refers to the act of crimping or compressing to anchor to the ground. Methods depends on slope steepness, accessibility, soil conditions, and longevity.
- Punching straw or hay to anchor the mulch to the ground is the preferred method of anchoring mulch for the following conditions:
 - Use a spade or shovel on small areas.
 - Use a knife-blade roller or straight bladed coulter (“crimper”) on slopes with soil, which can support construction equipment without undesirable compaction or instability.
 - Use plastic netting or jute on small areas and/or steep slopes. Geotextile pins, wooden stakes, or 11-gauge wire staples shall secure netting in place. This condition warrants consideration of the use of matting rather than mulch.
 - Use tackifiers on steep slopes unable to support construction equipment or large application areas where use of nettings, straw, or hay is not cost-effective. Tackifiers glue vegetable fibers together and to the soil surface until the establishment of permanent vegetation.



Use a tackifier, netting, or mechanical “punching” method to anchor mulch. Method depends on slope steepness, accessibility, soil conditions, and longevity.

GREEN MATERIAL

- Consists of recycled vegetation trimming such as grass and shredded shrubs and trees.
- Generally applied manually.
- Temporary ground cover with or without seedings.
- Evenly distribute green material on soil surface. Depth shall not exceed 4 inches.
- Anchor with a tackifier or netting on steep slopes or for areas with anticipated overland sheet flow. The condition warrants consideration of the use of matting rather than mulch.



Evenly distribute wood/bark chips on soil surface and maintain a 2-inch mulch depth to tree basins and a 4-inch mulch depth to shrub beds.

WOOD/BARK CHIPS

- Suitable for areas which will not be mowed such as around trees, shrubs, and landscape plantings.

Installation and Implementation Requirements *(continued)*

- Test soils prior to application. Add a minimum of 12 pounds of nitrogen per ton of mulch to counteract the effect of decomposing wood-based materials, which extract nitrogen from soil. Use a balanced, slow-release fertilizer or an organic source such as compost.
- Apply mulch manually.
- Evenly distribute wood/bark chips on soil surface and maintain a 2-inch mulch depth to tree basins and a 4-inch mulch depth to shrub beds.

Considerations

VEGETABLE FIBERS (HAY OR STRAW)

- Requires 3-step machinery.
- Labor intensive installation.
- For applications using straw blowers, the applicable area must be located within 150 feet of a road or surface capable of supporting loads from large vehicles. Use of straw is preferred, in lieu of hay, if available.
- Avoid applying fibers prior to an anticipated rain event.

GREEN MATERIAL

- Limited commercial availability.
- Variable quality.
- Application primarily uses manual labor.
- Unpredictable effectiveness as an erosion control measure. Requires overspray with a tackifying agent to increase effectiveness.
- Application of fertilizer may be required.
- Limit use to non-critical steep slopes and areas where alternative erosion control measures may be readily applied. A critical slope surface exists when a combination of soil and slope factors create a high potential for slope face failure and subsequent erosion, such as a slope greater than 2:1 (H:V) on freshly graded or disturbed slopes. Refer to *Slope Face Stabilization for Critical Slope Surfaces* at website – www.ccriindia.org/pdf/Object335PDFEnglish.pdf for more information on critical slopes.

WOOD/BARK CHIPS

- Poor erosion control effectiveness.

Considerations *(continued)*

- Anchoring of chips onto steep slopes is difficult due to potential movement from high winds.
- Subject to displacement from concentrated flows.
- Use of fertilizer with a high nitrogen content is required. This is to prevent nutrient deficiency in plants due to the decomposing wood-based materials, which extract nitrogen from soil. Improper fertilizer use may contribute to water quality pollution.
- Limit use to non-critical steep slopes and areas where alternative erosion control measures may be readily applied.

What to Inspect

- Is mulch applied to areas which will be regraded and/or revegetated?
- Is there uniform coverage of mulch?
- Was the application rate sufficient for the area?
- Is there evidence of rills or gullies?

Maintenance

- Mulches applied to seeded areas may be disturbed due to wind or runoff. Recover exposed areas until permanent vegetation has been established.
- Replace ornamental and landscape mulches of bark or wood chips if soil is visible in more than 75% of the designated area.
- If erosion has occurred, additional mulch may be required.



Description

Application of loose bulk material to stabilize disturbed soil by protecting bare soil, increasing infiltration, and reducing runoff. Materials used for mulching include hydraulic matrices, hydraulic mulches of recycled paper or wood fiber.

