**SOUTH
TECHNICAL
SERVICE
CENTER**

Technical Note

Subject: **WATERSHED PLANNING**
Series No.: **1704**
Reference: **Economic Effects Of Land Treatment On Onsite Sheet and Rill Erosion Control**
Date: **June 2,198l**

**SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE**

STSC TECHNICAL NOTE 1704

RE: Economic Evaluation of Onsite Sheet and Rill Erosion Control

An evaluation of all effects (national economic, regional economic, environmental, and social) is required for all measures included in water and related land resource projects planned using the Water Resources Council's "Principles and Standards for Water and Related Land Resources." This includes the economic effects of land treatment measures planned to reduce onsite sheet and rill erosion as well as offsite damages from gully and streambank erosion and resulting sedimentation.

The procedures for evaluating economic benefits from controlling erosion are described in WRC's "Procedures for Evaluation of NED Benefits and Costs in Water Resources Planning (Level C)," Section 713.209.

Existing procedures are adequate for developing necessary physical data needed to economically evaluate streambank and gully erosion as well as benefits from reducing resulting sedimentation. However, procedures have not been developed for obtaining the needed physical data necessary to evaluate the economic effects of reducing sheet and rill erosion. The purpose of this STSC Technical Note is to outline a method of providing such physical data.

Required Physical Data:

Data needed to make an economic evaluation of reducing erosion are: (1) changes in yield, and (2) changes in production inputs. As analysis of changes resulting from reduced erosion is made for without-project conditions and future conditions with alternative plans installed. The economist uses this data to estimate the changes in average net income to a landuser during the period of analysis.

Onsite beneficial economic effects of reducing erosion will be determined by subtracting the change in variable production cost from the change in gross income. These onsite economic impacts will then be added to the offsite economic impacts in order to determine the total beneficial impacts of land treatment.

As pointed out above, erosion affects income by reducing yields and/or increasing production costs.

Erosion affects yields by removing topsoil and reducing the soil's ability to grow plants. The topsoil provides a large part of the nutrients, and water required to grow plants. The impacts of losing topsoil on yield will vary from soil to soil and will be determined by the soil itself along with the amount of topsoil remaining. For example, the loss of 2 inches of topsoil from a soil with a depth of 6 inches will reduce yields more than losing 2 inches from a soil which has a depth of 24 inches.

Erosion affects production costs by increasing energy, labor, equipment costs of land preparation, planting and harvesting, etc. Production costs are also increased by the use of fertilizers, irrigation, etc., to offset the effects of erosion.

Basic Assumptions:

1. Changes in yield and/or production inputs may be determined as a result of physical changes. Since the monetary effects of technology is not known, technology will be considered as constant during the period of analysis.

2. An average level of management shall be used in estimating production inputs and yields for the three erosion phases.

Introduction

Evaluating onsite benefits and costs of conservation measures to control sheet and rill erosion is becoming increasingly important, especially in project type activities. Certain agronomic data re needed to make the evaluation; in most cases these data are not readily available. Seldom does the method used for making resource inventories provide adequate data for making onsite evaluations. The method outlined in this procedure will provide the necessary data to evaluate the onsite effects of alternative resource management systems on soil loss, life of soil resource, crop yield change, change in erosion phase, and cost over time.

The procedure is designed to determine resource conditions by conservation treatment unit (CTU). A conservation treatment unit is a field or group of fields or other units of land with similar soil and water conservation problems requiring similar combinations of land use and conservation treatment. In project activities the procedure is used to determine resource conditions based on a representative sample and expanded to the area. The number of CTU's in the sample will depend on the complexity of the area and the accuracy of the data needed. These data will play a significant role in forcasting future conditions with and without-plan.

The procedure is divided into 3 major parts. Part 1 provides a step by step method for data gathering. Parts 2 and 3 are appendices to Part 1. Appendix 1 contains sample worksheets for data collecting, and Appendix 2 are examples of the completed worksheets in Appendix 1.

Part 1 consists of 4 steps which in a way follows the steps of the planning process. The procedural steps are:

Step 1 - Problem Identification
Step 2 - Inventory, Forecast, and Analysis
Step 3 - Formulation of Resource Management Systems and Costs Estimates
Step 4 - Evaluation of Effects

STEP ONE - Problem Identification

1. Specify the problem and identify the land use where the problem exist. Example: Diminishing yield on eroding cropland.
2. Onsite problem may be identified through existing resource data without detail field studied.

