NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

TERRACE

(Ft, m)

CODE 600

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

Retain runoff for moisture conservation

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.

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. Terrace spacing may be determined by using the Revised Universal Soil Loss Equation (RUSLE2) (or other current erosion prediction tools) or by the horizontal interval method.

In no case shall the maximum horizontal spacing exceed that shown in Table 1 for the condition shown. The maximum limits may not be exceeded when making adjustments indicated below.

For all methods, the steepest significant land slope within the terrace interval shall be used to determine the terrace spacing. Figures 1 and 2 show the horizontal interval or erosion length to be used in calculating terrace spacing (figure 3). The interval from the high point of the area to be terraced to the top terrace may be up to one and one-half times the normal interval.

Spacing may be adjusted to provide better alignment, to adjust for farm machinery, or to reach a satisfactory outlet. All adjustments shall be made downward from the allowable soil loss spacing.

The horizontal spacing does not have to be less than 90 feet.

Table 1

Slope	RUSLE, R factor of:		With contour strip-cropping	Concen-trated Flow Control
	0-35	35-175		
%	(Ft)	(Ft)	(Ft)	(Ft)
0 - 2	700	500	600	700
2 -4	700	400	600	700
4 - 6	600	400	600	600
6 - 9	400	300	400	500
9 -12	400	250	250	500
12-18	250	200	150	400
> 18	250	200	150	300

RUSLE2 The spacing must be equal to or less than the maximum slope length that will keep soil loss within allowable limits as determined

by RUSLE2 with planned levels of management. The spacing shall be based upon the most intensive use planned.

Horizontal Interval Method The maximum spacing for terraces for erosion control shall be determined by:

H.I. = (xs + y) (100/s)

Where:

H.I. = horizontal interval in feet

(See Figures 2 and 3)

x = a variable with values from 0.4 to 0.8

s = land slope in percent

y = a variable with values from 1.0 to 4.0

Value of x for South Dakota is 0.8.

Values of y are influenced by soil erodibility, cropping system and crop management practices. A value of 1.0 shall be selected for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.0 shall be used for erosion- resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre) on the surface. A value of 2.5 shall be used if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 and 4.0 may be used according to the estimated quality of the factors.

Table 2 shows typical Y values. Table 3 shows maximum terrace spacing for soil erodibility factors of 0.28-0.64 and typical management systems in eastern South Dakota. Spacings for other soils or management systems must be determined on a case-by-case basis.

For level terraces used for erosion control and water conservation, the spacing shall be determined as previously described, but in no case shall the maximum horizontal spacing exceed 600 ft.

Table 2

Y

Ground Cover	Soil Erodibility Factor (K)		
	0-0.20	0.20-0.28	0.28-0.64
10%	2.5	1.75	1.0
40%	3.25	2.5	1.75
80%	4.0	3.25	2.5

Table 3

Terrace Spacing for K factor 0.28-0.64 (ft)

Field Slope	Ground Cover		
	10%	40%	80%
0-2%	140	170	210
3-4%	110	130	150
5-6%	100	110	125
7-8%	95	105	115
9-10%	90	100	105
11-13%	90	95	100
>13%	90	90	90

Alignment. Cropland terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery.

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 sediment is removed through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have the appropriate design capacity. When the capacity is determined by the formula Q = AV and the V (velocity) is calculated using Manning's formula, a minimum n value of 0.035 shall be used for bare channels. Agricultural Handbook Number 667, Stability Design of Grass-lined Open Channels, or equivalent, shall be used for vegetated channels.

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 three feet at the design elevation. The steepest slope of a vegetated front or back ridge slope is two horizontal:one vertical. Terrace ridges, especially those with steep back slopes, can be very hazardous. All cropped terrace slopes that are to be farmed shall be no steeper than those on which farm equipment can operate safely. Potential hazards must be brought to the attention of the responsible person. 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.

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

Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways;

Maximum channel velocity for cultivated 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. Velocity shall be computed by Manning's formula, using a maximum n value of 0.035;

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 lower reaches of the channel, thus reducing the velocity in those reaches and allowing steeper channel grades within the impoundment area. Minimum grades shall be such that ponding in the channel caused by 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 will control the gradient terrace length.

Outlets. All terraces must have adequate, stable outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or other vegetated area. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets shall be installed and vegetation established before the terrace is constructed to provide a stable outlet. 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, prevent reverse flows at lower inlets, and prevent excessive pressure in the conduit. Terraces shall be designed to control a 10-year frequency, 24-hour storm without overtopping. The release time shall not exceed the inundation tolerance of the planned crops. If sediment retention is desired, adjust release rate according to particle size.

The underground conduit shall meet the requirements specified for Underground Outlets (620) or Subsurface Drains (606). Conduits must be installed deep enough to prevent damage from tillage equipment. The inlet shall consist of a vertical perforated pipe or other structure 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. 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.

