6.0 Slope Stabilization Techniques

Definition: A system of permanent design measures used alone or in combination to minimize erosion from disturbed surfaces.

Purpose: To stabilize the soil, to reduce raindrop impact, to reduce the velocity of surface runoff, and to prevent erosion.

Applicability: Applicable to cleared, graded, disturbed slopes, or where vegetation alone does not provide adequate erosion protection.

Advantages:

1. Stabilizes the soil.
2. Absorbs raindrop impact.
3. Reduces velocity of surface runoff.
4. Improves infiltration.
5. Prevents erosion.

Disadvantages:

1. Rock slope protection can be considered unattractive.
2. Availability of mulch material within or near the Lake Tahoe Basin may be limited.

Effectiveness: Along with retaining structures discussed in the previous chapter, the following slope stabilization techniques can be used to limit soil erosion and mass movement on disturbed hill slopes, offering effective source control.

Slope stabilization techniques include:

- **6.1 - Rock Slope Protection**
- **6.2 - Slope Roughening, Terracing, and Rounding**
- **6.3 - Mulches (pine needle, wood, hydro)**
- **6.4 - Erosion Control Blankets/Mats**

References

More detailed construction specifications can be found in:

CalTrans. 2000. Statewide Storm Water Quality Practice Guidelines.

Goldman, et al. 1986. Erosion and Sediment Control Handbook. McGraw Hill.

TRPA. 1988. Handbook of Best Mangement Practices

6.1 Rock Slope Protection

Please read section 6.0 for important information applicable to all slope stabilization techniques.

Definition: A layer of loose rock or aggregate placed over an erodible soil surface.

Planning Considerations: Rock slope protection can be used with a variety of BMPs to break up the system rather than having a large span of the same BMP. Woody vegetation planted in interstices yields an aesthetically pleasing structure. Consider using rock slope protection if preferred rock is locally available.

Tips for Installation:

1. Rock should be large enough to prohibit unwanted displacement.
2. Seed should be broadcast before rock placement.
3. Grading and clearing before rock placement may not be necessary.
4. Do not use as a long, continuous expanse.
5. Select rock to match the surrounding area.
6. Unless required for structural integrity, geotextile fabric should not be installed under rock as it will slow seed germination and inhibit revegetation efforts.

Maintenance: If properly installed, rock slope protection requires little maintenance. Inspect periodically to see if rocks have been dislodged.

Where to Use: Rock slope protection is best suited in areas where revegetation is difficult, and is often used on steep slopes above retaining walls. Rock slope protection should be implemented only when hydrologic conditions prohibit alternative stabilization.

Where NOT to Use: Some areas restrict the use of rock slope protection adjacent to rights-of-way. Where feasible, rock slope protection should avoided where it may be considered unattractive or poses a public safety hazard.

Field Experience:

- Rock slope protection requires little maintenance.
- Some individuals feel rock riprap has been over used in the Tahoe Basin, depleting supplies of native rock.
- When conditions permit, revegetation is preferred.

6.2 Slope Roughening, Terracing, and Rounding

Please read section 6.0 for important information applicable to all slope stabilization techniques.

Definition: Various modifications made to cut or fill slopes including terraces, benches, steps, and serrations designed to minimize erosion potential or runoff originating on the slope and reduce the threat of landslides and/or boulder fall.

Planning Considerations: Slope shaping practices to reduce erosion potential should blend with the natural landscape. Maximum

stability is achieved when permanent revegetation has been established. Slope shaping can provide favorable sites for plant establishment. Be aware that spoils generated during slope shaping need to be removed and disposed of at an approved site. If topsoil is removed, store for replacement on site or use for future projects in need of topsoil.

Tips for Installation: Terraces can be large or small and are often referred to as benches, steps or serrations, depending on size. The decision to install a bench, step, or serration depends on the length and degree of the slope. Longer or steeper slopes may require benches while shorter, less steep slopes may be stabilized with steps and serrations.

1. Benches: Generally very wide horizontal, level, or slightly reverse sloping steps ranging from 4 to 10 feet wide.
2. Steps: Usually horizontal, 1 to 4 feet wide.
3. Serrations: Approximately 10 inches wide, often cut by a serrated wing blade.
4. Microtopography: Avoid smoothing of the surface. Allow for small, uneven bumps and ridges that will collect moisture and seeds, improving chances for successful revegetation.

Maintenance: Terraces need to be inspected periodically for damage resulting from surface runoff. If not repaired, rills and gullies may develop. Accumulated sediment should be removed to prevent entry into the storm drain system. Equipment may be used for sediment removal if site conditions permit; otherwise, work must be performed by hand. Maintenance activities have the potential for increasing erosion potential; limit re-disturbance when possible.

Where to Use: Slope shaping is well suited for large cut and fill slopes, especially those associated with highway construction.

Where NOT to Use: Slope shaping is generally ineffective on decomposed granitic soils due to excessive sloughing of material. As such, this practice has limited applicability in the Lake Tahoe Basin. Slope shaping techniques should not be implemented in areas with high groundwater.

Field Experience:

- Equipment is needed to maintain benches.
- Slope shaping has proven effective for controlling runoff on Highway 28 near Dollar Hill.

