4.2-h SLOPE SHAPING

Alternative Names: Slope Stepping, Gradient Terraces, Benching, Surface Roughing, Slope Bottom Benching

BMP DESIGN APPROACH
■ **Pollutant Source Control**
□ Hydrologic Source Control
□ Stormwater Treatment
SCALE OF APPLICATION
■ **All SFR and MFR < 1 acre**
■ **MFR 1-5 Acre and CICU < 5 acres**
■ **MFR and CICU > 5 acres and all WQIPs**
BMP TYPE
□ Temporary
■ **Permanent**

DESCRIPTION

Slope shaping is a physical modification to a steep slope that alters the geometry of the slope and/or increases the surface roughness of the soil on the slope. Slope shaping reduces the erosion potential of a slope by reducing runoff velocities, reducing the concentration of stormwater runoff, and increasing infiltration and sediment collection. Slope shaping also provides better conditions for vegetation establishment.

APPLICABILITY

- Typically used for slopes greater than 3:1 (run to rise) and more than 5 feet in height.
- Slope shaping practices should be used in conjunction with other soil stabilization practices described in this Handbook.
- Slope stepping practices described are not recommended for decomposed granitic soils, sandy soils, or other soils with low cohesiveness.

Advantages

- Helps promote vegetation establishment.
- Helps stabilize steep slopes and reduce the erosion potential of a steep slope.
- Typically promotes increased infiltration, which reduces surface runoff and may assist with vegetation establishment.
- Can be aesthetically pleasing when grading matches surrounding topography and vegetation is established.

Disadvantages

- Slope stepping practices described have limited success in granitic or highly sandy soils that are common in the Lake Tahoe Region.
- Drainage structures may be needed for designs that collect runoff.

DESIGN AND INSTALLATION CONSIDERATIONS

Slope shaping as defined in this Handbook includes the practices of surface roughening, slope bottom benching, and slope stepping. Considerations and guidance for each practice are given below.

Surface Roughening

Surface roughening is the practice of modifying the soil of a compacted slope to create a soil surface that is looser and less uniform. Surface roughening can reduce the concentration of runoff, enhance infiltration, and promote soil moisture retention to assist in vegetation establishment.

- Surface roughening methods are classified as follows:

- Scalloping and pocking are methods to produce small pockets in the soil that increase water retention.
- Tracking is a method for creating a pattern of tracks along the contours of a slope using a crawler tractor or equivalent equipment. Indentations in the soil created by the tracks can trap sediment and water along the slope.
- Grooving is a method of loosening or stirring the soil without turning it over. Grooves can be made using spring harrows, serrated wing blades attached to the side of bulldozer, or with the teeth on a front-end loader bucket. Grooving should follow the contours of the slope and should be less than 3 inches deep and less than 15 inches apart.

- Avoid surface roughening on slopes with a stable rock face.
- Avoid surface roughening when soil is wet.
- After a slope is roughened, do not drive on the slope or compact the surface in any manner.

Slope Bottom Benching

Slope bottom benching is the practice of grading a flat bench at the base of a steeper slope to retain material that erodes and sloughs from the steeper slope onto the bench. Slope bottom benching is typically used for over-steepened slopes that cannot be fully stabilized using other practices described in the Handbook because of constraints such as: lack of available land, lack of equipment access, and poor soil stability. Refer to the Slope Bottom Bench Figure.

- A slope bottom bench should be installed after roadside curb and gutters, retaining walls, or other structures that will be adjacent to the slope bottom bench have been installed.
- A slope bottom bench should be a minimum of 3 feet wide. Where drainage behind a structural facility is of concern, the bench should have a minimum slope of 2 percent. If drainage is not a concern, the bench may be flat.
- The slope bottom bench should be revegetated. If possible, the steeper slope section should be stabilized and revegetated.

Slope Stepping

Slope stepping is the practice of grading flatter terraced sections between steeper slope sections. Slope stepping practices may have limited success in granitic or highly sandy soils and may not be applicable in many locations in the Lake Tahoe Region. To be approved in the Lake Tahoe Region, slope stepping techniques should be combined with other structural slope stabilization techniques described in this Handbook (e.g., Terracing, Retaining Walls, etc.).