Applications

- Temporary ground cover until permanent vegetation has been established.
- Method used in combination with temporary or permanent seeding to enhance plant growth.
- Areas requiring soil moisture retention to prevent cracking of the soil.
- Ground cover for exposed soil between trees or shrubs.
- Mulch should be used in conjunction with other BMPs for optimal erosion control, especially on slopes.

Installation and Implementation Requirements

HYDRAULIC MULCHES OF RECYCLED PAPER

- Consists of recycled newsprint, magazines, and other wastepaper sources.
- May be applied with or without tackifiers.
- Hydraulic mulch materials shall conform to *2005 Hawaii Standard Specifications for Road and Bridge Construction*, Standard Specifications & Special Provisions Sections 209, 619 & 641, as in effect.

Installation and Implementation Requirements *(continued)*

- Mix mulch in a hydraulic application machine (hydroseeder) and apply as a liquid slurry.
- May be sprayed from a cannon up to 200 feet or from a hose up to 1,500 feet away from the application area.
- Mix mulch with seed and fertilizer as specified by the manufacturer. Apply mulch at the manufacturer's recommended rate to ensure uniform and effective coverage.
- Mulch used as temporary ground cover shall be reapplied to bare areas until permanent vegetation has been established.
 - Avoid spraying mulch onto sidewalks, lined drainage channels (i.e., concrete swales and concrete culverts), travelway areas, and existing vegetation.



Mulches must be applied at the manufacturer's recommended rate to ensure uniform and effective coverage.

HYDRAULIC MULCHES OF WOOD FIBER:

- Consists of wood waste from lumber mills or urban sources.
- May be manufactured with or without a tackifier.
- Hydraulic mulch shall conform to *2005 Hawaii Standard Specifications for Road and Bridge Construction*, Standard Specifications & Special Provisions Sections 209, 619, & 641, as in effect. Mix mulch in a hydraulic application machine (hydroseeder) and apply as a liquid slurry.
- Mix mulch with seed and fertilizer as specified by the manufacturer.
- Apply mulch at the manufacturer's recommended rate to ensure uniform and complete coverage.

HYDRAULIC MATRICES

- Hydraulic slurries consisting of wood fiber, paper fiber, or a combination of wood and paper fiber mixed with a binder system.
- Exceeds erosion control performance of blankets due to close contact with soil.
- Apply as an aqueous slurry (with seed) using standard hydroseeding equipment.
- Applications rates vary for different combinations of conditions and products.



Properly applied hydraulic mulches stabilize disturbed soil by protecting bare soil, increasing infiltration, and decreasing runoff.

Installation and Implementation Requirements *(continued)*

BONDED FIBER MATRIX (BFM) CONSISTING OF PREMIXED FIBER AND BINDERS

- After application and upon drying, BFM shall adhere to soil and form a 100% cover. The cover shall be biodegradable, promote vegetation, and prevent soil erosion.
- Are composed of long strand, thermally produced wood fibers (>88% of total volume by weight), held together by organic tackifiers (10%) and mineral bonding agents (<2%), which become insoluble and non-dispersible upon drying. Composition of BFM varies based on supplier.
- Perform a free liquid quality control test on the liquid slurry.
- Binder shall not dissolve or disperse upon watering.
- Upon applications to the soil, holes in the matrix shall not exceed 0.04 inches in size.
- There shall not be any gaps between the matrix and the soil.
- Minimum water holding capacity of the matrix shall be 1.2 gallons per pound matrix.
- The matrix shall be free of germination of growth inhibiting factors and shall not form a water-resistant crust.
- Materials used for the matrix shall be 100% biodegradable and 100% beneficial to plant growth.
- Testing and evaluation of the matrix by an independent research laboratory shall have been conducted to verify reported erosion control performance.
- A trained and manufacturer certified applicator with knowledge of proper mixing and product application shall install the BFM.
- Typical BFM application rates range from 3,000 to 8,000 pounds per acre per recommendations from various manufacturers.
- BFM shall not be applied 24 hours before an anticipated rain event, during a rainfall event, or immediately after a rainfall event to ensure a drying time of 24 hours after installation.

Considerations

HYDRAULIC MULCHES OF RECYCLED PAPER

- Limited erosion control effectiveness due to short fiber length and absence of a tackifier.
- Limited moisture and soil temperature moderation.
- Residual inks within mulches may be undesirable in environmentally sensitive areas.
- Significant decrease in longevity compared with wood fiber mulch.
- Difficulty budgeting for this product due to volatile prices for recycled paper products.

