

**Natural Resources Conservation Service
Conservation Practice Standard**

**TERRACE
(Ft.)
CODE 600**

DEFINITION

An earth embankment, or a combination ridge and channel constructed across the field slope.

PURPOSE

This standard applies to the planning and design of all types of terraces. It does not apply to diversions, which are constructed at a field border.

The purpose is to:

- Reduce slope length.
- Reduce erosion.
- Reduce sediment content in runoff water.
- Improve water quality.
- Retain runoff for moisture conservation.
- Prevent gully development.
- Reform the land surface.
- Improve farmability.
- Reduce flooding.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion by water is a problem
- There is a need to conserve water
- The soils and topography are such that terraces can be constructed and farmed

with reasonable effort

- A suitable outlet can be provided
- Excess runoff is a problem
- Where water quality is impaired by sediment

CRITERIA

General

Terraces may be gradient or provide temporary storage with tile outlets. Terraces may be constructed with a broad base for farming, steep grassed backslope, or steep grassed front-slopes and backslopes as desired.

The area engineer and a soil scientist should be consulted prior to constructing terraces on soils that are shallow due to erosion or have underlying fragipan, chalk, or rock; are on slopes steeper than 8 percent; or have other growth limitations.

Design

Spacing. The maximum spacing for terraces for erosion control shall be determined by use of the **Revised Universal Soil Loss Equation (RUSLE)**. The spacing shall not exceed the slope length determined by using the allowable soil loss, the most intensive use planned, the expected level of management, and the terrace P subfactor (Table 1).

In no case shall the maximum horizontal spacing exceed that shown in Table 2 for

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the conditions shown. The maximum limits may not be exceeded when making the adjustments indicated below. Spacing may be increased as much as 10 percent to provide better alignment or location, to adjust for farm machinery, or to reach a satisfactory outlet. Spacing may be increased an additional 10 percent for terraces with underground outlets. The spacing shall be adjusted to provide for an even number of trips for anticipated row crop equipment and maximum opportunity for changing row widths. The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be considered when determining the terrace interval.

For level terraces used for erosion control and water conservation, the spacing shall be determined as indicated earlier, but the maximum horizontal spacing shall not exceed 600 ft. Figures 1 and 2 show the horizontal interval or erosion length to be used in calculating terrace spacing (Figure 3).

For terraces on non-cropland, the maximum spacing shall be governed by the capacity requirement.

Table 1. Terrace P subfactors¹

Horizontal Interval (ft)	Closed Outlets ²	Open outlets with percent grade of ³		
		0.1 - 0.3	0.4 - 0.7	0.8
Less than 110	0.5	0.6	0.7	1.0
110 - 140	0.6	0.7	0.8	1.0
140 - 180	0.7	0.8	0.9	1.0
180 - 225	0.8	0.8	0.9	1.0
225 - 300	0.9	0.9	0.9	1.0
More than 300	1.0	1.0	1.0	1.0

¹NOTE: If contouring or stripcropping P subfactors are appropriate, they can be multiplied by the terrace P subfactor for the composite P subfactor.

²“P” subfactors for closed outlet terraces also apply to terraces with underground outlets and to level terraces with open outlets.

³The channel grade is measured on the 300 ft of terrace or the one-third of total terrace length closest to the outlet, whichever distance is less.

