Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

TERRACE

CODE 600

(ft)

DEFINITION

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

PURPOSE

This practice may be applied as part of a resource management system to support one or both of the following:

- Reduce soil erosion and trap sediment
- Retain runoff for moisture conservation

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion by water and excessive slope length 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

CRITERIA

General Criteria Applicable to All Purposes

Terraces shall be planned, designed, and constructed to comply with all federal, state, and local laws and regulations.

Spacing

The maximum spacing for terraces for erosion control shall be determined by use of one of the following methods:

1. V.I. = xs + y or H.I. = (xs + y) (100/s) Where:

V.I. = vertical interval in feet (m)

H.I. = horizontal interval in feet (m) (See Figure 1 and 2)

x = a variable with values from 0.4 to 0.8 (0.12 to 0.24)

s = land slope in percent

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y = a variable with values from 1.0 to 4.0 (0.3 to 1.2)

Use x = 0.4 (0.12) statewide for the value of “x” in Alabama. Values of “y” are influenced by soil erodibility, cropping system, and crop management practices. A value of 1.0 (0.3) should be selected for easily erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of

4.0 (1.2) should be used for erosion resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre or 3.4 metric tons per hectare) on the surface. A value of 2.5 (.75) should be used where one of the above factors is favorable and the other unfavorable. Other values between 1.0 (0.3) and 4.0 (1.2) may be used according to the estimated quality of the above factors. The horizontal spacing does not have to be less than 90 ft. (27m) as shown in Table 600-1.

2. Revised Universal Soil Loss Equation (RUSLE). The spacing shall not exceed the critical slope length as determined using RUSLE. When tables are used to calculate critical slope, refer to Table 600-2 of this standard for terrace P factor. Soil loss in the inter-terrace interval must be less than or equal to the allowable soil loss.

The maximum horizontal terrace spacing (Table 600-3) may not be exceeded when making adjustments as indicated below. Spacing may be increased as much as 10% to provide better alignment or location, to adjust for farm machinery, or to reach a satisfactory outlet. The spacing should be adjusted toprovide for an even number of trips foranticipated row crop equipment and maximumopportunity for changing row widths. Risers for underground outlets shall be placed uphill from the terrace ridge a distance equal to a multiple of the equipment width for 6 or 8 row equipment with all terrace intervals in multiples of 12 rows (12-48). The likelihood of benching of steep slopes by tillage, land forming, and erosion should be considered when determining the terrace interval. For example, use the proposed “as-built” slope and length in RUSLE calculations.

For Level Terraces used for Erosion Control and Water Conservation, the spacing shall be determined as above except the maximum horizontal spacing may not exceed 600 ft. (180m). An “x” value of 0.8 (0.24) may be used for all level terraces used primarily to impound water. Figures 1 and 2 show the horizontal interval or erosion length to be used in calculating terrace spacing in Figure 3.

For terraces on noncropland, the maximum spacing shall be governed by the capacity requirements.

Alignment

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

Capacity

The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. (See NEH, Part 650, Engineering Field Handbook, Chapter 2, for storm frequency values.) The capacity of storage terraces with underground outlets, 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 capacity to control a storm of a frequency consistent with the potential hazard involved.

For terraces with open outlets, base the terrace channel size on the capacity using the densest and longest vegetation. Base the capacity of the channel on a bare earth channel for cropped fields or in the case of a permanently vegetated channel, the appropriate vegetation. For bare earth channels use a Manning’s n value of 0.035 or greater to calculate capacity. For permanently vegetated channels, refer to the Alabama Conservation Practice Standard (412), Grassed Waterway for design criteria to determine capacity.

“Each storage terrace in a system does not have to be individually designed. The design for a system of storage terraces may be based on the height of the terrace with the largest watershed with:

1. A height sufficient to meet cross-section requirements for terraces that bypass onto a grassed waterway or disposal area.
2. A height based on the steepest average slope and channel grade for terraces which store and release the design storm through underground outlets."