STEP TWO - Inventory, Forecast, and Analysis

1. Make an onsite investigation of a conservation treatment unit (CTU), and gather the following information:
   - Acres in the CTU
   - Land use
   - Existing resource management system
   - Major resource problem
   - Soil series
   - Percent slope
   - Slope length
   - Depth of surface soil
   - Cover, crop sequence, and management
   - Crop yield

2. Using the Universal Soil Loss Equation (A=RKLSCP) calculate soil loss for present conditions.

   A - represents the predicted average annual soil loss, in tons of soil, from one acre of land. This figure is reached by multiplying the factors of the equation.
   R - is the rainfall factor
   K - is the soil erodibility factor
   L - is the length of slope
   S - is the steepness of slope
   C - is the cropping and management factor
   P - is the conservation practice factor

Example:	R	K	LS	C	P	= A
	300	0.43	0.54	.350	1.0	24.38 Tons/Acre

3. Classify unit according to erosion phase. Erosion Phase I, include soils with slight erosion and no mixing of surface soil and subsoil in the plow layer.1/ Erosion Phase II, include those soils that have some mixing of subsoil into the plow layer. These soils are termed moderately eroded. Erosion Phase III, includes severely eroded soils where the plow layer is predominantly subsoil material.

Erosion Phase	Depth of A Horizon
I	> 6"
II	3" to 6"
III	< 3"

   When soil erosion is allowed to continue change in erosion phase occur. A soil with a 7 inch surface layer will change from erosion Phase I, to erosion Phase II, when 1 acre-inch or 158 tons per acre of the surface layer have eroded away. The same soil will change from Phase II to Phase III when 3 inches or 473 tons of the surface layer have been eroded away.

   Using the following equation the required soil loss for change in erosion phases can be calculated: C = rw

   C - represents the tons of soil loss required to change from one erosion phase to another.
   r - is a factor representing 1 acre-inch of the surface layer.2/
   w - is the weight of 1 acre-foot of surface soil

Example:	r	x	w	=	C
	.083	x	1900	=	157.7
			Tons		

1/ The plow layer or soil moved in tillage operations is approximately 6 inches
2/ One-twelth of one foot (1/12 = .083).

4. Forecast the life of the A horizon under present conditions. The life of the A horizon means the years required to erode away the remaining A horizon. The rate of erosion of the A horizon will vary depending on rainfall, slope length, percent slope, soil erodibility, and management. The estimated life of a surface soil is expressed in the following equation:

$$L = \frac{dw}{e}$$

L - is the life of the A horizon in years. This figure is reached by multiplying the depth of the A horizon by the weight of 1 acre foot of soil, and dividing by the average annual soil loss.
d - is the depth of the A horizon (expressed in a percentage based on 12 inche standard).
w - is the weight of 1 acre-foot of surface soil.
e - is the average annual soil loss.

Example:	d	x	w 3/	÷	e	=	L
	0.58		1900 Tons		24.0 Tons		45.9 years (See Figure 1)