Figure 1

Horizontal Interval for Steep Back-Slope Terraces

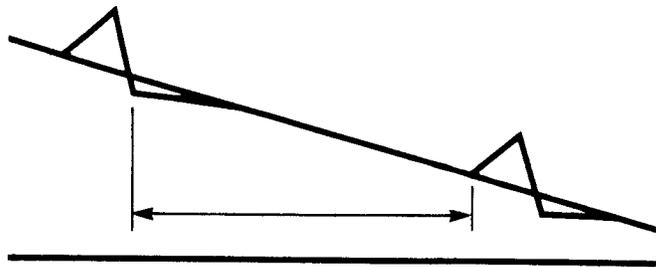


Figure 2

Horizontal Interval for Broad-Based Terraces

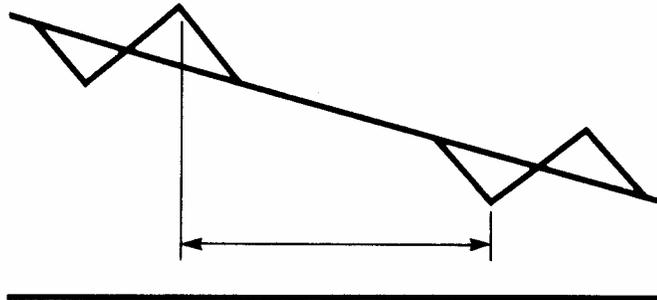


Figure 3

Terrace Spacing

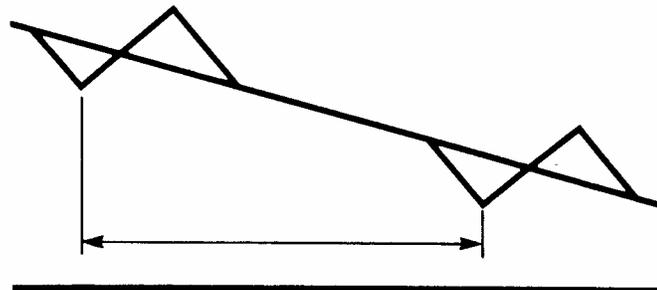


Table 2. Maximum horizontal spacing for terraces

Slope	RUSLE		
	R factor of More than 300	With contour stripcropping	For concentrated flow control

Percent	ft	ft	ft
0 - 2	450	600	700
2 - 4	300	600	700
4 - 6	200	600	600
6 - 9	150	400	500
9 - 12	150	250	500
Minimum spacing required all slopes	90	90	200

Alignment. Terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery. Land forming, extra cut fill along the terrace line, multiple outlets, variations in grade, channel blocks, and other methods shall be used to achieve good alignment.

Field efficiency may be used to compare alternative terrace systems. Field efficiency is the ratio of time required to farm the field being planned to that required to farm a rectangular field of the same acreage $\frac{1}{2}$ mi. long.

Capacity. The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, the capacity shall be increased by the estimated 10-year sediment accumulation, unless provisions are made to maintain the design capacity through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have adequate capacity to control a storm of a frequency consistent with the potential hazard

Cross-section. The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery

used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety. The ridge shall have a minimum width of 3 ft. at the design elevation. The minimum slope of a vegetated front or back ridge slope is 2:1. If necessary, steeper slopes may be used for special purposes but must be stable. The opening at the outlet end of gradient and open-end level terraces shall have a cross section equal to that specified for the terrace channel.

End closures. Level terraces may have open ends, partial end closures, or complete end closures. Partial and complete end closures shall be used only on soils and slopes where the stored water will be absorbed by the soil without appreciable crop damage or where underground outlets are provided.

If terraces with closed or partly closed ends are specified, the end closures must be installed before the terraces are completed. The end closures shall be designed so that the water flows over the end closure before overtopping the terrace ridge.

Partial end closures shall not be more than half the effective height of the terrace

ridge. Complete end closures are more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

Channel grade. Channel grade shall be determined by one of the following methods:

1. Maximum channel grade in the lower reaches of the channel shall not exceed 0.6 percent.
2. Maximum channel velocity for farmed channels shall be nonerosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/s; for average soils, 2.0 ft/s; and for easily erodible soils, 1.5 ft/s. Maximum velocity for Hawaii shall be 5.5 ft/s. Velocity shall be computed by Manning's formula, using an n value of 0.035.
3. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.

Channel grades may be uniform or variable. Channel velocity shall not exceed that which is nonerosive for the soil and planned treatment. For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment. If terraces have an underground outlet, water and sediment will pond in the channel, thus reducing the velocity and allowing steeper channel grades near the outlet. Minimum grades shall be such that ponding in the channel because of minor irregularities will not cause serious damage to crops or delay field operations.