Terrace Cross Section

The cross section for standard gradient terraces shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. Avoid the use of terrace cross-sections that result in disturbance of all of the soil in the spacing between terraces. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effects of normal tillage operations and safety. The ridge shall have a minimum width of 3 ft. (1.0 m) at the design elevation. The minimum cross sectional area of the terrace channel for gradient terraces shall be as follows:

1. For slopes up to and including 5%:
   Settled - 8 sq. ft. (2.42 m^2)

   Newly constructed - 9 sq. ft. (2.72 m^2)

2. For slopes above 5%

   Settled - 7 sq. ft. (2.1 m^2)

   Newly constructed - 9 sq. ft. (2.72 m^2)

Design all farmable terrace slopes no steeper than 5:1 in order to allow safe operation of farming equipment. The minimum slope of vegetated front or back 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 or greater than the capacity of the terrace channel.

For channel-type terraces constructed for two row equipment the minimum horizontal distance measured from the top of the ridge to the bottom of the channel shall be 7 ft. (2.1), and the minimum distance from the top of the ridge to the lower side of the terrace shall be 7 ft. (2.1); giving a minimum base width of 14 ft. (4.2).

For channel type terraces constructed for multi-row equipment, the minimum horizontal distance measured from the top of the ridge to the bottom of the channel and from the top of the ridge to the lower side of the terrace shall be consistent with the spacing required for the row equipment used but shall not be less than 13 ft. (3.9); therefore, the minimum base width shall be 26 ft. (7.9).

Ridge type terraces shall have a minimum (1) base width of 10 ft., (2) top width of 3 ft., and (3) settled height (vertical measurement) of 1 ft. from the ground surface above the terrace to the top of the terrace ridge. The constructed height shall be 1.2 ft. (0.36) to allow for settlement.

The design height of the storage terrace shall be increased by the amount needed to insure that the design top elevation will be maintained after all settlement has taken place. The design height shall include a minimum of 0.5 ft. for freeboard and settlement.

With a given height it will be necessary to compute the storage. Storage may consist of natural storage, excavated storage, or both.

Tables or available computer programs may be used to calculate available storage. The use of natural storage allows for securing construction material from surrounding areas including old terraces and ridges.

End Closures

Level terraces may have open ends, partial end closures or complete end closures. Partial and complete end closures will 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.

When terraces with closed or partially closed ends are specified, the end closures must be installed before the terraces are considered complete. The end closures should be designed so the water will flow 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. Full end closures are those more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

Topsoiling

Salvage topsoil from the footprint of the construction area of the terrace to spread over the excavated slopes and terrace ridges to facilitate restoration of the field unless the excavated slope or ridge surface is of similar texture as the available topsoil.

Channel Grade

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

1. Maximum channel grade to the lower reaches of the channel should not exceed 0.6 ft. per 100 ft. (0.6 percent) of length.
2. Maximum channel velocity for farmed channels shall be non-erosive for the soil and planned treatment. Maximum velocity for erosion resistant soils is 2.5 ft/sec (0.75 m/sec), for average soils 2.0 f/sec, (0.6 m/sec), and for easily erodible soils
3. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.

   1.5 ft/sec (0.45 m/sec). Velocities are to be computed by Manning's formula using a minimum "n" value of 0.035.

Terrace Lengths

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 will be minimized. Level terrace length shall not exceed 3,500 ft. (1060m) unless the channel is blocked at intervals not exceeding 3,500 ft. (1060m). Gradient terrace length will normally be controlled by capacity and thenon-erosive velocity requirement.

Outlets

All terraces must have adequate outlets. The outlet may be a natural or constructed grassed waterway, vegetated disposal area, or underground outlet. Vegetated outlets are to be installed before terrace construction. All outlets must convey water to a point where the discharge will not cause damage. See the Alabama Conservation Practice Standard (CPS), Grassed Waterway, Code 412, for policy on stable outlet as follows:

1. Vegetated outlets may be used for gradient or open end level terraces. Such an outlet may be a grassed waterway or vegetated disposal area. The capacity of the vegetated outlet must be large enough so that the water surface in the outlet is at or below the water surface in the terrace at the design flow. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets are to be installed and vegetated before terrace construction 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. Underground outlets may be designed for either pressure or gravity flow. If a pressure system is designed, all pipes and joints must be adequate to withstand the design pressure, including surges and vacuum. For gravity flow systems, use a flow- restricting device such as an orifice or weir to limit flow into the conduit or choose conduit sizes that are large enough to prevent pressure flow. The outlet consists of an intake and underground conduit. An orifice plate, an increase in conduit size, or other feature, shall be installed in each inlet 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.

