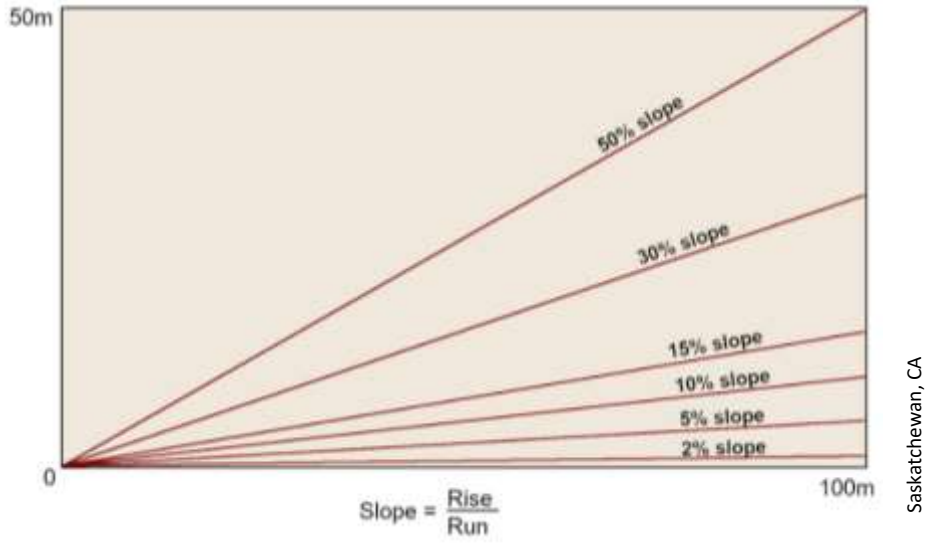
Guidance for Determining the Slope

The slope of the land is an important consideration for land use planning and site development. If the grade is too steep, runoff can rush down the hillside and cause flash flooding, washouts, and water pollution. Although some amount of flooding and erosion is natural, careful management of land use on steep slopes is needed to reduce the costly damage to property and roads.

A standard way to describe the steepness of a slope is as the percent of the vertical change relative to horizontal change. This can be measured in the field or on a topographic map. A slope with 1-foot vertical change for each horizontal foot is a 100% grade. For development, a 15% grade is considered steep and requires extra attention to slope stability and drainage issues (if the elevation change is more than 1 ½ feet over a 10-foot horizontal distance). A 25% grade is challenging and should be left undisturbed if possible.

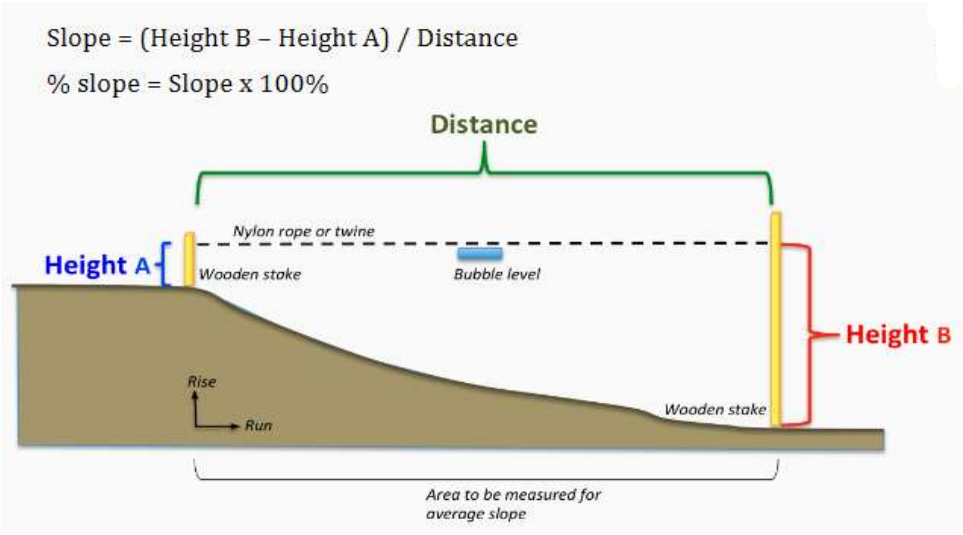


Steep slopes present challenges because of the difficulties of stabilizing steep soils and safely managing runoff.