Considerations *(continued)*

HYDRAULIC MULCHES OF WOOD FIBER

- Limited erosion control effectiveness.
- Short-term use of 1 growing season.

HYDRAULIC MATRICES

- Avoid applying mulch 24 hours before an anticipated rainfall event, during a rainfall event, or immediately after a rainfall event.
- Hydromulch requires a drying time of 24 hours.
- To ensure complete coverage over roughen terrain, hydromulch may have to be applied from multiple angles and sides.

What to Inspect

- Is mulch applied to areas which will be regraded and/or revegetated?
- Is there uniform and complete coverage?
- Was the application rate sufficient for the disturbed area?
- Is there evidence of rill or gullies?

Maintenance

- Mulches applied to seeded areas may be disturbed due to wind or runoff. Recover exposed areas until permanent vegetation has been established.
- Replace ornamental and landscape mulches of bark or wood chips if soil is visible in more than 75% of the designated area.
- If erosion has occurred, additional mulch may be required.



Description

Application of soil binders to exposed soil to temporarily prevent water- and wind-induced erosion.

Applications

- Disturbed areas requiring short-term temporary protection.
- Good alternative to mulches in areas where grading activities will soon resume.
- Suitable for use on stockpiles.
- Applied in conjunction with mulching or seeding applications.

Installation and Implementation Requirements

- Soil types will dictate appropriate soil binders to be used.
- A soil binder must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and must not stain paved or painted surfaces. Soil binders must not pollute storm water. Prior to application, submit the manufacturer's material product data sheets to the Engineer for review and approval.
- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.
- Avoid overspray onto roads, sidewalks, lined drainage channels (i.e., concrete swales and concrete culverts), existing vegetation, etc.

Installation and Implementation Requirements *(continued)*

SELECTING A SOIL BINDER

- Properties of common soil binders used for erosion control are provided in Table EC-16.3. Use the Table to select an appropriate soil binder.
- Consult with the Engineer if soil binders are an appropriate option for temporary stabilization.
- Factors to consider when selecting a soil binder include the following:
 - Suitability to situation
 - Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders.
 - Soil types and surface materials
 - Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.
 - Frequency of application
 - The frequency of application can be affected by subgrade conditions, surface type, climate, and maintenance schedule. Frequent applications could lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment cleanup.

PLANT-MATERIAL BASED (SHORT-LIVED) BINDERS

- Guar: Guar is a non-toxic, biodegradable, natural galactomannan (or plant carbohydrates/sugars) based hydrocolloid treated with dispersant agents for easy field mixing. It must be mixed with water at the rate of 11 to 15 pounds per 1,000 gallons. Recommended minimum application rates are as provided in table EC-16.1.
- Psyllium: Psyllium is composed of the finely ground mucilloid coating of seeds (from Plantago plant) that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but rewettable membrane that binds soil particles together but permits germination and growth of seed. Psyllium requires 12- to 18-hours drying time. Application rates must be 80 to 200 pounds/acre, with enough water in solution to allow for a uniform slurry flow.
- Starch: Starch is non-ionic, cold water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 150 pounds/acre. Approximate drying time is 9 to 12 hours.

Table EC-16.1 Application rates for Guar soil stabilization.

Slope Gradient (H:V)	Pounds/Acre
• Flat	• 40
• 4:1	• 45
• 3:1	• 50
• 2:1	• 60
• 1:1	• 70

Installation and Implementation Requirements *(continued)*

PLANT-MATERIAL BASED (LONG-LIVED) BINDERS

- Pitch and Rosin Emulsion: Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin must be a minimum of 26% of the total solids content. The soil stabilizer must be non-corrosive, water dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted and must be applied as follows:
 - For clayey soil: 5-parts water to 1-part emulsion.
 - For sandy soil: 1-part water to 1-part emulsion.
- Application can be by water truck or hydraulic seeder with the emulsion and product mixture applied at the rate specified by the manufacturer.

POLYMERIC EMULSION BLEND BINDERS

- Acrylic Copolymers and Polymers: Polymeric soil stabilizers must consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound must be handled and mixed in a manner that will not cause foaming or must contain an anti-foaming agent. The polymeric emulsion must not exceed its shelf life or expiration date; manufacturers should provide the expiration date. Polymeric soil stabilizer must be readily miscible in water, non-injurious to seed or animal life, non-flammable, must provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and must not reemulsify when cured. The applied compound should air cure within a maximum of 36 to 48 hours. Liquid copolymer must be diluted at a rate of 10-parts water to 1-part polymer and the mixture applied to soil at a rate of 1,175 gallons/acre.