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 crops.

Combinations of different types of outlets may be used on the same system to maximize water conservation, to affect water quality, 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.

Drainage. Install subsurface drainage to stabilize terrace where needed. It shall be designed taking into consideration the effect of snowcatch and melt on water budget components.

Additional Criteria Applicable To Retaining Runoff For Moisture Control

Terrace capacity shall be designed in accordance with a water budget analysis.

CONSIDERATIONS

Consider adjusting the spacing to allow an even number of trips with the equipment.

The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be considered when determining the terrace interval. For example, use the proposed as-built slope and length in RUSLE calculations.

Consider aligning terraces and/or installing subsurface drainage to correct seepage problems.

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.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for the operator.

The minimum requirements to be addressed in the O&M plan are:

Provide periodic inspections, especially immediately following runoff events;

Promptly repair or replace damaged components as necessary;

Maintain terrace ridge height and outlet elevations;

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;

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;

Vegetation, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means;

Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

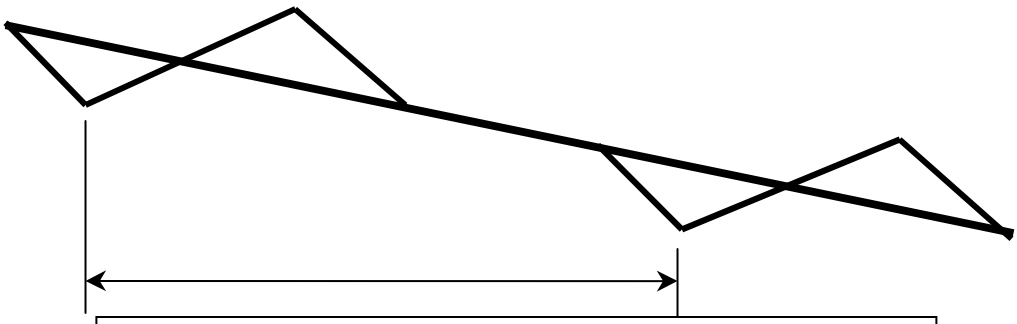

Figure 1. Horizontal Interval for Broad-Base Terraces

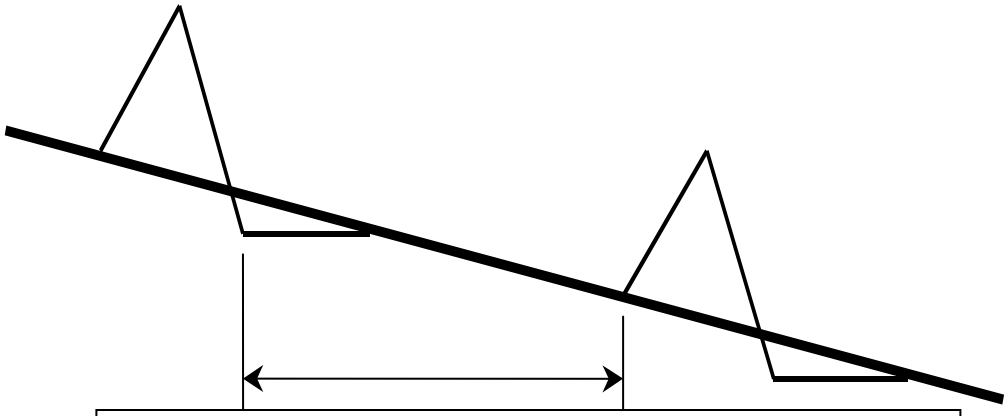

Figure 2. Horizontal Interval for Steep Back-Slope Terrace

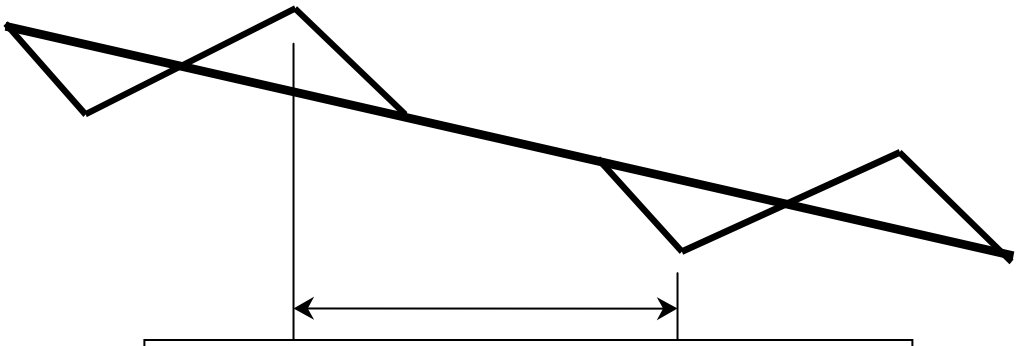

Figure 3. Terrace Spacing