"I brought you into a fertile land to eat its fruit and rich produce. But you came and defiled my land and made my inheritance detestable."

.... **Jeremiah 2:7**
(New International Version, New York International Bible Society, 1978)

Soil & Water Conservation Society of Metro Halifax (`SWCSMH')

(a scientific stakeholder-group)
310-4 Lakefront Road, Dartmouth, NS, Canada B2Y 3C4
Email: limnes@chebucto.ns.ca Tel: (902) 463-7777
Homepage: http://chebucto.ca/Science/SWCS/SWCS.html

Ref.:	wab02-08	(total= 20 pages)
To:	Chairman Wayne Stobo PhD and colleagues Halifax/Halifax County Watershed Advisory Board (WAB), HRM	
From:	S.M. Mandaville B.E., Post-Grad Dip., Professional Lake Manage. Chairman and Scientific Director (and group rep on the WAB)	
Date:	October 04, 2002	
Subject:	**Buffer Strips: two suggestions, A & B**	

Over the last several years, I have noted in person at the board meetings as well as in the minutes that there have been several discussions on buffer strips and that the width should be determined based more on various soil characteristics and slopes rather than on an over-simplified 50-ft or 100-ft or whatever.

There are basically two (2) methodologies described below, A & B; `A' is simple but does take into account soil erodability as well as slope in a general fashion; `B' is based on sound science and needs some calculations. Further, the second one (`B') can utilize formal reports from the Federal-Provincial ¾ million $ (1978 dollars) Shubenacadie-Stewiacke River Basin Board. References are listed as applicable. The fundamentals described below originate with the world-class USDA (United States Dept. of Agriculture) whose reports are used worldwide including in our beloved Canada.

Table of Contents

1 Methodology-A

(The simple methodology)

1.1.1.1.1 Table wab02-08-1: Width of Filter Strip (ft) adjacent to lakes and on both sides of the perennial or intermittent streams with a clearly defined channel. This is a minimum requirement to protect the water resources (US Dept. of Agriculture, SCS, 1976)

Erosion hazard of soil in Filter Strip	Percent Slope						
	0	10	20	30	40	50	60
Slight	30	55	80	105	130	155	180
Moderate	40	75	100	140	170	200	235
Severe	50	90	130	170	210	250	290

This methodology though may not effectively address the significant removal of the post-development human-derived pollutants.

2 Methodology-B

(The more scientific one, the preferable methodology especially in larger areas, e.g., subdivisions)

2.1 Standard Buffer

(US Dept. of Agriculture, SCS, 1977 [Source: Wilson, 1967])

A "Standard Buffer" is defined as a particular length of site capable of trapping 953 kg. of sediment per year:

Buffer (m)=(16.16 + 17.69 Soil-K + 1.34 Slope%) * (31 RCN)/(6900 – 69 RCN)

where Buffer is the slope distance needed for filtering out the sediment, soil-K is the soil erodability index from the USLS equation, and RCN is the Runoff Curve Number from the SCS Engineering Handbook. The ratio of actual buffer distance to the standard buffer distance times 953 kilograms equals the yearly sediment trapped. The relationship of road erosion minus sediment trapped has implications that can be used as a first approximation of some land use effects on water quality.

The values for the various parameters in the equation above are easily ascertained from the following tables, and the soil-K factors have been reported by the Shubenacadie-Stewiacke River Basin Board during the late 1970s. Most of the soils encountered in HRM have been reported by the said Board.

It is important to note that in order to obtain the maximum benefit from buffer strips, concentrated inflows have to be converted to sheet flows through the use of `level spreaders' or other effective ways prior to discharge into the buffer strips.

Note: This buffer may also assist in removing some of the inevitable post-development human-derived pollutants to various degrees if the buffer is properly designed.

2.1.1 Average sheet and rill erosion from rainstorms

(Adapted from Truitt, 1978 [Shubenacadie-Stewiacke River Basin Board])

a) During residential development construction on drumlin topography in the Shubenacadie headwaters region, the range is 88,900 – 103,400 kg/acre/year, depending upon amount of exposed substrate.

b) Average soil loss on actual construction sites (cleared, grubbed and graded roadways and building lots) is in the range of 96,200 – 111,600 kg/acre/year, depending upon amount of exposed substrate.

c) Total soil loss from sheet and rill erosion, including that which result from snowmelt runoff, thaw, and other winter/early spring erosive forces, is perhaps 15% greater than the above estimates.

Subdivision development on previously forested drumlins in the region increases erosion by a factor of approximately 100. This increase is conservatively estimated.

