DOCUMENTATION REQUIREMENTS
Terrace - 600

I. Reference Materials

The following is a list of reference materials to be used in terrace design and construction.

a. Engineering Field Manual - Chapter Eight
b. Supplement to Engineering Field Manual - Chapter Two
c. King's Handbook showing use of Manning's Formula
d. Section IV Technical Guide, Practice Standard 600, Terrace
e. Hydrology Manual for North Dakota
f. County Soil Survey Report
g. North Dakota Construction and Material Specifications for Conservation Practices
h. Section I-C Technical Guide (USLE, RUSLE) and (NRCS-Soils-Form 5)
i. Suitable Computer Software:

Hydraulics (e.g. Ohio Program)
Watershed Hydrology (e.g. EFM2, EFH2, TR55)
Excel Spreadsheet Hydrology (e.g. ND-ENG-12e)
Excel Spreadsheet Yardage (e.g. ND-ENG-1e)
Design (e.g. MO Terraces - as applicable)

II. Site Investigation/Data Collection

The following is a list of items to be checked in the field:

a. Determine engineering job class.
b. With the landowners, discuss present and future farming operations to determine type of terrace, cross section, slopes, and spacing
c. Check for buried utilities – North Dakota ONE-CALL
d. Adaptability of site (i.e. level, gradient, parallel)
e. Suitable outlet, existing or to be constructed (natural, grassed, tile)
f. Soils
g. General land slopes
h. Maintenance requirements

III. Design Surveys

1. Select approximate terrace spacing and grade. Survey terrace lines as needed to determine stable outlet grade. Approximate terrace length can be obtained.
2. Design surveys of most terraces that are not complex are usually combined with layout survey.
3. Parallel terracing on complex layouts will require a topographic map of the area. Parallel terrace systems that require little cut and fill can be designed and laid out in one operation.
4. The design survey shall be recorded on field notes. The field notes shall show a good location sketch, with each terrace identified and numbered. Provide enough survey data in the field so that ND-ENG-3, 4, or 5, can be completed (Terrace Data Sheets). ND-ENG-2 can be used in place of field notes.

IV. Design Plans and Specifications

The steps in design are as follows:

1. Following Standard and Specification 600 - Terrace, Section IV, Technical Guide, determine:
   a. Soil series and type to determine "K"
      (1) Soil Survey Report
      (2) NRCS
   b. Slope used to help determine spacing
   c. Spacing (Vertical Interval Method or USLE, RUSLE)
      (1) Engineering Field Manual - Chapter 8
      (2) Section I - C Technical Guide
      (3) The percent ground cover can be figured from Tables 1, 2, and 3

The amount of residue actually produced by a copy is influenced by the growing season, variety, fertilizer program, and other factors. Table 1 gives the average residue produced by common North Dakota crops.

TABLE 1

Crop	Unit	Lbs. Residue Per Unit
Rye	Bu.	120
Spring wheat, durum, winter wheat	Bu.	100
Barley, flax, buckwheat, millet, mustard, rapeseed, safflower	Bu.	80
Corn, grain sorghum	Bu.	60
Oats, soybeans	Bu.	50
Sunflowers	Lb.	1.5
Corn and/or sorghum silage	each inch of stubble height per 10,000 plants	50

Example: A 30 bu. per acre crop of spring wheat produces 3,000 lbs. of residue per acre

Tillage implements vary greatly in how much residue they bury. Table 2 gives a comparison of commonly used machines, and how much residue can be expected to be left after each operation.

TABLE 2

Operation	Approximate Residue Left After Each Operation
Spraying (for chemical fallow)	100%
Undercutters, sweeps 24", or wider	90%
Cultivators, 14"-22" wide w/low crown shovels	85%
Cultivator with 8" - 12" shovels, rodweeder with shovels	80%
Chisel plow	
Straight points	75%
Twisted points	50%
Tandem disc, one-way and offset disc	
3" deep	30%
6" deep	10%
Moldboard plow	10%
Overwinter weathering	70% to 80%

Table 3 shows the percent of ground cover that can be expected from various amounts of small grain, corn, grain sorghum, and sunflower residue.

TABLE 3

	Percent Cover		
Pounds Residue	Small Grain	Corn Grain Sorghum	Sunflowers
200	10%		
400	20%	10%	
600	30%	15%	
800	40%	20%	
1,000	50%	25%	10%
1,500	65%	35%	15%
2,000	75%	50%	20%
2,500	80%	60%	25%
3,000	85%	65%	30%
4,000	85%	75%	40%

Example 1: A small grain field that has 1,000 lbs. per acre residue has 50% ground cover (Table 3)

Example 2: Percent Ground Cover

(a) Spring Wheat

(b) Farm Average = 30 bu. per acre and it produces 100# residue per bu. X 30 bu. per acre = 3000# residue per acre (Table 1).

