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 practice is applied as part of a resource management system for one or more of the following purposes:

- Reduce erosion by reducing slope length
- Retain runoff for moisture conservation

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion caused by water and excessive slope length is a problem
- Excess runoff is a problem
- There is a need to conserve water
- The soils and topography are such that terraces can be constructed and reasonably farmed
- A suitable outlet can be provided

CRITERIA

General Criteria Applicable to All Purposes

Spacing. Space terraces at intervals across the slope to achieve the intended purpose. The maximum spacing of terraces for erosion control is that necessary to achieve soil loss tolerance (T). Include both the terrace system with planned as-built slopes and management practices such as residue management when determining soil loss. The slope length used when calculating soil loss for a proposed terrace spacing is the Horizontal Interval as described in the Nebraska Supplement to the National Engineering Handbook, Part 650, Chapter 8. Maximum spacing for erosion control based on soil loss tolerance may be increased by as much as 10 percent to provide better location, alignment to accommodate farm machinery or to reach a satisfactory outlet.

The methods that may be used to determine terrace spacing include the current NRCS accepted erosion prediction technology or the Horizontal Interval Equation as described in the Nebraska Supplement to the National Engineering Handbook, Part 650, Chapter 8, Terraces. Refer to the current NRCS accepted erosion prediction software and user guide to determine soil loss. Refer to the Engineering Field Handbook, Chapter 8, Terraces for use of the Horizontal Interval Equation.

Terraces shall not exceed the spacing as determined by the methods shown in the Nebraska Supplement to the NEH, Part 650, Chapter 8.

The drainage area above the top terrace, shall not exceed the area that would be drained by a terrace of equal length with normal spacing.

Drainage area for design of non-parallel terraces will be determined based on actual location of any upstream terraces. Calculation of drainage area by applying the allowable spacing to the terrace length is not allowed.

Alignment. To accommodate farm machinery and farming operations, design cropland terraces with long gentle curves. When multiple terraces are used in a field, design the terraces to be as parallel to one another as practicable.

Capacity. Design terraces to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terrace systems designed to control excess runoff or to function with other structures, choose a larger design storm that is appropriate to the risk associated with the installation. For terraces with

underground outlets, the combination of storage and out flow through the underground outlet can be used to design the required storage capacity. The storage capacity of terraces must be increased by the estimated 10-year sediment accumulation, unless the Operation and Maintenance Plan specifically addresses the annual removal of sediment.

Use bare earth channel for crop fields, or the appropriate vegetative cover for permanently vegetated channels, to determine terrace capacity. For bare earth channels a Manning's n value for the expected conditions should be used, but shall not be less than 0.035 to calculate capacity. For permanently vegetated channels refer to Conservation Practice Standard (412), Grassed Waterway for design criteria to determine capacity.

Design level terraces to contain the runoff from a 10-year 24-hour rainfall event. Storage volume should also include the expected 10-year sediment accumulation, unless the Operation and Maintenance Plan specifically addresses the annual removal of sediment.

Terrace cross section. Proportion the terrace cross section to fit the land slope, the crops grown, and the farm machinery used. Add ridge height if necessary to provide for channel sediment deposits, ridge erosion, the effect of normal tillage operations, or safety. The ridge shall have a minimum width of 3 feet (measured from channel bottom to 3 foot wide ridge) at the design height.

The minimum design heights for gradient and non-storage portions of all terraces, which include overfill for settlement, are:

- Broadbase 1.3 ft
- Steep Backslope 1.3 ft
- Steep Frontslope 1.3 ft
- Narrow Base 1.7 ft

The minimum design height in the storage portion of all terraces listed above shall be increased 0.4 feet (to provide freeboard) above the design storm storage. The minimum design height for level terraces shall be 1.6 feet, which includes settlement and freeboard. All farmable terrace slopes shall be no steeper than that on which farm equipment can be operated safely, which is generally 5H:1V.

Non-farmable terrace slopes shall not be steeper than 2H:1V unless an analysis of site specific soil conditions indicate that steeper slopes will be stable.

Borrow to construct embankments for Steep Frontslope, Steep Backslope, and Narrow Base terraces shall be obtained downslope from the terrace.