Terrace length. The volume of water stored in level terraces is proportional to the length. Therefore, it is necessary that the length be held within reason so that damage in case of a break is minimized. Level terrace length shall not exceed 3,500

ft unless the channel is blocked at intervals not exceeding 3,500 ft. Normally, the capacity and the nonerosive velocity requirements control the gradient terrace length.

Outlets. All terraces must have adequate outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or a vegetated area. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets shall be installed and vegetated before the terrace is constructed if necessary to provide a stable non-erodible outlet or to insure establishment of vegetative cover. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used on gradient or level terraces. The outlet consists of an intake and an underground conduit. An orifice plate, increase in conduit size, or other features shall be installed as needed to control the release rate and prevent excessive pressure when more than one terrace discharges into the same conduit. The discharge, when combined with the storage, shall be such that a 10-year frequency, 24-hour storm will not overtop the terrace, and growing crops will not be damaged significantly by standing water. The release time shall not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops, depending on soils characteristics and water tolerance of crops to be grown.

The underground conduit shall meet the requirements specified for underground outlets (620) or for subsurface drains (606). Conduits must be installed deep

enough to prevent damage from tillage equipment. The inlet shall consist of a vertical perforated pipe of a material suitable for the intended purpose. The inlet shall be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, if necessary, provide for the anticipated accumulation of sediment and subsequent raising of the terrace ridge. The outlet of the conduit shall have adequate capacity for the design flow without causing erosion. Blind inlets may be used where they are effective, usually in well-drained soils.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration must permit drainage of the design storm from the terrace channel with a reasonable period so standing water does not significantly damage crops.

Combinations of different types of outlets may be used on the same system to maximize water conservation and to provide for economical installation of a more farmable system.

Vegetation. All areas to be vegetated shall be established as soon as practicable after construction.

CONSIDERATIONS

Water quantity

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
- Variability effects caused by seasonal or climatic changes.
- Effects of snowcatch and melt on water budget components.
- Potential for a change in plant growth and transpiration because of changes in the volume of soil water.
- Effects on the downstream or aquifers that could affect other water uses and users.
- The effect on the water table of the field to ensure that it will provide a suitable rooting depth, field wide, for anticipated land uses.
- Potential for water management to supply alternate uses.

Water quality

- Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.
- Effects of nutrients and pesticides on surface and ground water quality.
- Effects on the visual quality of onsite and downstream water.
- Short-term and construction-related effects on the quality of onsite and downstream water.
- Potential for development of saline seeps or other salinity problems

resulting from increased infiltration in soils that have restrictive layers.

- Potential for uncovering or redistributing toxic materials such as saline soils.
- Effects on the movement of dissolved substances below the root zone and to the ground water.
- Effects on wetlands and water related wildlife habitats.

Safety

Terrace ridges, especially those with steep back slopes, can be very hazardous. For this reason, some farmers prefer steep front slopes, thus keeping machinery away from the steep back slopes. All cut and fill slopes that are to be farmed must be no steeper than those on which farm equipment can operated safely. Any hazards must be brought to the attention of the responsible person.

OPERATION AND MAINTENANCE

A program shall be established for maintaining terrace capacity, storage, ridge height, and outlets. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets

damaged or cut off by farm machinery must be replaced or repaired immediately. The sod shall be maintained and trees and brush controlled by chemical or mechanical means.

PLANS AND SPECIFICATIONS

Plans and specifications for installing terraces shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

REFERENCE

NRCS Conservation Practice Standards:
Critical Area Planting, Code 342
Grassed Waterway, Code 412
Subsurface Drain, Code 606
Underground Outlet, Code 620
NRCS Engineering Field Handbook, Part 650,
Chapter 8

**Natural Resources Conservation Service
Construction Specification**

TERRACE

1. SCOPE

Work shall consist of constructing the terrace, including the channel, supporting ridge, and outlets, to the lines and grades as shown on the drawings or as staked in the field. The location of the terrace shall be as shown on furnished drawings or as staked in the field.

that endanger the performance of the terrace. Topsoil should be stockpiled and spread over excavated channel and borrow areas to facilitate revegetation, if required. Seedbed preparation, fertilizing, seeding, and mulching shall comply with specifications in technical guides.