6.3 Mulches

Please read section 6.0 for important information applicable to all slope stabilization techniques.

Definition: Temporary or permanent barrier to protect bare or disturbed soil from raindrop impact, reduce runoff velocity, and protect against erosion.

Planning Considerations: Application of mulch material is one of the easiest, most cost effective ways to *temporarily* stabilize loose soil. There are several options for effective mulching including pine needles, wood chips, and hydromulch. Pine needles are the preferred native mulch, as they last

longer than other mulches and may be a source of long term organic nitrogen.

Installation Tips:

In General:

1. Revegetation should accompany mulch application to ensure long-term stabilization.
2. Be sure to achieve good soil/mulch contact – blowing achieves better contact than hand application.
3. For areas adjacent to streams or other drainage, use netting to prevent mulch material from entering the waterway.
4. Apply to a depth of at least 0.5 inches and no more than 2 inches to allow for seed germination.
5. Crimping across slope length may improve retention.
6. On steep slopes, incorporate mulch into the soil to prevent movement toward the toe of the slope. Erosion control blankets may be needed to keep mulch in place.

Straw: **NOT RECOMMENDED**
Straw does not persist on bare slopes, is susceptible to wind and water erosion, and is a source of invasive species.

Pine Needles:

1. When feasible, rake and stockpile needles prior to site disturbance.
2. Composted needles should be used when available – they mimic native duff material and provide nutrients for revegetation.

Wood Chips:

1. Avoid green, fresh chips that may exude phytotoxins that can hinder vegetative growth.
2. Ensure application rate does not preclude revegetation efforts (i.e. is not too thick to inhibit seedlings).
3. In general, wood chips do not provide as much protection as other mulch alternatives.
4. Not recommended for steep slopes.
5. May float off-site with surface runoff.
6. Wood Chip decomposition may deplete soil nitrogen content.

Hydromulch/Tackifiers:

1. Application rate must be heavy to serve as effective mulch.
2. Application must be consistent. Monitor mix to ensure uniformity.
3. Some types of mulch/tackifier require extended curing times. Consult manufacturer for details.
4. Provide regulatory agencies with Material Safety Data Sheets for applied tackifiers.

Maintenance: Mulched areas should be inspected regularly for adequate cover and remulched as needed.

Where to Use: Mulch should be applied where soil has been disturbed and vegetation has been removed. Hydromulch is only recommended for steep, inaccessible areas.

Where NOT to Use: Mulch is not well suited to very steep slopes or extremely sandy soils. Avoid using in inundated areas such as wetlands or stream environment zones. Mulch is considered a temporary BMP; it should not be relied on for long term slope stabilization.

Field Experience:

- The USFS reported good reveg success by tilling wood chips into a disturbed skeet range.
- Pine needle mulch brings in less weed species than straw mulch and mimics native duff material.
- In response to problems with Tall White Top, TRPA and the Native Plant Society may take straw off the approved material list of use in the Tahoe Basin. Currently, TRPA does **NOT** recommend the use of straw in the Tahoe Basin. If straw is used, it must be accompanied by a "weed free" certificate from the county agricultural commissioner.
- If needles are not clean (containing pinecones, branches, etc.) a hammer mill may be required when blowing pine needle mulch (may add to cost).
- Wood chips applied to relatively flat terrain on USFS lands have eroded readily during summer rainstorms.

6.4 Erosion Control Mats/Blankets

Please read section 6.0 for important information applicable to all slope stabilization techniques.

Definition: Erosion control blankets and/or mats are generic terms given to fabrics or geotextiles that are placed in direct contact with the soil for temporary erosion control.

Planning Considerations: Erosion control blankets/mats provide a protective layer to bare soils for stabilization and protect the surface from raindrop impact. Mats and blankets are available in a variety of widths/sizes. Blankets are easily rolled onto graded surfaces and securely stapled to provide uniform coverage. Blankets/mats can be used with long term revegetation practices.

Installation Tips:

1. Prepare and/or seed the disturbed area.
2. Starting above the disturbed area, bury the top end of the mat/blanket in a trench at least 4 inches deep and 8 inches wide.
3. The blanket/mat material should extend beyond the edge of the disturbed area.
4. Secure mat/blanket with staples. Ensure maximum soil contact to prevent erosion beneath the mat/blanket.

Maintenance: If properly installed, erosion control blankets/mats provide effective soil protection with little maintenance. Blankets/mats should be inspected periodically and repaired as needed.

Where to Use: Erosion control blankets/mats are cost effective methods for stabilizing disturbed soil on steep slopes and graded construction sites. They can also be used to stabilize constructed channel ways. Consult the manufacturer for appropriate application of a specific product.

Where NOT to Use: Do not use blankets/mats as a stand-alone method for erosion control. Do not use on unprepared soils. Blankets should be considered as a temporary BMP until sufficient vegetation is established; blankets should not be considered a permanent slope stabilization method.

Field Experience:

- Erosion control blankets/mats have been used extensively as part of many erosion

control projects in the Lake Tahoe Basin. They can be ineffective when flows can get beneath the blanket/mat.

- Plastic blankets (even photodegradable) can trap and harm small animals. More easily degradable fiber material is preferred.