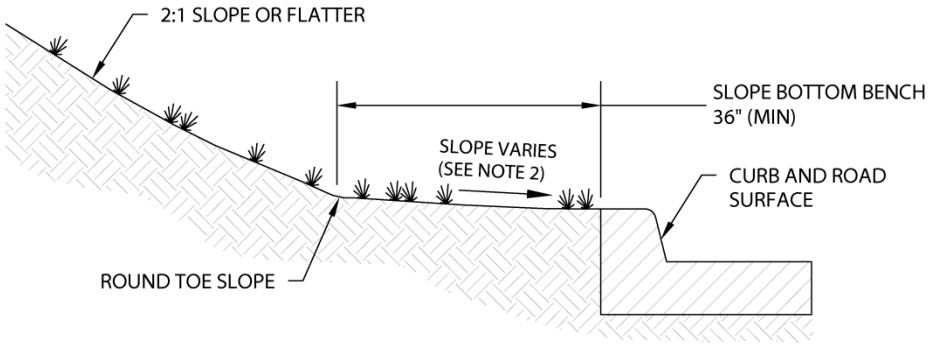
Slope stepping practices described require slopes that are flat enough to permit access to heavy equipment, typically 2:1 (run to rise) or less. Three slope stepping techniques are described:

- **Serrations** – small steps graded into a slope using a grader equipped with a special blade, usually a serrated wing blade having a series of 10 inch grooves. The blade is positioned at the same angle as the slope, and the serrations are

made along the contour of the slope. The maximum slope length for this slope stepping technique should be 100 feet. Refer to Serrations Figure.

- **Contour Furrows** – relatively deep inundations graded into a slope to provide a location for collection of sediment and runoff. The distance between contour furrows typically ranges from 10 to 20 feet, with a maximum distance of 40 feet. The maximum slope length for this slope stepping technique should be 200 feet. Refer to Contour Furrows Figure.

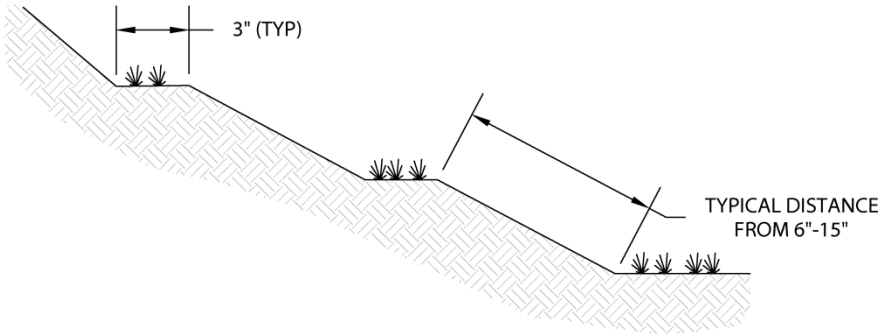
Slope Bottom Bench Figure



NOTES:

1. FOR NON-PERMITTED PROJECTS, REVEGETATE ADJACENT AREAS IN ACCORDANCE WITH THE TRPA BMP HANDBOOK. FOR PERMITTED PROJECTS, REVEGETATE ADJACENT AREAS TO SPECIFICATIONS OF REVEGETATION PLAN.
2. WHERE DRAINAGE BEHIND A STRUCTURAL FACILITY IS OF CONCERN, THE BENCH SHOULD HAVE A MINIMUM SLOPE OF 2 PERCENT. IF DRAINAGE IS NOT A CONCERN THE BENCH MAY BE FLAT.