Factors K, LS and C (*cf.* §2.2) are controlled to some extent by the developer's site plan and construction techniques. Depth of cuts and types of fill may alter the K value. LS is affected by grade changes and runoff diversions. If vegetation is left on construction sites, or if cleared areas are mulched during construction, a C factor is introduced which will reduce predicted erosion to a small fraction of the RKLS (bare soil) value (*cf.* §2.2)

2.1.1.1.1 Table wab02-08-2: Summary of curve number (RCN) and impervious percentage by land use (Panuska and Schilling, 1993 [Source: USDA, 1986])

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	**Average % impervious area**	**A**	**B**	**C**	**D**
Grass in good condition (grass cover > 75%)		39	61	74	80
Urban districts					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size					
1/8 acre or less (townhouses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

2.1.1.1.1.1 Hydrologic soil groups (USDA, 1986 [TR 55])

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting:

- Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.30 in/hr).

- Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

- Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

- Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan of clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

2.1.1.1.1.2 Disturbed soil profiles

As a result of urbanization, the soil profile may be considerably altered. In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred:

- A Sand, loamy sand, or sandy loam
- B Silt loam or loam
- C Sandy clay loam
- D Clay loam, silty clay loam, sandy clay, silty clay, or clay

2.1.2 K factor

2.1.2.1.1 Table wab02-08-3: Average values for nomograph parameters and K factor of surface materials (Beke and Webb, 1978 [Shubenacadie-Stewiacke River Basin Board])

Association	Associate	Nomograph Parameters					K factor
		Sand %	Silt %	O.M. %	Structure Rating	Perm Rating	
	moderately well drained						
Halifax	Halifax	31.6	60.1	5.0	3	4	.32
Wolfville	Wolfville	19.2	61.0	6.2	4	6	.38
Gibraltar	Gibraltar	41.0	51.1	5.8	4	6	.40
Cumberland	Cumberland	42.8	44.1	2.6	4	3	.29
Bridgewater	Bridgewater	22.1	61.2	4.6	4	6	.40
Hebert	Hebert	50.2	39.2	3.5	4	2	.22
	imperfectly drained						
Halifax	Danesville	19.4	67.4	5.3	4	5	.42
Queens	Queens	24.8	59.2	4.0	4	6	.42
Wolfville	Hantsport	26.5	59.3	4.7	4	5	.42
Bridgewater	Riverport	25.6	60.8	3.4	4	6	.48
Hebert		45.8	47.3	5.0	4	6	.37
Stewiacke	Stewiacke	32.7	36.0	3.2	4	6	.34
Pugwash	Pugwash	44.9	41.8	3.5	4	6	.33
	poorly drained						
Halifax	Aspotogan	31.2	63.1	3.5	4	6	.47
Wolfville	Mahone	40.0	54.4	4.4	4	6	.42
Bridgewater	Middleton	20.2	67.4	5.1	4	6	.42
Stewiacke	Chaswood	37.2	55.4	1.0	4	6	.56
Cumberland	Chaswood	11.2	58.1	3.3	4	6	.33

2.1.2.1.2 Table wab02-08-4: Average subsurface erodability data (Beke and Webb, 1978 [Shubenacadie-Stewiacke River Basin Board])

Association	Associate	Nomograph Parameters					K factor
		Sand %	Silt %	O.M. %	Structure Rating	Perm Rating	
Halifax		36.8	58.0	.37	4	5	.55
Wolfville		30.1	47.2	.11	4	6	.44
Gibraltar		64.8	31.3	.52	4	6	.38
Cumberland		37.0	52.7	1.16	4	4	.44
Bridgewater		24.6	51.6	.10	4	6	.48
Hebert		80.7	15.4	.30	4	4	.20
Stewiacke		1.1	57.6	.03	4	6	.44
Pugwash		29.4	55.8	0	4	6	.56
Queens		29.2	45.6	.48	4	5	.40

2.2 Prediction of Soil Erosion from Land Development

(Excerpts from Truitt [1978], Shubenacadie-Stewiacke River Basin Board)

The USLE (Universal Soil Loss Equation) predicts long-term average soil losses from sheet and rill erosion under specified land uses. It does not predict soil losses from gully erosion, nor does it predict erosion from runoff that is not directly associated with raindrop impact (such as thaw and snowmelt runoff).The equation does not account for sediment deposition, so the amount of eroded soil that reaches the toe of slopes or the mouth of a drainage area (sediment yield) can only be estimated with a sediment delivery ratio (SDR).

Nevertheless, since we want to simplify the ascertaining of buffer strips around lakes and rivers, the USLE may be sufficient together with the `Standard Buffer' equation in §2.1.