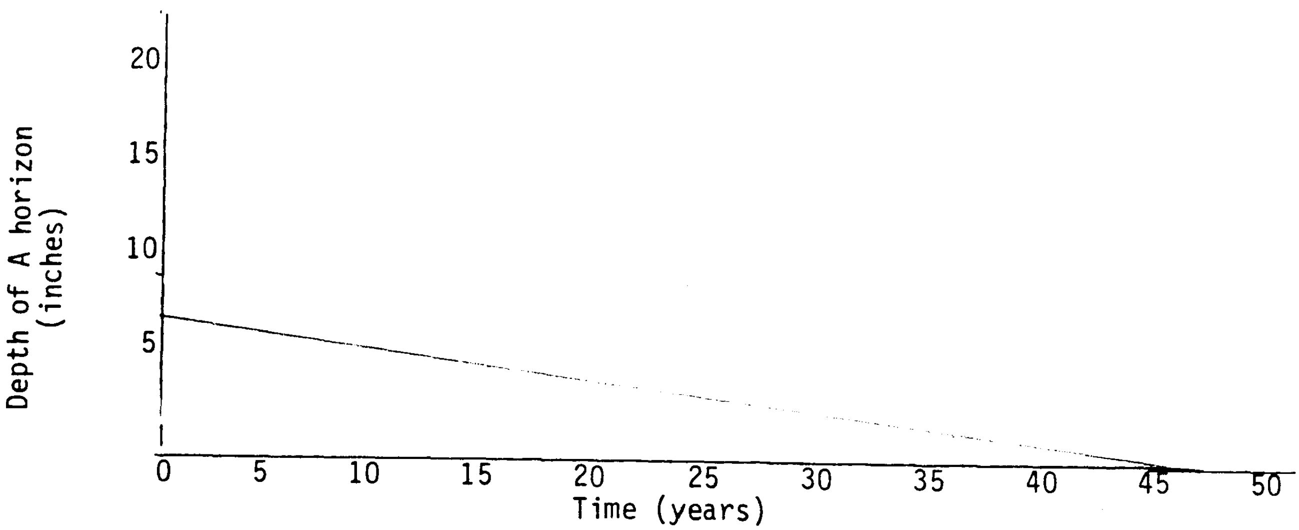

Figure 1. Life of A horizon under present conditions

5. Compute the time period between erosion phases by dividing the acre feet of soil loss required for change in erosion phase by the average annual soil loss. The computation is expressed in this equation, $t = \frac{c}{e}$

t = time (years) required for change in erosion phase
c = soil loss required for change in erosion phase
e = average annual soil loss

Example:	c	÷	e	=	t
	158 Tons		24.0 Tons		6.58 years (See Figure 2)

3/ Soil with a bulk density of 1.4

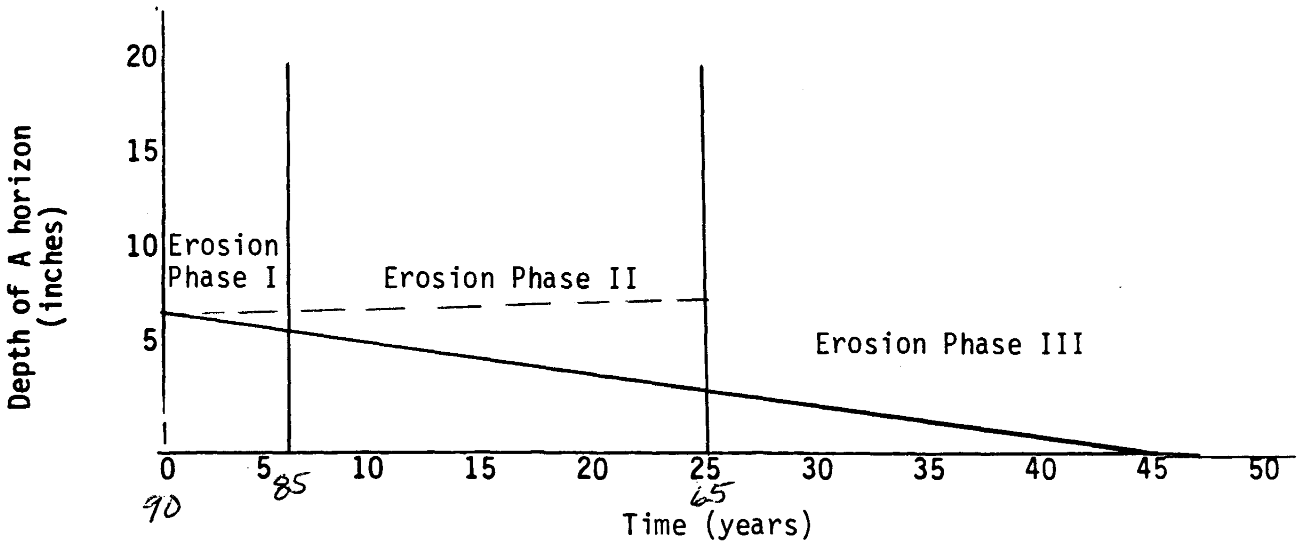

Figure 2. Time between erosion phases.

6. Forecast crop yield for without-project conditions. Where erosion is allowed to continue a regression in erosion phase occurs. As erosion phase regresses crop yields are expected to decrease. To estimate the without-project crop yields it is necessary to establish yields for each erosion phase, time period between erosion phases I and II, II and III, and the average annual soil loss for the unit being studied. Crop yield estimates are established from producers' records, observations, research, soil survey reports, etc., and are verified by producers, community leaders, and Federal, state, and local agricultural agencies.