Measuring Slope in the Field

The slope can be determined by measuring the vertical and horizontal distances on a hillside. For a localized measurement, a board can be laid down the slope and the downhill end raised until a bubble level indicates it is horizontal. The height of the downhill end is the vertical change over the length of the board. If the slope changes two feet over the length of an 8-foot board, then the slope is 25% [(2 feet / 8 feet) X 100 = 25%]. A 14-inch vertical change over the length of the 8-foot board would indicate a 15% grade [14 inches / 96 inches) X 100 = 15%].

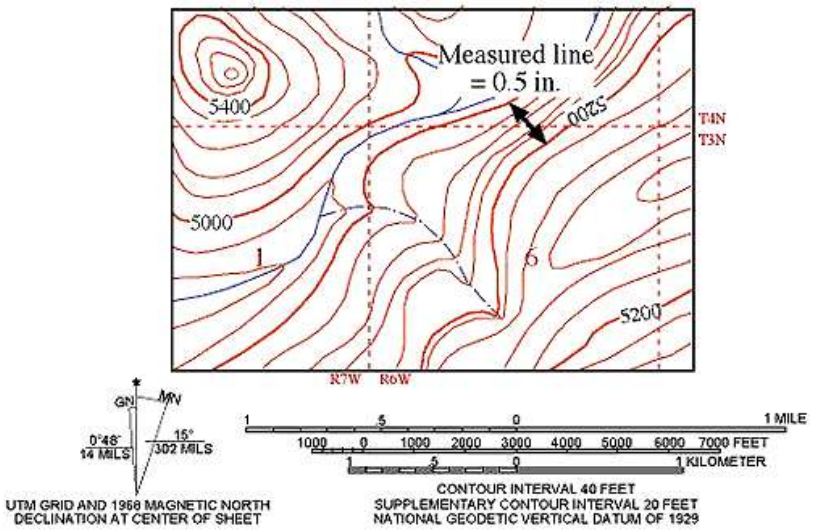
For a longer slope, vertical stakes can be placed at the top and bottom and connected by horizontal rope or twine. Use a bubble level to make sure that the stakes are vertical and the rope is horizontal; then measure the vertical change and horizontal distance.



University. of Tennessee Extension

Measuring Slope on a Topographic Map

On a topographic map, each contour line represents a uniform elevation, and the contour interval is the change in elevation between adjacent lines. The contour lines are closer together in steep areas and farther apart on gentler slopes. The slope can be determined by measuring the horizontal distance on the map and counting the number of contour lines crossed to determine the elevation change.



Determining hillslope from a topographic map

Length of measured line = 0.5 in. 0.5 in x $\frac{2000 \text{ ft}}{1 \text{ in}}$ = 1000 ft (.19 mi)= horizontal distance

Elevation change = 200 ft. (read off of contour lines)

Percent slope = $\frac{200 \text{ ft}}{1000 \text{ ft.}}$ x 100 = 20% slope

GeoSTAC

One of many sources for a topographic map is the STC Planning Tool Online Mapper at https://stcgis.maps.arcgis.com/apps/webappviewer/index.html?id=76f6329778cc4b6e887a17fddd6ad224. This mapping tool uses a topographic base map with a 10- or 20-foot contour interval (depending on the zoom level). After zooming in to the area of interest, measure the map distance perpendicular to the contour lines using the Measurement Tool. (Select the ruler icon to open the tool. Then select the ruler to measure distance and feet from the units dropdown menu. Click once on the map to start measuring and double click to stop.) Determine the change in elevation from the contour lines and calculate the percent slope:

If the horizontal distance between 10-foot contour lines is less than 65 feet, the slope is greater than 15% and is considered steep. 40 feet between 10-foot contour lines indicates a 25% grade, which should be protected.