(c) Three operations using a chisel with straight points 3000* per acre residue. First trip 3000# X 75% = 2250 lbs., second trip chisel with straight points 2250 lbs. X 75% = 1687 lbs., third trip chisel with straight points 1687 lbs. X 75% = 1265 lbs. (Table 2).

(d) Overwinter weathering 1265 lbs. X 80 (Table 2) = 1012 lbs. residue.

(e) Spring wheat rotation with overwinter weathering gives 1012 lbs. residue which equals 50% ground cover (Table 3).

2. Determine 10 year-24 hr. storage or peak discharge for each terrace. Chapter 5 of the North Dakota Hydrology Manual, Chapter 2 of the Engineering Field Manual or Supplement will be used for determining runoff for storage or peak "Q's".
3. For gradient terraces, determine allowable grades or velocities and capacity.
   a. Using Soil Survey Report or SCS-Soils-Form 5 determine "K".
   b. For guidance for allowable velocity, use Manning's equation or SCS-TP-61.
4. Determine the required terrace and outlet dimensions by filling out the appropriate forms: ND-ENG-3, ND-ENG-4, or ND-ENG-5.

V. Material and Construction Requirements

A set of plans and specifications for the terrace construction shall be filed in the cooperator's file. The plans can consist of Form ND-ENG-3, 4, or 5, or appropriate sized sheets. If the project warrants it, two sets of plans and specifications will be given to the cooperator. The cooperator shall provide a set to the contractor.

The plans shall contain, as a minimum, the following:

1. Overall Plan View - May be superimposed on the location map. Show terraces and number them.
2. Cross Sections - Show typical cross sections for each terrace.
3. Construction Notes - Add notes to clarify or furnish direction in construction.
4. Quantities - Estimates
5. Job Approval (NRCS personnel)

Construction specifications shall be provided with each set of plans. The North Dakota Construction and Material Specification for Conservation Practices shall be used for each item of work and material, as applicable or available. Additional specifications may need to be written to provide full material and installation instructions. A cover sheet and list of specifications shall be provided with the specifications.

VI. Layout and Installation Procedures

Layout surveys shall be recorded in loose-leaf or bound survey books. Set necessary centerlines or stakes for alignment, depth, width, and side slopes. Set grade stakes as needed. Survey notes shall be kept in the format as shown in Chapter 1, Engineering Field Manual, and/or Technical Release 62. Electronic survey notes will be documented in a format to allow complete checking by others.

A bench mark shall be established and maintained for storage type terraces with mechanical outlets.

VII. Checkout

1. Make visual inspection of complete system.
2. Compliance checking - record in field notes or ND-ENG-2, 3, 4, or 5.
    a. Survey and record profile (100-foot intervals) of channel and ridge for at least one terrace in each field. Survey and record at least one cross section per 500 feet of channel and ridge for the same terrace. The terrace selected should be one that appears least likely to meet specifications if there is an apparent difference in the size of the terraces.
    b. Land slope and vertical or horizontal interval for the terraces for which profile and cross section notes are recorded.
    c. Check adequacy of outlet protection. Note the number of outlets if mechanical outlets are used.
    d. Record length of each completed terrace. The lengths may be obtained by tape, chain, or wheel and state method of measurement.
    e. In addition to the above minimum requirements for the recorded data, profiles and cross sections on as many terraces or parts of terraces will be checked as needed to determine that all work meets specifications.
    f. Complete Form ND-ENG-2, 3, 4, or 5.
3. The key items to inspect during and after terrace construction are:
    a. Bottom width, depth compliance, side slopes and compaction.
    b. Protection of inlet riser.
    c. Underground outlet needs an animal guard.
    d. If terrace requires seeding, check adequacy of the seed mixture and seeding rates.
4. "As-Built" Plans

    "As-built" plans are a record of constructed facilities. Changes from design are to be superimposed in a different color or 2H pencil on the official file copy of the plans. On the "as-builts" show:

    a. Significant design changes.
    b. Significant changes in linear measurements or cut-fill quantities.
    c. Final quantities.
    d. Identify "as-builts" on plans with construction date, contractor and address.
    e. Statement of compliance on "as-built" - state the construction is complete according to plans and specifications. Date and sign by individual making determination.