Example:

Erosion Phase	Crop Yield
I	90 bushels
II	85 bushels
III	65 bushels

Assuming erosion continues at the present rate and all factors of production and technology remain constant, the average annual change in crop yield is estimated by dividing the difference in erosion phase yield by the time required for change in erosion phase. An erosion phase yield difference of 5 bushels over a 6 year period has an annual yield change of 0.83 bushels. (See Figure 3) The computation of yield change is expressed in this equation $y = \frac{D}{t}$

y - represents the expected change in crop yield
D - is the difference in erosion phase yield
t - is the time required for change in erosion phase

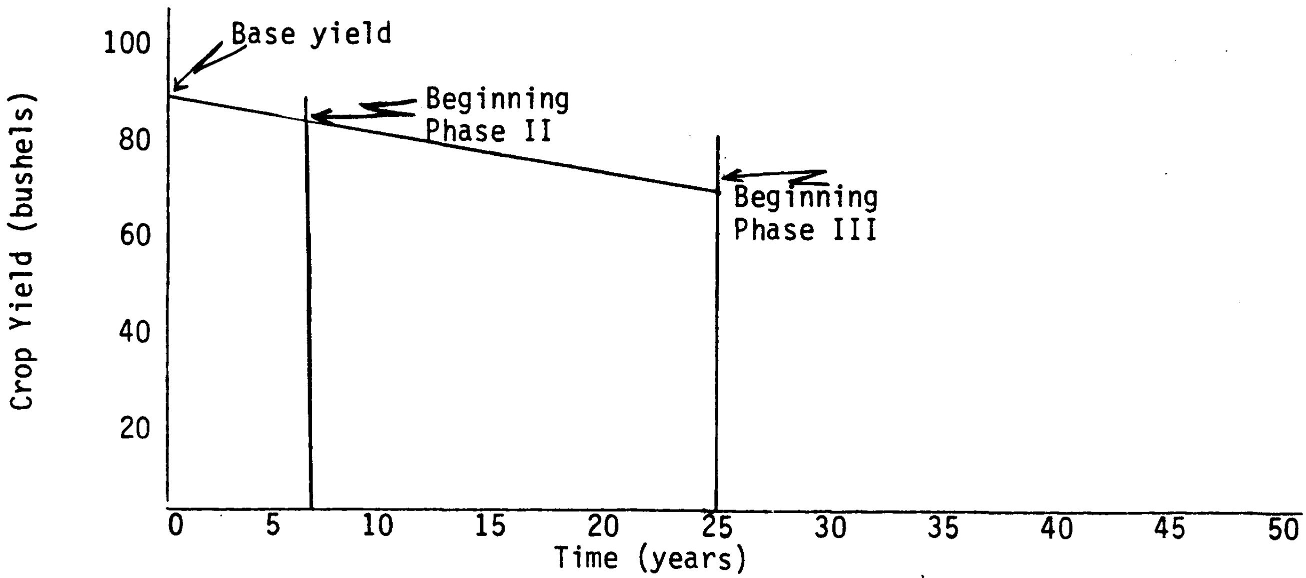

Figure 3. Crop yield by erosion phase over time

7. An interdisciplinary team is responsible for compiling and documenting data required to complete this step. The soil scientist, agronomist, and geologist are the principal team members.

8. Complete Appendix 1, Worksheet 1 and 2.

STEP THREE - Formulate Alternative Resource Management Systems and Make Cost Estimates

1. Resource management system development begins by identifying conservation practices and measures which will be effective in reducing erosion. The process continues with the combining of conservation practices and measures with various cropping-management systems. Develop several alternative systems and calculate their effects on erosion reduction. Systems should be effective in erosion control, acceptable by the land user and implementable.

2. Develop a list of conservation practices and measures used in developing the alternative systems, and estimate average cost for each practice and measure. Average cost is based on actual cost data collected on a representative number of jobs completed within the general area.

3. Field, Area, and Program Service staffs are responsible for compiling and documenting the data in this Step.

4. Complete Appendix 1, Worksheet 3 and 4.

STEP FOUR - Evaluation of Effects

1. Evaluate the effects of each alternative resource management system on soil loss, life of soil resource, crop yield change, change in erosion

phase, and cost. Procedures for making these projections follow procedures presented in preceeding steps.

a. Soil loss - Step 2(2) A = RKLSCP
b. Change in erosion phase - Step 2(3) C = rw
c. Life of soil resource - Step 2(4) $L = \frac{dw}{e}$
d. Time between erosion phase change - Step 2(5) $t = \frac{c}{e}$
e. Crop yield change - Step 2(5) $y = \frac{D}{t}$
f. Cost - Step 3(2)

2. The Planning Staff and Program Service Staff specialists are responsible for completing this Step.

3. Complete Appendix 1, Worksheets 5a and 5b.

Appendix 1
Worksheet 1

RESOURCE INVENTORY

CTU	Soil Series	Acres	Land Use	Slope Length	Present Slope	Cover, Crop, Sequence and Management

RESOURCE INVENTORY AND FORECASTING
(Present Conditions)

CTU	Resource Management System	Soil Loss	Crop Yield	Depth of Surface Soil	Erosion Phase	Life of Soil Resource 1/

1/ Life of soil resource expressed in years.