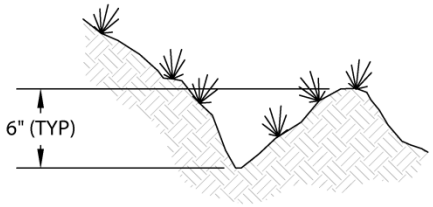
Serrations Figure



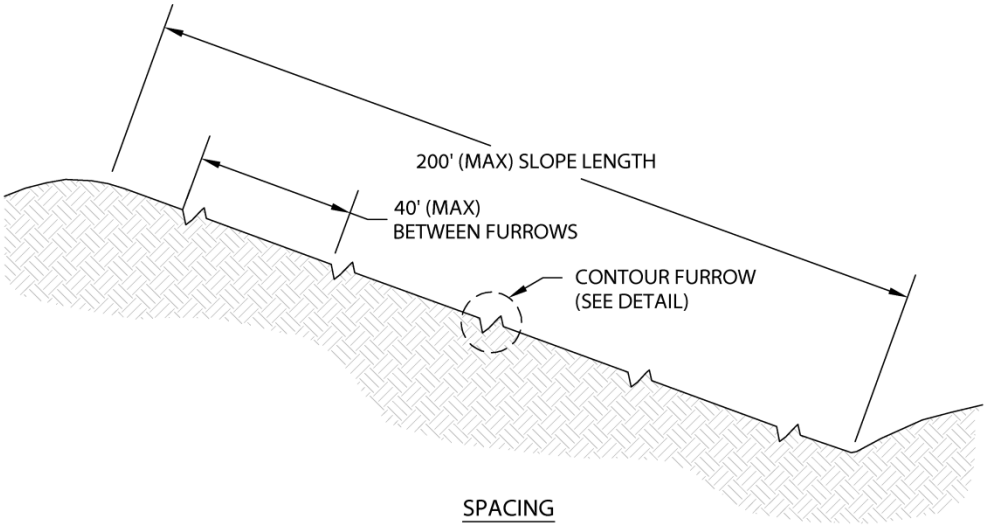
NOTES:

1. MAXIMUM OVERALL SLOPE SHALL NOT BE GREATER THAN 2:1.
2. MAXIMUM SLOPE LENGTH SHALL BE 100 FEET.
3. BREAK IN SLOPE SHALL BE GRADED PARALLEL TO SLOPE CONTOURS TO CREATE A SERRATED PROFILE.
4. FOR NON-PERMITTED PROJECTS, REVEGETATE ADJACENT AREAS IN ACCORDANCE WITH THE TRPA BMP HANDBOOK. FOR PERMITTED PROJECTS, REVEGETATE ADJACENT AREAS TO SPECIFICATIONS OF REVEGETATION PLAN.

Contour Furrows Figure



DETAIL



SPACING

NOTES:
1. EXCAVATED FURROWS SHALL BE GRADED PARALLEL TO SLOPE CONTOURS.
2. FOR NON-PERMITTED PROJECTS, MULCH AND REVEGETATE SLOPE IN ACCORDANCE WITH THE TRPA BMP HANDBOOK, FOR PERMITTED PROJECTS, MULCH AND REVEGETATE SLOPE TO SPECIFICATIONS OF REVEGETATION PLAN.

Slope steps should be roughly level, or angled back into the predominant slope. Grading of a step should occur in the opposite direction relative to grading of the preceding step to minimize buildup of material at the edges of grading.

Where concentration of runoff on a slope step is a concern, the design should incorporate drainage channels to control runoff that collects on a slope step. Construction of downdrains may be required to convey runoff from the slope steps to the base of the slope to avoid erosion.

INSPECTION AND MAINTENANCE

- Inspect shaped slopes at least monthly in the first year after construction. Thereafter, inspect after significant runoff events. If signs of rilling or erosion are evident, consider installing additional slope stabilization BMPs to the steeper slope segments between slope steps.
- Remove accumulated sediment from slope bottom benches when accumulated sediment has the potential to slough off the bench into a drainage system.

EFFECTIVENESS CONSIDERATIONS

Slope shaping can be a highly effective practice for reducing soil erosion from steep slopes when combined with other soil stabilization measures. However, slope stepping practices described may have limited success in granitic or highly sandy soils found in many areas of the Lake Tahoe Region.