2. SITE PREPARATION

All old terraces, fence rows, brush, and tall standing vegetation shall be removed from the area occupied by the terrace ridge and the area from which the earthen construction material will be taken. All brush, logs, stumps, or other debris must be removed from the terrace ridge or channel area and disposed of by burning, burying, or removal from field area.

All dead furrows, ditches, or gullies shall be filled before constructing the terrace or shall be part of the construction. All old terraces, fencerows, hedgerows, trees, and other obstructions shall be removed, as necessary, to install a farmable system.

3. MATERIAL

Materials for earthfill shall be obtained from excavation in the channel, immediately downhill of supporting ridge, or other designated areas and shall be free of objectionable materials such as brush, roots, and rock particles

4. CONSTRUCTION

The terraces shall be constructed according to planned alignment, grade and cross section with the specified overfill for settlement and the channel graded to drain reasonably well.

Any ditch or depression at the bottom of the back slope shall be filled and smoothed so that drainage will be away from the terrace and not parallel to it.

The surface of the finished terrace shall be reasonably smooth and present a workmanlike finish.

5. PLACEMENT OF EARTHFILL

All fills shall be full-bodied, with cross-sections conforming to that specified at all stations. Top of the constructed ridge shall not be lower at any point than the design elevation with required freeboard plus the specified overbuild for settlement.

For terrace ridges, the specified overbuild for settlement shall be the larger of 0.2 foot or 10 percent of the designed fill height.

All survey rod readings taken to determine ridge dimensions shall be taken in a footprint that has had a person's full weight applied. Construction equipment shall be routed over the fill to provide compaction such that no bridging results. The ridge top, side slopes, end closures, channel, and other excavated areas shall be finished to a smoothness so the surface can be readily traveled upon by farm type equipment.

Final construction shall be considered satisfactory when:

- Fill elevations are at or within 0.5 foot above design height plus settlement.
- Excavation elevations are within ± 0.2 foot of design grade and have a positive slope toward the outlet.
- Fill slopes are no steeper than 2.0:1 and 6.0:1, respectively, for narrow-based and broad-based terraces.

6. UNDERGROUND CONDUIT

Underground conduits, when used, will be located under the terrace and have adequate compaction of the conduit trench and embankment material. Provisions must be made to prevent piping if underground circuits are located under terrace ridges. Mechanical compaction, water packing, trench sidewall sloping, and installation and backfill of conduit trenches early enough to allow adequate settlement are methods that can be used. Conduit installation before terrace embankment construction is recommended. The materials used for the inlet and the conduit shall be suitable for the purpose intended (see standard 606). Terrace ridges constructed across gullies or depressions shall be compacted by machinery travel or by other suitable means to insure proper functioning of the terrace.

Underground conduit installation shall be considered satisfactory when the pipe is within ± 0.3 foot of design grade and has a positive slope toward the outlet.

A 2-foot minimum cover over top of pipe is recommended. An animal guard shall be installed on the outlet of each pipe.

7. MEASUREMENT

Measurement will be of the ridge for ridge-type terraces and the channel for the channel-type terraces. The amount of earthfill or excavation, as appropriate, will be the design yardage computed from the natural ground line to the neat line as specified. When needed, volume of earthfill or excavation will be computed to the nearest cubic yard. Linear measurement along the terrace ridge shall be to the nearest 1 foot.

Measurement for vegetative planting area will cover all disturbed areas (ridge, channel, borrow, disposal) that are not to be cultivated. Areas will be measured to the nearest 0.1 acre.

Measurement of underground conduit will be the field laying length from the inlet end to the outlet end. No separate accounting of appurtenances (band, tee, ell, etc.) will be made. The length of each pipe size used will be identified.