FORMULATION

CTU	Resource Management Systems	Soil Loss	Costs 1/

1/ Installation costs plus production costs.

AVERAGE COSTS

Conservation Practices and Measures	Unit	Cost per Unit

Appendix 1
Worksheet 5a

EVALUATION OF EFFECTS
(Without-project conditions)

				Change in Erosion Phase				
		Soil	Life of Soil	Time 1/		Crop Yield 2/		
CTU	Resource Management Systems	Loss	Resource	I-II	II-III	I-II	II-III	Costs 1/

1/ Years
2/ Average annual decrease in yield
3/ Production costs plus costs of installing resource management system

Appendix 1
Worksheet 5b

EVALUATION OF EFFECTS
(With-project conditions)

				Change In Erosion Phase				
				Time 1/		Crop Yield 2/		
CTU	Alternative Resource Management Systems	Soil Loss	Life of Soil Resource	I-II	II-III	I-II	II-III	Costs 3/

1/ Years
2/ Average annual decrease in yield
3/ Production costs plus cost of installing resource management system

Appendix 2
Worksheet 1

RESOURCE INVENTORY

CTU	Soil Series	Acres	Land Use	Slope Length	Percent Slope	Cover, Crop, Sequence and Management
1	Lexington	85	Cropland	200	3.0	Corn, Continuous rd. l. without W.C.

RESOURCE INVENTORY AND FORECASTING
(Present Conditions)

CTU	Resource Management System	Soil Loss	Crop Yield	Depth of Surface Soil	Erosion Phase	Life of Soil Resource 1/
1	Corn, continuous, rd. l. without W.C.	24.0	90 bu.	7"	1	42.3

1/ Life of soil resource expressed in years.

FORMULATION

Resource Management Systems	Soil Loss	Costs 1/
Corn, continuous, rd. l., without W.C.	24.4	$181.00
Corn, continuous, rd. l., with late seeded W.C.	23.3	$187.00
Corn, continuous, rd. l., with late seeded W.C., contour, grassed waterway	11.6	$543.00
Corn, continuous, rd. l., with late seeded W.C., terrace, contour, grassed waterway	6.0	$650.00
Corn, rd. l. - corn, rd. l. - M-M (a.lesp) contour, terrace, grassed waterway	4.8	$430.00

1/ Installation costs plus production costs

AVERAGE COSTS

Conservation Practices and Measures	Unit	Cost Per Unit
Conservation tillage system	acre	$18.00
Contour farming	acre	6.00
Cover and green manure crop	acre	6.00
Critical area planting	acre	$375.00
Crop residue use	acre	18.00
Diversion	feet	.80
Fencing	feet	1.20
Field border	feet	.50
Grade Stabilization Structure	number	11,000.00
Grassed waterway or outlet	acre	350.00
Grasses and legumes in rotation	acre	105.00
Land smoothing	acre	135.00
Pasture and hayland planting	acre	105.00
Terrace		125.00
Tree planting	acre	55.00
Waste management system	number	10,000.00
Stripcropping	acre	35.00
Small grain	acre	18.00

Appendix 2
Worksheet 5a

EVALUATION OF EFFECTS
(Without-project conditions)

CTU	Resource Management Systems	Soil Loss	Life of Soil Resource	Change in Erosion Phase: Time 1/ I-II	Change in Erosion Phase: Time 1/ II-III	Change in Erosion Phase: Crop Yield 2/ I-II	Change in Erosion Phase: Crop Yield 2/ II-III	Costs 3/
1	Corn, continuous, rd.l., without W.C.	24.4	42.3	6	19	0.8	1.3	$181.00

1/ Years
2/ Average annual decrease in yield
3/ Production costs plus installation costs

EVALUATION OF EFFECTS
(With-project conditions)

				Change in Erosion Phase				
				Time 1/		Crop Yield 2/		
CTU	Alternative Resource Management Systems	Soil Loss	Life of Soil 1/ Resource	I-II	II-III	I-II	II-III	Costs 3/
1	Corn, rd.1.- corn, rd. 1. - MM, contour, terrace, grassed waterway, grass and legumes in rotation.	4.8	211	30	90	0.2	0.3	$430.00

1/ Years
2/ Average annual decrease in yield
3/ Production costs plus installatin costs