Installation and Implementation Requirements *(continued)*

- **Liquid Polymers of Methacrylates and Acrylates:** This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants, or silicates. For soil stabilization applications, it is diluted with water in accordance with manufacturer's recommendations and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours after applications.
- **Copolymers of Sodium Acrylates and Acrylamides:** These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient, as described in Table EC-16.2.
- **Polyacrylamide and Copolymer of Acrylamide:** Linear copolymer polyacrylamide is packaged as a dry flowable solid. When used as a standalone stabilizer, it is diluted at a rate of 11 pounds/1,000 gallons of water and applied at the rate of 5 pounds/acre.
- **Hydro-Colloid Polymers:** Hydro-Colloid Polymers are various combinations of dry flowable polyacrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 pounds/acre. Drying time is 0 to 4 hours.

Table EC-16.2 Application rates for copolymers of sodium acrylates and acrylamides.

Slope Gradient (H:V)	Pounds/Acre
• Flat to 5:1	• 3 – 5
• 5:1 to 3:1	• 5 – 10
• 2:1 to 1:1	• 10 – 20

CEMENTITIOUS-BASED BINDERS

- **Gypsum:** This is a formulated gypsum-based product that readily mixes with water and mulch to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86%. It is mixed in a hydraulic seeder and applied at rates of 4,000 to 12,000 pounds/acre. Drying time is 4 to 8 hours.

Installation and Implementation Requirements *(continued)*

APPLYING SOIL BINDERS

- After selecting an appropriate soil binder, the untreated soil surface must be prepared before applying the soil binder. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution. The following steps shall be followed:
 - Follow manufacturer’s specifications for application rates, pre-wetting of application area, and cleaning of equipment after use.
 - Prior to application, roughen embankment and fill areas.
 - Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders shall not be applied during or immediately before rainfall.
 - Avoid overspray onto roads, sidewalks, drainage channels (i.e., concrete swales and concrete culverts), sound walls, existing vegetation, etc. Soil binders shall not be applied to areas with standing water, under rainy conditions, or when the temperature is below 40° Fahrenheit during the curing period.
 - More than 1 treatment is often necessary, although the second treatment may be diluted or have a lower application rate.
 - Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer’s instructions for specific cure time.
 - For liquid agents:
 - Crown or slope ground to avoid ponding.
 - Uniformly pre-wet ground at 0.03 to 0.3 gallons/yard² or according to manufacturer’s recommendations.
 - Apply solution under pressure. Overlap solution 6 to 12 inches.
 - All treated area to cure for the time recommended by the manufacturer; typically, at least 24 hours.
 - Apply second treatment before first treatment becomes ineffective, using 50% application rate.
 - In low humidity, reactivate chemicals by rewetting with water at 0.1 to 0.2 gallons/yard².



Soil binders can be used on large stockpiles to prevent erosion from wind and rain.

Considerations

- Soil binders are temporary in nature and may need reapplication.
- Some soil binders may not be compatible with existing vegetation.
- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer.
- Soil binders may need reapplication after a rain event.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.
- Soil binders do not hold up to pedestrian or vehicular traffic across treated areas.
- Soil binders may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.
- Soil binders may not cure if low temperatures occur within 24 hours of application.
- A sampling and analysis plan should be incorporated into the *Storm Water Pollution Prevention Plan (SWPPP)*, as soil binders could be a source of non-visible pollutants.

What to Inspect

- Has soil binder broken down due to natural elements?
- Is there evidence of erosion?
- Does the soil binder need to be reapplied?
- Are the soil binders an effective BMP for the area?

Maintenance

- Repair areas where erosion is evident and reapply BMPs as soon as possible. Care must be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- Reapply the selected soil binder as needed to maintain effectiveness.



Soil Binders

Table EC-16.3 Properties of soil binders used for erosion control.

Evaluation Criteria	Binder Type			
	Plant Material Based (Short-lived)	Plant Material Based (Long-lived)	Polymeric Emulsion Blends	Cementitious-Based Binders
Relative Cost	Low	Low	Low	Low
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time Before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/ Chemically Degradable	Photodegradable/ Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/Powder	Powder	Liquid	Liquid/powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies	Varies	Varies	4,000 to 12,000 pounds/acre