Indeed, in the usual case of a standard small development, it may not even be necessary to calculate the USLE below, just the standard buffer may be sufficient for buffer width computation based on typical sediment yields reported by Truitt, 1978 (§2.1.1).

USLE:

$$A = R\ K\ L\ S\ C\ P$$

where

A	is the soil loss (in tons/acre/year) – or the amount of soil moved from its original position on a slope;
R	Is a measure of the erosive forces of rainfall and runoff;
K	reflects the inherent erodability of the soil;
L and S	are adjustment factors for slope length, steepness, and slope shape;
C	is a soil loss reduction factor for vegetative covers and their residual effects;
P	reflects the benefits of erosion control practices normally associated with agricultural land use (such as contouring and strip cropping).

2.2.1 Application to development sites- general procedure

a) Determine the R factor for the site from an iso-erodent map (§2.2.2).

b) Determine the K factor for each of the site's soil types from a table of area soil K values (Tables wab02-08-3 and wab02-08-4, §2.1.2).

c) Calculate slope gradients (%) and lengths- the LS values (§2.2.3).

   Slope length (L) is the distance from the point of origin of runoff to either the point where the slope gradient decreases sufficiently to cause deposition or the point where runoff enters a well-defined channel.

   If the slope has a uniform gradient, determine the topographic factor (LS) from a table of LS values for uniform slopes (§2.2.3.1).

   If the slope is not uniform i.e., concave, convex or a series of concave, convex and uniform segments, compute LS values for the slope segments or the overall slope profile from one of two methods for calculating the topographic factor for irregular slopes (§2.2.3.2).

d) Determine the C factor for the site's land uses (expressed in terms of the vegetative cover) from tables of C factor values (§2.2.4).

e) Calculate soil loss (A) in tons/acre/year from the product RKLSC.

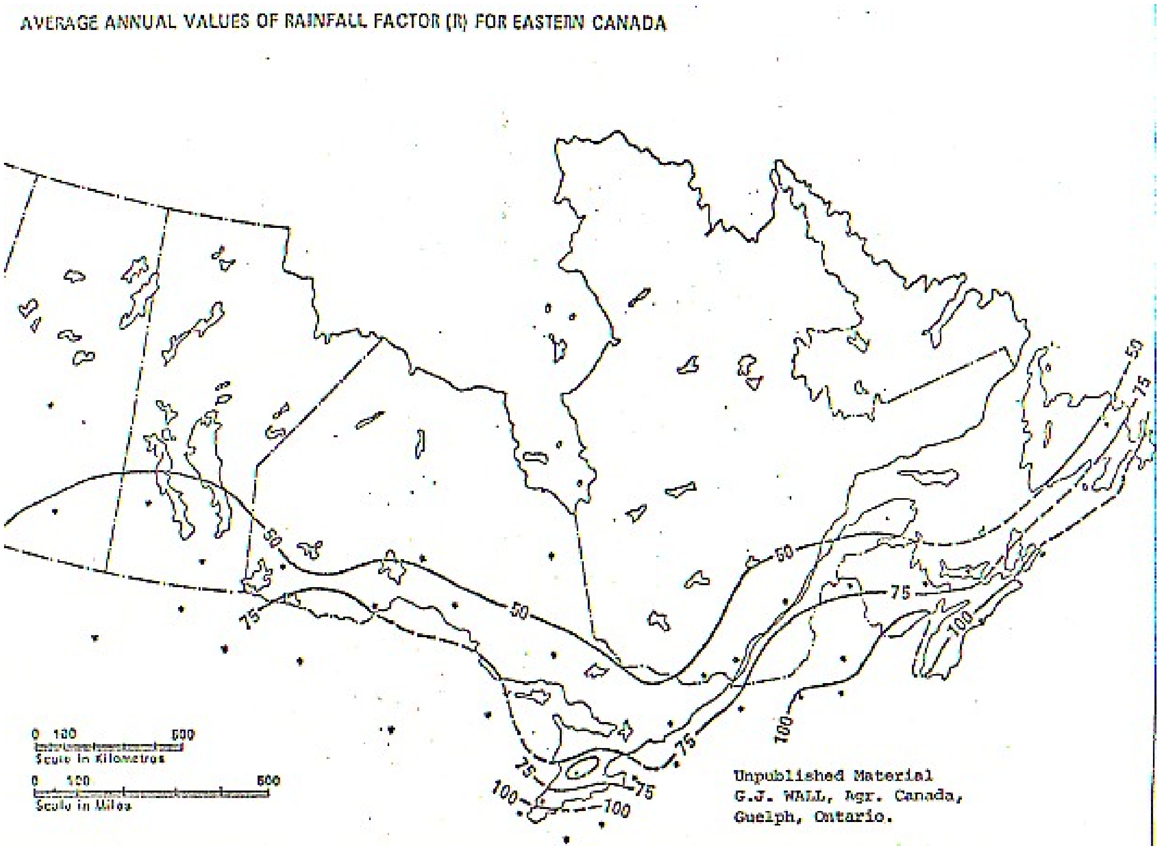
   The P factor is usually not applicable to non-agricultural erosion control practices.