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

End closures less than or equal to half the effective height of the terrace ridge are considered partial closures while those greater than half the height are considered complete closures. The cross-sectional area of the end closure fill may be less than the terrace cross section, but shall have a top width and side slopes that prevent destruction of the closure during normal tillage operations. For level terraces with end closures lower than the terrace ridge elevation, areas receiving overflow must provide a stable outlet for expected flows.

Channel grade. Design the terrace channel to be stable with non-erosive velocities but with sufficient grade to prevent undesired ponding in the terrace channel.

For cultivated terraces, base the channel stability on a bare earth condition. The maximum velocity for very erosion resistant and erosion resistant soils is 2.5 ft/s; for erodible soils , 2.0 ft/s; and for easily erodible soils , 1.5 ft/s. If Manning's equation is used to compute velocity, use a maximum n value of 0.035 to determine velocity for channel stability.

For permanently vegetated channels, base the channel stability on the appropriate vegetation. Refer to Conservation Practice Standard 412, Grassed Waterway for design criteria to determine stability.

Channel grades may be increased in the first 300' of the upper reaches to improve alignment. For terraces with an underground

outlet, channel grades can be increased for short distances within the impoundment area.

Level terrace length. The volume of water stored in level terraces is proportional to the length. To reduce the potential risk from failure, level terraces should not exceed 3,500 feet unless the channel is blocked at intervals not exceeding 3,500 feet. Blocks should be placed to provide generally equal terrace lengths along the alignment.

Outlets. All terraces must have adequate outlets to convey runoff water to a point where it will not cause damage. For terraces with open outlets, the capacity of the outlet must equal or exceed the capacity of the channel.

Vegetated outlets are suitable for gradient or open-end level terraces. Grassed waterways or naturally vegetated drainage ways may be used as a vegetated outlet. Install and stabilize grassed waterways prior to the construction of the terrace so that the terrace will have a stable outlet when it is constructed. The capacity of the vegetated outlet must be large enough so that the water surface in the outlet is below the water surface in the terrace at the design flow.

Underground outlets are suitable on storage or level terraces. The outlet consists of an intake and an underground conduit. Refer to Conservation Practice Standard (620), Underground Outlet for design criteria for the underground outlet.

Design the intake structure for the underground outlet to control the flow out of the terrace and to prevent excessive pressure in the underground conduit. Design the outlet so that the flow release time does not exceed the inundation tolerance of the planned crops. If sediment retention is a primary design goal, adjust the release rate according to sediment particle size. Locate the inlet for the underground outlet to accommodate farming operations and to allow for sediment accumulation.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration rates, under average rainfall conditions, must permit infiltration of the design storm from the terrace channel within the inundation tolerance of the planned crops.

Combinations of different outlet types may be used on the same terrace system to optimize water conservation, improve water quality, accommodate farming operations, or to provide for economical installation.

Vegetation. Stabilize all areas planned for vegetation as soon as possible after construction. Refer to Conservation Practice Standard, 342, Critical Area Planting for seeding criteria.

Additional Criteria Applicable to Retaining Runoff for Moisture Control

For terraces installed to retain 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 key to a successful terrace system is assuring 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 so that they 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 limiting layers to plant growth in the soil profile. 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 slopes on terraces that are permanently vegetated can provide significant 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.

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

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

Inlets for underground outlets can be easily damaged during normal farming operations. Using brightly colored inlets, barriers around the inlet or otherwise clearly marking the inlet will help prevent damage.

For terraces that will be farmed or otherwise vegetated, the stripping and stockpiling of topsoil from the construction area prior to excavation and then spreading the topsoil on the completed terrace will improve the growth of vegetation after construction.

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 shall include:

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

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. The minimum requirements to be addressed in a written operation and maintenance plan are:

1. Periodic inspections, especially immediately following significant runoff events.
2. Prompt repair or replacement of damaged components.
3. Maintenance of terrace ridge height, channel profile, terrace cross-sections and outlet elevations.
4. Removal of sediment that has accumulated in the terrace channel to maintain capacity and grade.
5. Regular cleaning of inlets for underground outlets. Repair or replacement of inlets damaged by farm equipment. Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the terrace channel.
6. Where vegetation is specified, seasonal mowing and control of trees and brush.
7. Notification of hazards about steep slopes on the terrace.

REFERENCES

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

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

Nebraska Supplement to National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 8.