2. The underground conduit shall meet the requirements specified in the Alabama CPS, Underground Outlet, Code 620 or in Subsurface Drain, Code 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 should be located uphill of the front slope of the terrace ridge to permit passage of farm machinery and, where necessary, to 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.

3. Soil infiltration may be used as the outlet for level terraces. Soil infiltration must permit draining the design storm from the terrace channel in a period so that growing crops are not significantly damaged by standing water.

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

Vegetation

All steep back slope terraces (and steep front slope, if used) shall be vegetated as soon as practicable after construction. The sod shall be maintained and trees and brush controlled by chemical or mechanical means. Refer to the Alabama Conservation Practice Standard, 342, Critical Area Planting and as needed, use the criteria in the Alabama Conservation Practice Standard, 484, Mulching.

Additional Criteria Applicable to Retaining Runoff for Moisture Conservation

For terraces installed to conserve moisture, perform a water budget analysis to determine the volume of water that must be collected to meet the requirements of the water budget. As a minimum the terrace must still meet the design storm and sediment volume requirements in the Capacity section of this standard.

CONSIDERATIONS

One of the keys to a successful terrace system is to make sure that the terrace layout fits the farm equipment. This includes making curves long and gentle and spacing terraces so that the operator can make an even number of trips between terraces in order to end up on the same side of the field they started on.

Terrace ridges and cut slopes can introduce steep and potentially hazardous slopes into a crop field. Where slopes will be farmed, make sure they can be safely negotiated with the operator’s equipment. Where steep slopes are unavoidable make sure the operator is aware of the location and potential danger of the slopes.

The soil survey can be a valuable resource when planning and designing terrace systems. The soil survey can identify potential problems such as the presence of layers in the soil profile that will limit plant growth.

Field investigations can then identify problem areas to avoid such as shallow bedrock or dense, acid or saline layers that will adversely affect plant growth if construction brings them into the root zone.

Steep sided terraces that are in permanent vegetation can provide significant areas of habitat for wildlife. Consider planting native species that provide food and cover for wildlife. Do not mow these areas until after the nesting season to improve wildlife production.

Hillside seeps in a crop field can cause cropping problems. Consider aligning terraces and/or installing subsurface drainage to intercept and correct seepage problems. Install the drainage prior to terrace construction by using the Alabama Conservation Practice Standard 606, Subsurface Drain.

Erosion can be a problem at the outfall of an underground outlet. To ensure an adequate outlet, protect the outfall of the underground outlet so that it is stable.

Outlets from terraces might provide a direct conduit to receiving waters for contaminated runoff from cropland. Terraces should be installed as part of a conservation system that addresses issues such as nutrient and pest management, residue management and filter areas.

Intakes for underground outlets can be easily damaged during cultivation, planting and harvesting operations. Using brightly colored inlets, barriers around the inlet or otherwise clearly marking the inlet will help prevent damage.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for terraces that describe the requirements for applying the practice according to this standard. As a minimum the plans and specifications must include:

- A plan view of the layout of the terrace system.
- Typical cross sections of the terrace(s).
- Profile(s) or planned grade of the terrace(s).
- Details of the outlet system
- If underground outlets are used, details of the inlet and profile(s) of the underground outlet.
- Seeding requirements if needed.
- Bill of materials needed for the construction.
- Site specific construction specifications that describe in writing the installation of the terrace system.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for the operator.

The minimum requirements to be addressed in the operation and maintenance plan are:

1. Provide periodic inspections, especially immediately following runoff events.
2. Promptly repair or replace damaged components as necessary.
3. Maintain terrace ridge height and outlet elevations.
4. Remove sediment that has accumulated in the terrace to maintain capacity, a positive channel grade, and to maintain capacity where soil infiltration serves as the outlet.
5. 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.
6. Vegetation, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means.
7. Vegetated outlets should be established before construction when feasible.
8. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all

potential hazards.

REFERENCES

USDA, NRCS. 2004. Revised Universal SoilLoss Equation, Ver. 2 (RUSLE2).

USDA, NRCS. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 7, Grassed Waterways

USDA, NRCS. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 8, Terraces