   On portions of the site that have been cleared for construction, soil loss is the product **RKLS.** This erosion can be reduced by a variety of means, and the equation is equipped to quantitatively assess the reduction.

   A soil loss (in tons/acre/year) is then predicted for each area of homogenous RKLSC values. This prediction is then adjusted for area acreage to obtain total soil loss (in tons/year). The totals of all RKLSC areas are summed to calculate annual sheet and rill erosion on the development site.

2.2.2 Rainfall-Erosion Factor (R)

2.2.2.1.1 Figure wab02-08-1: R values (Truitt, 1978 [Shubenacadie-Stewiacke River Basin Board])



The R value in the Shubenacadie headwaters region is 105.

2.2.3 Topographic Factor (LS)

The slope length factor (L) and the slope gradient factor (S) have been evaluated separately in research. In field application, however, it is convenient to consider the two factors as a single topographic factor (LS).

2.2.3.1 Slopes that have a nearly uniform gradient, soil type and cover throughout their length

The LS value for a given combination of length and steepness is given by a published slope-effect chart (Wischmeier and Smith, 1965). Values for selected combinations are given in the table below.

2.2.3.1.1 Table wab02-08-5: LS values for uniform slopes of given lengths and steepness[1] (Truitt, 1978 [Shubenacadie-Stewiacke River Basin Board])

Length	Steepness (%)							
(ft)	2	4	6	8	10	12	16	20
25	0.13	0.23	0.34	0.50	0.69	0.90	1.42	2.04
50	0.16	0.30	0.48	0.70	0.97	1.28	2.01	2.88
75	0.19	0.36	0.58	0.86	1.19	1.56	2.46	3.53
100	0.20	0.40	0.67	0.99	1.37	1.80	2.84	4.08
150	0.23	0.47	0.82	1.21	1.68	2.21	3.48	5.00
200	0.25	0.53	0.95	1.40	1.94	2.55	4.01	5.77
300	0.28	0.62	1.17	1.72	2.37	3.13	4.92	7.07
400	0.31	0.70	1.35	1.98	2.74	3.61	5.68	8.16
500	0.33	0.76	1.50	2.22	3.06	4.04	6.35	9.12
600	0.34	0.82	1.65	2.43	3.36	4.42	6.95	10.00
800	0.38	0.92	1.90	2.81	3.87	5.11	8.03	11.50
1000	0.40	1.01	2.13	3.14	4.33	5.71	8.98	12.90

[1] $LS = (\lambda/72.6)^m (65.41 \sin^2\theta + 4.56 \sin\theta + 0.065)$ where λ = slope length in feet; m = 0.2 for gradients less than 1%, 0.3 for 1 to 3% slopes, 0.4 for 3.5 to 4.5% slopes, 0.5 for 5% slopes and steeper; and θ = angle of slope

2.2.3.2 Evaluating LS for irregular slopes

When a slope steepens or flattens significantly toward the lower end or is composed of a series of convex and concave segments, its overall length and gradient do not correctly indicate the topographic effect of soil loss. Neither can successive slope segments be evaluated as independent slopes when runoff flows from one segment to the next.

There are two methods for evaluating LS for irregular slopes (Wischmeier, 1964; Foster and Wischmeier, 1974).

2.2.3.2.1 First method for evaluating LS for irregular slopes:

The first method requires dividing the slope into equal length segments and multiplying the Table wab02-08-5 value for each segment by an adjustment factor (Table wab02-08-6) which accounts for the position of the segment on the slope. The average of the adjusted segment LS values is then a good estimate of the effective LS values for the slope.

This method assumes that, a) any change in gradient is insufficient to cause upslope deposition, and b) the irregular slope can be divided into a small number of equal-length segments in such a manner that, for practical purposes, the gradient within each segment can be considered uniform.