$$\text{Percent slope} = \frac{\text{Map distance (feet)}}{\text{Elevation change (feet)}} \text{ X } 100$$

Slope Information from Soil Mapping Units

Soil survey data provide another source of information about slopes. Soil mapping units are assigned a slope class to convey the dominant range of slope gradients occurring within the unit. The slope class is represented as a capital letter (from A to F) at the end of the mapping unit symbol. Although the slope ranges may vary, the general meaning is:

- A – Nearly level (0-3%)
- B – Gently sloping or undulating (1-8%)
- C – Strongly sloping or rolling (4-16%)
- D – Moderately steep or hilly (10-30%)
- E – Steep (20-60%)
- F – Very steep (greater than 45%)

Soil mapping units can be found on the STC Planning Tool Online Mapper at https://stcgis.maps.arcgis.com/apps/webappviewer/index.html?id=76f6329778cc4b6e887a17fddd6ad224. (Open the Layer List using the layer icon at the top right corner of the screen and then select Soils to turn on this data layer.) If the mapping unit label ends with a capital letter, this provides a general indication of the representative slope for this soil type.

More detailed information about the slope and other soil characteristics is available from the Web Soil Survey Application at https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. The welcome page provides instructions for defining the area of interest, creating and viewing a soil map for this area, and obtaining a detailed description of each soil unit in the area of interest.

Slopes with Special Stormwater Management Requirements

Increased runoff and erosion from construction activities are regulated under the New York State Stormwater Permit for Construction Activity (https://www.dec.ny.gov/chemical/43133.html). However, construction on some steep slopes may be ineligible for coverage under the general permit and

therefore require an individual permit with a more stringent design and review process. This special requirement applies to projects that disturb land with no existing impervious cover in areas that:

- are mapped on the Soil Survey as having a soil slope class of E or F, or a slope class of D with a map unit name that is inclusive of slopes greater than 25%; and
- are tributary to a drinking water source classified by New York State as AA or AA-s. In the Southern Tier Central region, this applies to watersheds draining into the following Class AA waterbodies:
    - Keuka Lake
    - Seneca Lake
    - Lime Kiln Creek (in the Towns of Fremont and Dansville)
    - Reservoir Creek (in the Towns of Cohocton and Prattsburgh)
    - unnamed tributaries to Waverly Reservoirs (in the Town of Chemung)

Online Maps with Steep Slope Information

Maps showing the watershed boundaries and areas with steep slope soils for the following drinking water sources are available at https://www.stcplanning.org/documents/?fwp_document_categories=runoff-erosion&fwp_document_tags=map:

- Keuka Lake (Towns of Pulteney and Wayne)
- Keuka Lake (Towns of Bath, Urbana, Wayne, Wheeler, and Village of Hammondsport)
- Lime Kiln Creek (Towns of Dansville and Freemont)
- Reservoir Creek (Towns of Cohocton and Prattsburgh)

Maps showing watershed boundaries, topographic contours, slopes, and steep soils for the following small lake watersheds are available at https://www.stcplanning.org/documents/?fwp_document_categories=small-lakes-mapping&fwp_document_tags=map:

- Cayuta Lake (Towns of Catherine, Enfield, Hector, and Newfield)
- Lamoka Lake (Towns of Bradford, Orange, Tyrone, and Wayne)
- Waneta Lake (Towns of Barrington, Tyrone, and Wayne)
- Tanglewood Lake (Towns of Addison and Thurston)
- Lake Salubria (Town of Bath)
- Lake Demmon (Town of Howard)
- Smith Pond (Towns of Avoca and Howard)
- Loon Lake (Towns of Dansville and Wayland)

Development on slopes with a grade of 15% or greater should be avoided, if possible, to limit soil loss, erosion, excessive stormwater runoff and the degradation of surface water. On slopes greater than 25%, no development, re-grading, or stripping of vegetation should even be considered. (Source: New York State Stormwater Management Design Manual, January 2015; https://www.dec.ny.gov/chemical/29072.html.)