Erosion and Sediment Control Design:

Session 1 - Site Planning and Soil Loss Prediction

ENVIRONMENTAL, STORMWATER, AND RIGHT-OF-WAY TRAINING

DECEMBER 10, 2014

Data Collection and Analysis

Facility Planning & Design

Planning/Design Erosion/Sediment Controls

Types, placement, sizing

Data Collection and Analysis

- Topography
- Soils
- Drainage
- Ground Cover
- Adjacent Areas

Facility Planning & Design

- Determine limitations of project and site
- Confine construction activities to least critical areas when possible
- Minimize impervious areas
- Utilize natural drainage systems

Planning/Design Erosion/Sediment Controls

Types, placement, sizing

- Divide the site into drainage areas
- Determine limits of clearing and grading
- Select erosion and sediment control measures

Site planning

Construction site evaluations:

- Construction phases and timing
- Soils on the site
- Changes to slope gradients and lengths
- Cover conditions

It is often necessary to divide the site up into smaller, more uniform pieces

CAMPUS DRIVE

Soil loss prediction

Knowledge of potential erosion problems on a construction site is a valuable asset for proper planning and design

- An estimate of soil loss due to erosion can help plan and design control measures

Soil loss prediction

One of the first models to see widespread usage was the Universal Soil Loss Equation (*USLE*)

- First published in 1965
- Data from 10,000 test plots throughout the United States

The USLE model was modified in 1975 to create the Modified Universal Soil Loss Equation (*MUSLE*)

Soil loss prediction

One of the most common ways to estimate the amount of soil loss on a construction site is by using the Revised Universal Soil Loss Equation (*RUSLE*)

- Released in 1997
- Uses same factors as *USLE*

Soil loss prediction

The *RUSLE* calculates the rate of erosion per unit area *(A)*:

$$A = (R)(K)(LS)(C)(P)$$

Based on five factors:

- Rainfall energy *(R)*
- Soil erodibility *(K)*
- Land slope and length *(LS)*
- Degree of soil cover *(C)*
- Conservation practices *(P)*

Soil loss prediction

Rainfall energy factor is based on relationship between rain energy and erosion yield