2.2.3.2.2 Table wab02-08-6: Factors to adjust LS chart values for successive segments of a slope where the slope-length exponent equals 0.5 (Truitt, 1978 [Shubenacadie-Stewiacke River Basin Board])

Segment no. (top to bottom)	Number equal length segments into which the slope is divided for evaluation of LS			
	2	3	4	5
1	0.71	0.58	0.50	0.45
2	1.29	1.06	0.91	0.82
3		1.37	1.18	1.06
4			1.40	1.25
5				1.42

2.2.3.2.3 Second method for evaluating LS for irregular slopes:

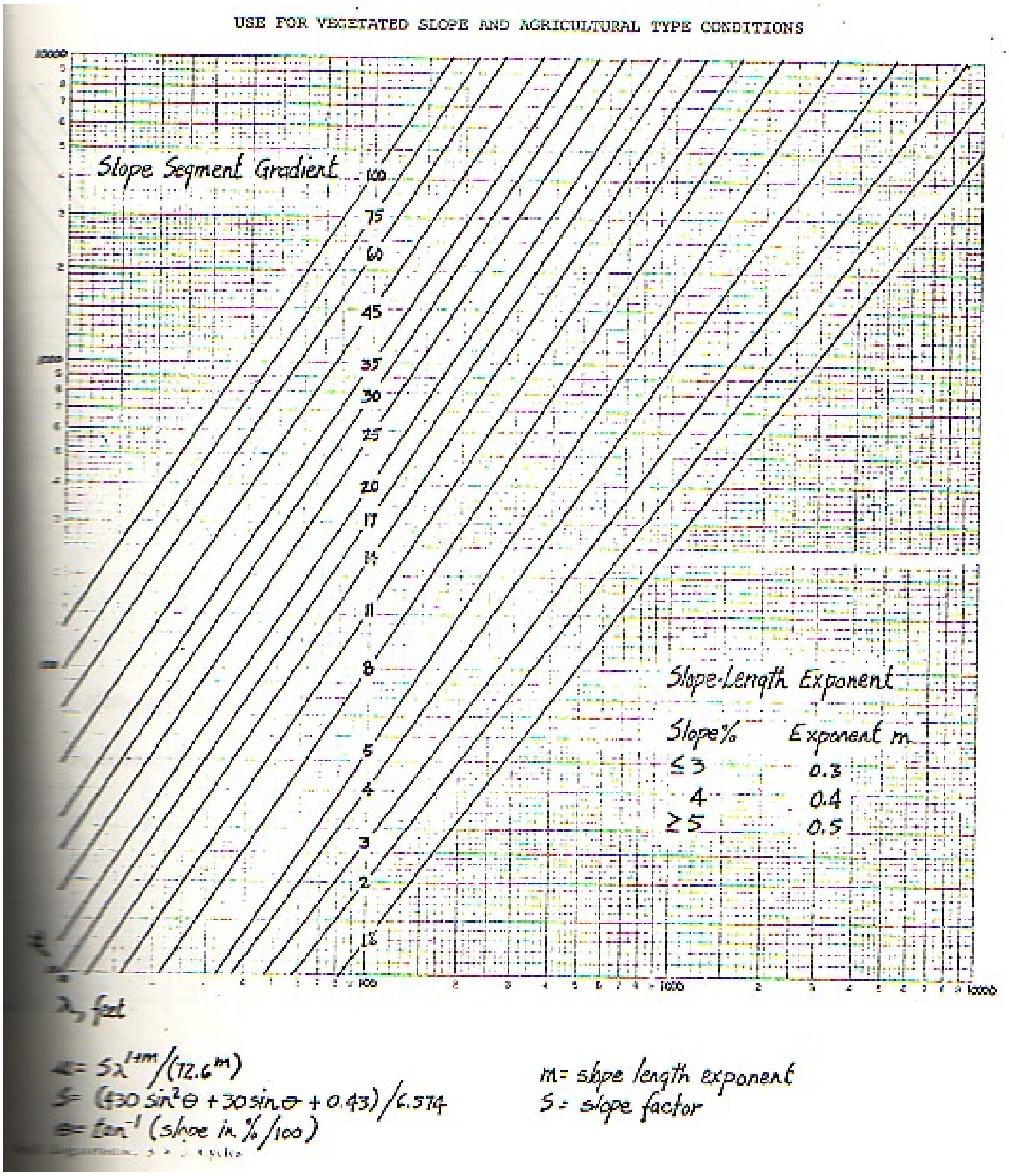
The second method which enables more precise evaluation of LS on irregular slopes requires dividing the slope into a series of n segments, not necessarily of equal length, such that the slope steepness and the soil erodability within each segment can be treated as uniform.

