NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

TERRACE

(Ft)
CODE 600

DEFINITION

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

PURPOSE

To: (1) reduce slope length, (2) reduce erosion, (3) reduce sediment content in runoff water, (4) improve water quality, (5) intercept and conduct surface runoff at a nonerosive velocity to a stable outlet, (6) retain runoff for moisture conservation, (7) prevent gully development, (8) reform the land surface, (9) improve formability, or (10) reduce flooding.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

1. Water erosion is a problem,
2. There is a need to conserve water,
3. The soils and topography are such that terraces can be constructed and farmed with reasonable effort,
4. A suitable outlet can be provided, or,
5. Runoff and sediment can damage land or improvements downstream or impair water quality.

DESIGN CRITERIA

All planned work shall comply with all Federal, State, and local laws and regulations**.**

Spacing. The maximum horizontal spacing shall not exceed the values shown in Table A for the following conditions:

Condition 1 - Areas with defined drainage patterns resulting in concentrated flows and conventional tillage and/or stubble mulch practices.

Condition 2 - Areas with defined drainage patterns and no-till farming.

Condition 3 - Areas with long broad slopes resulting in sheet flow runoff with fallow cropping, up and downhill tillage, 200 to 500 pounds residue.

Condition 4 - Areas with long broad slopes resulting in sheet flow runoff with continuous cropping or wheat fallow cropping, cross-slope farming with stubble mulch (1,000+ pounds residue).

Condition 5 - Landowners practicing no-till and cross-slope farming on long broad slopes.

Spacing is defined as the horizontal distance between the centerline of the ridge tops of adjacent terraces. Spacing along a terrace may be adjusted to provide better alignment or location, to adjust for farm machinery, or to reach a satisfactory outlet.

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

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.

TABLE A
MAXIMUM HORIZONTAL SPACING FOR TERRACES (Feet)

Slope (%)	Condition 1	Condition 2	Condition 3	Condition 4	Condition 5
0-4	400	600	400	600	600
4-6	400	600	300	600	600
6-9	300	400	200	400	600
9-12	250	400	200	400	500
12-14	200	300	200	250	400
14-18	200	250	200	200	300
>18	200	200	200	200	200

When the capacity of gradient terraces is determined by the formula Q = AV and the V is calculated by using Manning's formula, an n value of 0.06 shall be used for bare channels. SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation, Chapter 7, Engineering Field Manual or equivalent, shall be used to design vegetated channels. The design capacity for level terraces storing runoff from cropland shall be the larger of either the 10-yr 24-hr runoff or 1 inch of runoff, except where no-till is being practiced. With no-till farming the runoff shall be the larger of either the10-yr 24-hr runoff or 0.75 inch of runoff. On cropland with tillage pans the soil hydrologic group shall be adjusted to represent a higher runoff potential.

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 feet (1 m) at the design elevation. The recommended side slope for farmed terraces is 6:1 or flatter and shall not be steeper than 4:1. The slope of a vegetated front or back ridge shall not be steeper than 2:1. The channel bottom width and all side slopes are to be adjusted to fit the most critical farm equipment widths.

Where terraces cross draws and the fill exceeds 3 feet, a 10 percent over fill or 0.5 feet shall be added to the height of the fill to allow for potential settlement.

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. Partial end closures shall be designed so that the water flows over the end closure before overtopping the terrace ridge.

Alignment. Terraces shall be as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery. Land forming, extra cut or fill along the terrace line, multiple outlets, variations in grade, channels blocks, and segmenting level terraces or other methods shall be used to achieve good alignment. Level terraces do need to be a continuous terrace. Alignments should be adjusted at hogbacks by ending one segment of a terrace and beginning another terrace on the other side. The alignment of terraces across small draws should be adjusted by increasing fill heights across the draw to eliminate sharp curves.

Channel grade. On gradient terraces 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 (0.75 m/s); for average soils, 2.0 ft/s (0.6 m/s); and for easily erodible soils, 1.5 ft/s (0.45 m/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 (1,000 m) unless the channel is blocked at intervals not exceeding 2,000 ft (1,000 m). Normally, the capacity and the nonerosive velocity requirements control the length of a gradient terrace.

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 nonerodible 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 soil characteristics and water tolerance of crops to be grown. Pipe outlets for gradient terraces must be designed for no less than the 10-yr 24-hr peak flow.

The underground conduit shall meet the requirements specified for Underground Outlet Practice Code (620). 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 within a reasonable period so standing water does not significantly damage that crops. Except where the average annual precipitation exceeds 16 inches and the soils have low permeabilities due to high clay content or

hardpans or are shallow to rock, underground pipe outlets are required on level terraces.

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 to grass as soon at practicable after construction. The sod shall be maintained and trees and brush controlled by chemical or mechanical means.

CONSIDERATIONS

Field efficiency should be used to compare alternative terrace systems.

Terraces on closer spacing intervals generally result in smaller more farmable cross-sections.

When practical the spacing should be adjusted to provide for an even number of trips for anticipated row crop equipment and to provide maximum opportunity for changing row widths.

All cut and fill slopes that are to be farmed must be no steeper than those on which farm equipment can operate safely.

Locate terraces to avoid shallow soils when hard to vegetate sub soil will be exposed or consider stripping of topsoil, over excavation and recovering with topsoil.

Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge.

The type of outlet, time of water detention, geology, and topography of the site.
Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances carried by runoff.

Effects of nutrients and pesticides on surface and ground water quality. Filtering effects of vegetation on movement of sediment and dissolved and sediment attached substances.

Short-term and construction-related effect on the quality of downstream water.

Effects on the movement of dissolved substances below the root zone and toward the ground water.

Potential for uncovering or redistributing toxic materials and low productive soils that might cause undesirable effects on the water or plants.

PLANS AND SPECIFICATIONS

Plans and specifications for installing terraces shall show layout, terrace cross-section details, grade if applicable, outlet detail or end block details, compaction requirements and any other features needed to install the terrace.

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.

REFERENCES

- Engineering Field Manual for Conservation Practices,
  Chapter 2, Estimating Runoff
  Chapter 8, Terraces

- SCS - TP-61 Handbook of Channel Design for Soil and Water Conservation.

- NRCS Practice Standards
  Underground Outlet, Code 620