5.0 Retaining Structures

Definition: A retaining structure refers to a wall or other structure designed by a qualified professional engineer and placed at the toe of an overly steep slope.

Purpose: To stabilize a slope against mass-movement, to protect the toe or face of a slope against scour and erosion by storm runoff, improve traction sand recovery, prevent undercutting by snow removal equipment, and to allow flattening above to increase the potential for revegetation success.

Applicability: Applicable to cut or fill slopes that are steeper than 2:1 that cannot be regraded to a shallower angle. Retaining structures are usually located between the base of a slope and an adjacent roadway or driveway.

Advantages:

1. Prevents slope failure.
2. If properly installed, retaining structures can prevent sediment from entering the storm drain system.
3 Allows flattening of the slope above the structure so vegetation can reestablish.
4. Minimizes slope and vegetation disturbance by eliminating the need to lay back or flatten slopes.

Disadvantages:

1. Structures can be damaged by snow removal equipment when located adjacent to roadways.
2. Damaged retaining structures must be rebuilt, causing re-disturbance.
3. Accumulated sediment may be inaccessible to sweepers; hand labor may be required.

Planning Considerations: When possible, all grading, filling, and clearing operations shall be designed to preserve, match, or blend with the natural contours and undulations of the land. Ideally, cut slopes should have a rounded top contoured to a uniformly sloping face, with a rounded toe slope. The maximum slope angle should not exceed the angle of repose for the slope material. In areas where this requirement cannot be met, the following retaining methods may be used to stabilize the toe of the slope and limit soil displacement:

- **5.1 - Wood Walls**
- **5.2 - Rock Walls**
- **5.3 - Keystone Block Wall**
- **5.4 - Concrete Wall**

References

More detailed construction specifications can be found in:

TRPA. 1988. Handbook of Best Management Practices

5.1 Wood Retaining Wall

Please read section 5.0 for important information applicable to all retaining structures.

Description: A low wall of posts and planks.

Planning considerations: If wood is preserved, avoid using in wet areas where leaching is likely to occur and provide a Material Safety Data Sheet for the preservative to the appropriate permitting agency for review. Environmentally damaging preservatives such as creosote should be avoided. For wet areas, consider using alternate synthetic materials such as

wood polymer in place of wood. If using alternate materials, be sure to properly calculate structural capacity. A qualified professional engineer must perform such calculations.

Tips for Installation:

1. Set posts in a concrete footing.
2. Install planking on the upslope side of the posts.
3. Leave sufficient spacing to allow drainage at the base of the wall and between planks.
4. Backfill behind the wall with drain rock and cover with soil. Include filter fabric behind the wall to prevent migration of fine material.
5. Revegetate the backfilled bench and slope behind the wall as soon as possible.
6. Install subsurface drainage as needed.

Maintenance: If properly installed, wood retaining walls require little maintenance. Walls should be inspected periodically for damage caused by subsurface drainage or snow removal equipment.

Where to Use: Wood walls are best suited for preventing soil erosion from short (in length) oversteepened slopes. They are most effective when used is combination with vegetative practices.

Where NOT to Use: Wood walls should not be installed at the base of long slopes, in areas where damage from snow removal activities is likely, or in moist areas.

Field Experience:

- El Dorado County no longer uses wood retaining walls because they can be easily damaged by snow removal equipment. Repairs can be time consuming and expensive.
- Longevity may be reduced by wood rot if preservatives are not used.
- Wood walls installed as part of several projects by Washoe County effectively control slope erosion.
- Washoe County currently uses larger posts and added planks for better strength – over-size materials may add longevity.

5.2 Rock Retaining Wall

Please read section 5.0 for important information applicable to all retaining structures.

Description: A low wall, usually 1-1.2 meters (3-4 feet high), constructed of irregularly shaped rocks (25- 91 centimeters (10 inches-3 feet) in diameter) stacked at the toe of a slope.

Planning Considerations: Rock walls should be porous to allow revegetation to establish in interstices. Rocks should be laid on a firm foundation of undisturbed or compacted soil. Rock walls are not intended to resist large lateral earth pressures; they act more as a revetment than a retaining wall. Rock walls must be designed by a qualified professional engineer.

Tips for Installation:

1. Excavate a footing trench along the toe of the slope and stockpile material.
2. Place the largest boulders in the base trench with their longitudinal axis into the slope face.