The LS value for each segment is obtained by finding the appropriate μ value (Figures wab02-08-2 and wab02-08-3 below) for λ_j (the distance, in feet, from the top of the slope to the lower end of any segment j), and for λ_j-1 (the slope length above segment j).

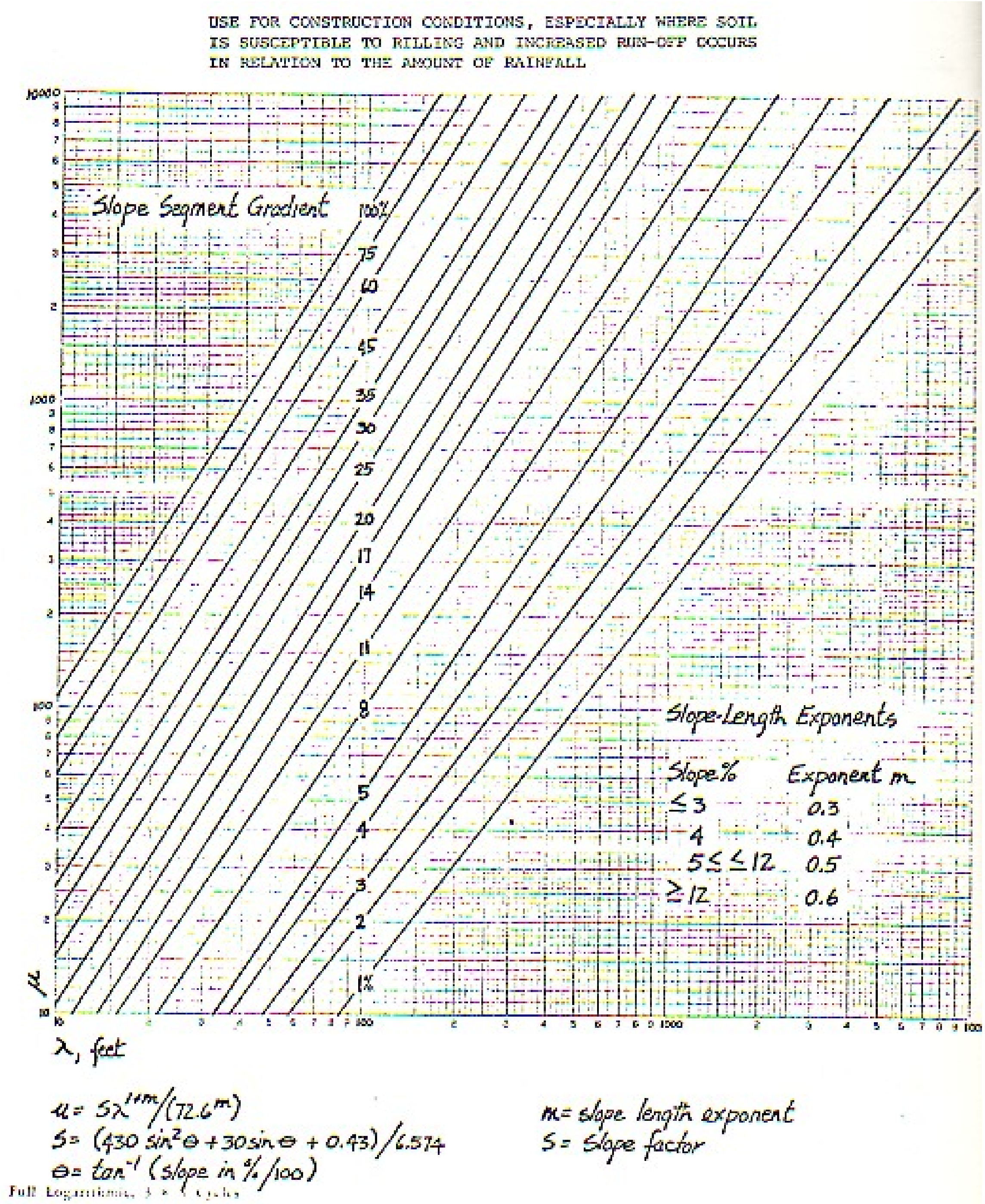
The segment LS is (μ_2-μ_1)/(segment length), where μ_2 is derived from λ_j, and μ_1 is derived from λ_j-1. Figure wab02-08-2 should be used to obtain μ on slopes under agricultural type conditions. Figure wab-02-08-3 should be used for construction conditions, especially where the soil is particularly susceptible to rilling and increased runoff occurs in relation to the amount of rainfall.

The overall slope LS is obtained by dividing the sum of the (μ_{2j}-μ_{1j}) by the total slope length.

2.2.3.2.4 Figure wab02-08-2: Chart for computing μ where maximum slope length exponent = 0.5 (Truitt, 1978 [Shubenacadie-Stewiacke River Basin Board])



2.2.3.2.5 Figure wab02-08-3: Chart for computing μ where maximum slope length exponent = 0.6 (Truitt, 1978 [Shubenacadie-Stewiacke River Basin Board])



2.2.4 Cover Factor (C)

The cover factor is also referred to in agricultural applications as the cropping management factor. The factor C reflects the influence of the type and quality of vegetative cover, mulches, surface soil management, and erosion and sediment control practices. The C values for undisturbed areas are given in Table wab02-08-7, and those for erosion and sediment control practices are given in Table wab02-08-8.

The C value on disturbed (bare soil) portions of a development site is 1.0.

2.2.4.1.1 Table wab02-08-7: C values for permanent pasture, rangeland, and idle land[1] (Truitt, 1978)

Line no.	Type	Effective Height[2]	Percent Cover[3]	Mulch or vegetation at the ground surface: Type[4]	Percent cover at surface: 0	20	40	60	80	95-100
	Column no.	2	3	4	5	6	7	8	9	10
1	None			G	0.45	0.20	0.10	0.042	0.012	0.003
2				W	0.45	0.24	0.15	0.091	0.043	0.011
3	Tall weeds or short brush	0.5m	25	G	0.36	0.17	0.09	0.038	0.013	0.003
4				W	0.36	0.20	0.13	0.083	0.041	0.011
5			50	G	0.26	0.13	0.07	0.035	0.012	0.003
6				W	0.26	0.16	0.11	0.076	0.039	0.011
7			75	G	0.17	0.10	0.06	0.032	0.011	0.003
8				W	0.17	0.12	0.09	0.068	0.038	0.011
9	Brush or bushes	2m	25	G	0.40	0.18	0.09	0.040	0.013	0.003
10				W	0.40	0.22	0.14	0.087	0.042	0.011
11			50	G	0.34	0.16	0.085	0.038	0.012	0.003
12				W	0.34	0.19	0.13	0.082	0.041	0.011
13			75	G	0.28	0.14	0.08	0.036	0.012	0.003
14				W	0.28	0.17	0.12	0.078	0.040	0.011
15	Trees	4m	25	G	0.42	0.19	0.10	0.041	0.013	0.003
16				W	0.42	0.23	0.14	0.089	0.042	0.011
17			50	G	0.39	0.18	0.09	0.040	0.013	0.003
18				W	0.39	0.21	0.14	0.087	0.042	0.011
19			75	G	0.36	0.17	0.09	0.039	0.013	0.003
20				W	0.36	0.20	0.13	0.084	0.041	0.011

1 All values shown assume i) random distribution of mulch or vegetation, and ii) mulch of significant depth where credited.
2 Average fall height of water drops from canopy to soil surface in meters.
3 Percentage of total-area surface that, in a vertical projection, would be hidden from view by the canopy.
4 G—cover at surface is grass or compacted duff; W—cover at surface is weeds or undecayed residue.

2.2.4.1.2 Table wab02-08-8: C values for Erosion and Sediment Control Practices[1] (Truitt, 1978)

NOT SEEDED[2]

Mulch Type	Mulch T/ac	Slope[3] %	C-value	Max. length[4] ft.
1. No mulching or seeding		all	1.00	
2. Straw or hay, tied down by anchoring and tracking equipment, used on slope[5]	1.0	≤ 5	0.20	200
		6-10	0.20	100
	1.5	≤ 5	0.12	300
		6-10	0.12	150
	2.0	≤ 5	0.06	400
		6-10	0.06	200
		11-15	0.07	150
		16-20	0.11	100
		21-25	0.14	75
		26-33	0.17	50
		34-50	0.20	35
3. Crushed stone	135	≤ 15	0.05	200
		16-20	0.05	150
		21-33	0.05	100
		34-50	0.05	75
	240	≤ 20	0.02	300
		21-33	0.02	200
		34-50	0.02	150

SEEDED

Seeding	Mulch	C-values[6] Pd. 1	C-values[6] Pd. 2
Temporary (grain or fast-growing grass)	None	0.70	0.10
	Straw 1 T/ac	0.20	0.07
	Straw 1.5 T/ac	0.12	0.05
	Straw 2 T/ac	[7]	0.05
	Stone 135 T/ac	0.05	0.05
	Stone 240 T/ac	0.02	0.02
	Woodchips 7 T/ac	0.08	0.05
	Woodchips 12 T/ac	0.05	0.02
	Woodchips 25 T/ac	0.02	0.02
Permanent seeding, second year		-	0.01
Sod		0.01	0.01

1. Based on research data and field experience; prepared at a workshop of personnel from USDA Agricultural Research Service, Soil Conservation Service and various Maryland state and local agencies.