3. Use angular rock to allow stones to lock in place.
4. Place rocks such that their center of gravity is as low as possible with bedding planes facing inward toward the slope toe.
5. Fill material should be added around and behind the rocks as they are placed and thoroughly compacted.
6. Construct the wall such that the external face is inclined slightly.
7. Ensure stabilized drainage at the outside toe of the rock wall to prevent undercutting.
8. Revegetate the slope above the rock wall as soon as possible.
9. Install subsurface drainage if needed.
10. The angle of the slope above the wall should not exceed 3:1.
11. Filter fabric **should not** be placed behind boulders. The addition of filter fabric precludes vegetation establishment.

Maintenance: If properly installed, rock retaining walls require little maintenance. Walls should be inspected periodically for damage caused by subsurface drainage, material sloughing, or snow removal equipment.

Where to Use: Rock walls are well suited for preventing soil erosion at the base of oversteepened slopes (greater than 2:1) where deemed appropriate by a professional engineer. They are most effective when used in combination with vegetative practices.

Where NOT to Use: Like wood walls, rock walls should be avoided in areas subject to damage by snow removal activities. When feasible, avoid installing rock walls where they are considered unattractive; consult TRPA's scenic requirements.

Field Experience:

- Rock should be selected to blend with the surrounding area – choose rock with appropriate color.
- Proper installation requires a skilled contractor with the appropriate equipment (such as an excavator equipped with a bucket-thumb).
- Washoe County avoids rock walls because of scenic complaints.
- Revegetation can be difficult. Rock placement that allows for larger interstices for better moisture penetration may improve revegetation success.
- Minimal long term maintenance.
- Holds snow pack well, allows for infiltration of spring melt.

5.3 Block Walls

Please read section 5.0 for important information applicable to all retaining structures.

Description: Walls constructed of interlocking blocks.

Planning Considerations:
Block/interlocking block walls are alternatives to rock or wood walls. Where possible, allow interstices for enhanced revegetation.

Tips for Installation: There are several commercially available block/interlocking block wall systems available. Follow the manufacturer's instructions for proper installation. In general:

1. Prepare a smooth, level, compacted foundation.
2. Place the first layer of stones in an even line.
3. Backfill behind the first layer.

4. Stack and attach the second layer (using rods or pins, if applicable).
5. Backfill and repeat.
6. Revegetate the slope above the wall as soon as possible.
7. Install subsurface drainage if needed.
8. The angle of the slope above the wall should not exceed 3:1.

Maintenance: If properly installed, block/interlocking block walls require little maintenance. Walls should be inspected periodically for damage caused by subsurface drainage, material sloughing, or snow removal equipment.

Where to Use: Block walls are well suited for oversteepened slopes where deemed appropriate by a professional engineer, especially those slopes requiring walls higher than 3-4 feet.

Where NOT to Use: When feasible, avoid installing block walls where they are considered unattractive; consult TRPA's scenic requirements.

Field Experience:

- Washoe County has used interlocking block walls to successfully control erosion on several projects.
- Although block walls are labor intensive, associated revegetation does well.
- Lack of adequate wall height may allow material from the slope to overtop the wall.

5.4 Concrete Walls

Please read section 5.0 for important information applicable to all retaining structures.

Definition: Walls formed by large pre-cast or cast-in-place concrete slabs.

Planning Considerations: Concrete walls are another option for stabilizing oversteepened slopes. Walls must be designed by a professional engineer.

Tips for Installation: Installation is site specific. In general:

1. Install subsurface drainage if necessary.
2. Attempt to match surrounding area by texturing the surface and staining concrete to tone with local colors. In general, earth tones, dark colors, and flat finishes are preferred. Consult community plans where applicable.

Maintenance: If properly installed, concrete retaining walls require little maintenance. Walls should be inspected periodically for damage caused by subsurface drainage, material sloughing, or snow removal equipment.

Where to Use: Concrete walls are well suited to areas requiring long walls to stabilize expansive slopes. Smaller concrete walls may also be appropriate for smaller slopes. Concrete walls can be designed to withstand more lateral pressure than other retaining walls.

Where NOT to Use: Concrete walls should be avoided in wet areas requiring extensive drainage. When feasible, avoid installing

concrete walls where they are considered unattractive; consult TRPA's scenic requirements.

Field Experience:

- Concrete walls have been successfully employed to control erosion on Highway 89 at Emerald Bay and Caspian (along the West Shore).
- Proper use of surface texturing can yield an aesthetically pleasing structure provided pattern repeats are less obvious.