2. If seeding is late in Fall, these values would extend until the next Spring.

3. Development on slopes steeper than 50% is not permitted.

(Table continued on next page)

(Table wab02-08-8 continued): C values for Erosion and Sediment Control Practices[1]

NOT SEEDED[2] Mulch Type	T/ac	Slope[3] %	C-value	Max. length[4] ft.
4. Woodchips	7	≤ 15	0.08	75
		16-20	0.08	50
	12	≤ 15	0.05	150
		16-20	0.05	100
		21-33	0.05	75
	25	≤ 15	0.02	200
		16-20	0.02	150
		21-33	0.02	100
		34-50	0.02	75

SEEDED Seeding	Mulch	C-values[6] Pd. 1	Pd. 2

4. Maximum length of slope for which mulch application is permitted. If exceeded, a greater application rate is required or the slope shall be shortened with benches, diversions, etc.

5. If the straw is not anchored to the soil, rilling may occur beneath the mulch. C values on moderate or steep slopes of soils having a K-value greater than 0.30 should then be taken at double the values shown in the table.

6. The two periods are defined as follows:
Pd. 1: Through first 6 weeks of growing period,
Pd. 2: After 6 weeks of growth.

7. Use values for no seeding for appropriate slope steepness.

Other mulch materials for which C values were not available (Truitt, 1978) include:

- asphalt emulsion	600-1200 gal/acre (more or less may be required depending upon slope gradient and length)
- cornstalks, chopped or shredded	4-6 tons/acre “ “
- pine straw or needles	2 tons/acre “ “
- wood excelsior (green or air-dried burred wood fibers – 3”)	2 tons/acre “ “
- wood fiber cellulose (partly digested wood fibers – air-dried)	1-2 tons/acre “ “
- twisted Kraft paper yarn	
- jute, twisted yarn	
- excelsior wood fiber mats	
- glass fiber	

3 References cited and additional ones

Foster, G.R., and Wischmeier, W.H. 1974. Evaluating irregular slopes for soil loss prediction. Trans. ASAE. 17(2):305-309.

Holdren, C., Jones, W., and Taggart, J. 2001. Managing Lakes and Reservoirs. N. Am. Lake Manage. Soc. and Terrene Inst., in coop. with Off. Water Assess. Watershed Prot. Div. U.S. Environ. Prot. Agency, Madison, WI. xiv, 382 p.

Mandaville, S.M. 2000. Limnology- Eutrophication and Chemistry, Carrying Capacities, Loadings, Benthic Ecology, and Comparative Data. Project F-1, Soil & Water Conservation Society of Metro Halifax. xviii, Synopses 1, 2, 3, 13, and 14. 210p.

Panuska, J.C., and Schilling, J.G. 1993. Consequences of Selecting Incorrect Hydrologic Parameters When Using the Walker Pond Size and P8 Urban Catchment Models. Lake and Reserv. Manage. 8(1):73-76.

Truitt, P.G. 1978. Prediction and control of soil erosion from land development. Tech. Rpt. #5, Shubenacadie-Stewiacke River Basin Board. iv, 70, ill.

US Dept. of Agriculture, SCS. 1976. Erosion Prevention and Control. Sec. 2482, Title 2400 of the Forest Service Manual, Supp. No. 22.

US Dept. of Agriculture, SCS. 1977. Handout on Erosion Control. Env. Servs. Div.

US Dept. of Agriculture, SCS. 1986. Urban hydrology for small watersheds- Technical Release No. 55 (Sec. Ed.). 160p.

USEPA. 1976. Areawide assessment procedures manual. Vols I-III. Municipal Environ. Res. Lab., Cincinnati, Ohio. EPA-600/9-76-014.

Wilson, L.G. 1967. Sediment Removal from Flood Water by Grass Filtration. Tans. ASAE.

Wischmeier, W.H. 1964. New developments in estimating water erosion. Proc. 29th Annual Meeting, Soil Conserv. Soc. Am., Ankeny, IA.

Wischmeier, W.H. 1976. Use and misuse of the Universal Soil Loss Equation. J. Soil and Water Cons. 31:5-9.

Wischmeier, W.H., and Smith, D.D. 1965. Predicting Rainfall-Erosion losses from cropland east of the Rocky Mountains. Agr. Handbook No. 282, US Dept. Ag., Washington, DC.