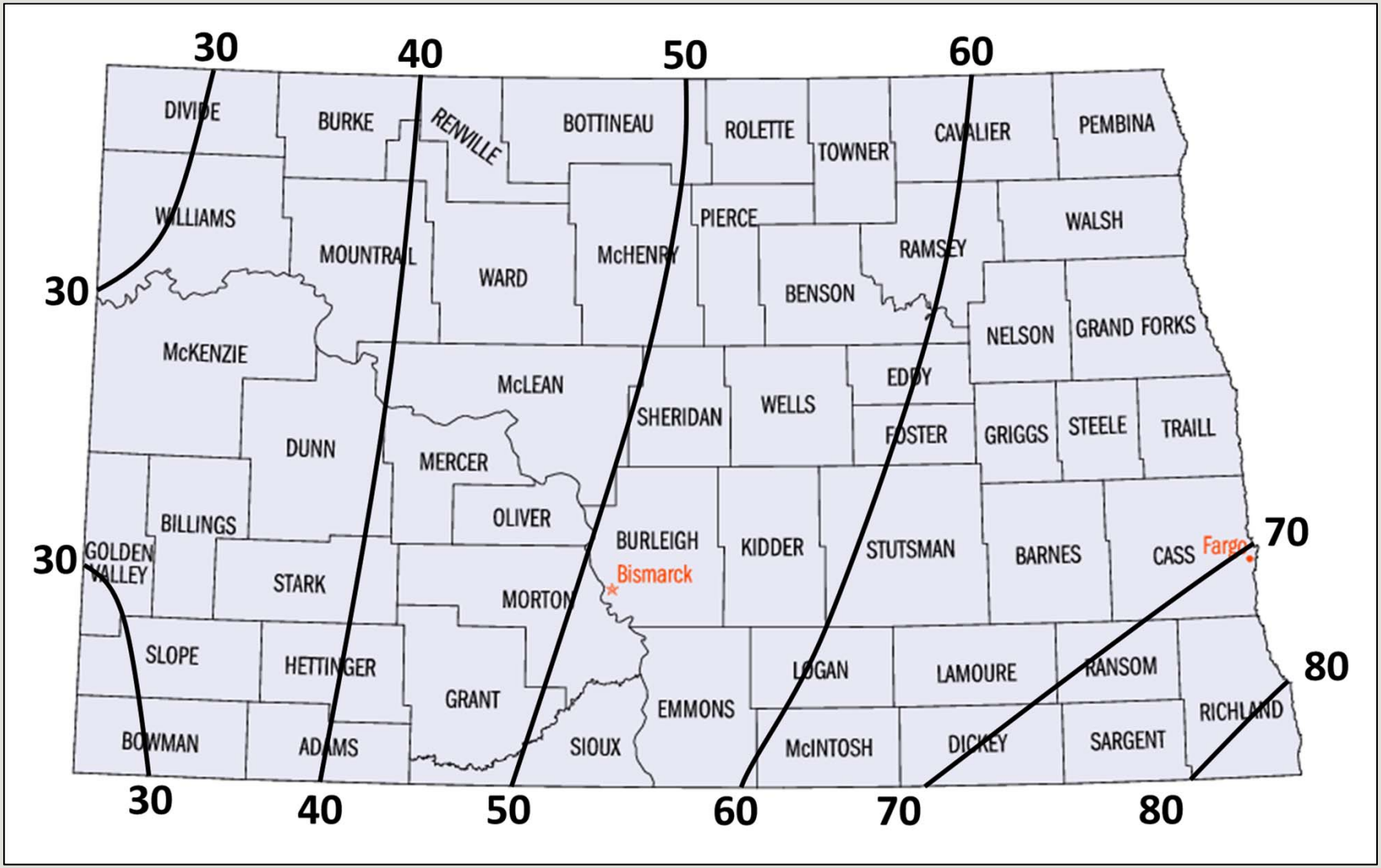
Annual *R* values can be obtained from an isoerodent map

- *R* values should be adjusted based on the period construction is taking place

Monthly distribution of the Erosivity Index (EI) for North Dakota	
Month	**Percentage**
January	0.00
February	0.00
March	0.00
April	0.02
May	0.04
June	0.17
July	0.26
August	0.28
September	0.18
October	0.04
November	0.01
December	0.00
TOTALS	100%

North Dakota Isoerodent Map

Annual *R* Values (EPA 2001)



Soil loss prediction

The *K* factor is the soil erodibility factor

- Function of susceptibility of the soil to erode and the rate of runoff

Important characteristics of soil resistance to erodibility:

- Soil type (i.e. silt loam)
- Particle size and texture
- Organic content

Soil loss prediction

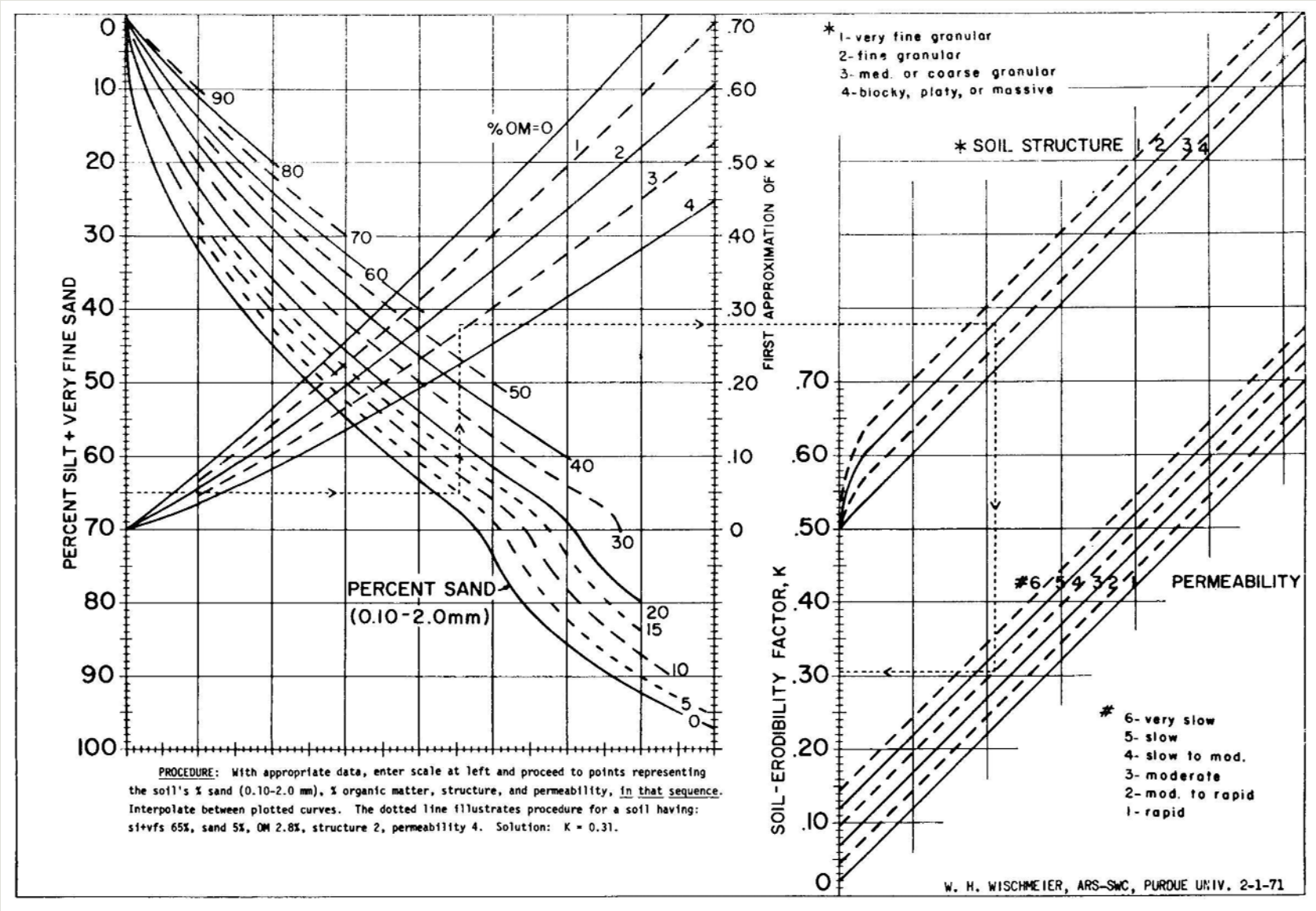
Soils high in clay typically have lower *K* values

- Range between 0.05 to 0.15

Coarse textured soils, such as sandy soils, typically have low *K* values because of higher infiltration rates

Soils with high silt contents are the most erodible with *K* values greater than 0.4

High organic matter reduces erodibility



Source: Wischmeier, W. H., Johnson, C.B., and Cross, B.V. (1971). A soil credibility nomograph for farmland and construction sites. J. of Soil Water Conservation 26:189-193.

Soil loss prediction

Another method is using the Web Soil Survey on the USDA Natural Resources Conservation Services (NRCS) website

- Area of interest
- Soil maps
- % clays, silt, and sand
- *K* factor for different depths

Web Soil Survey - Home | Web Soil Survey

websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

All Layers (Weighted Average)

View Description | View Rating

- T Factor
- Wind Erodibility Group
- Wind Erodibility Index

Soil Physical Properties

Soil Qualities and Features

Water Features

Tables — K Factor, Whole Soil — Summary By Map Unit

Summary by Map Unit — Stark County, North Dakota (ND089)

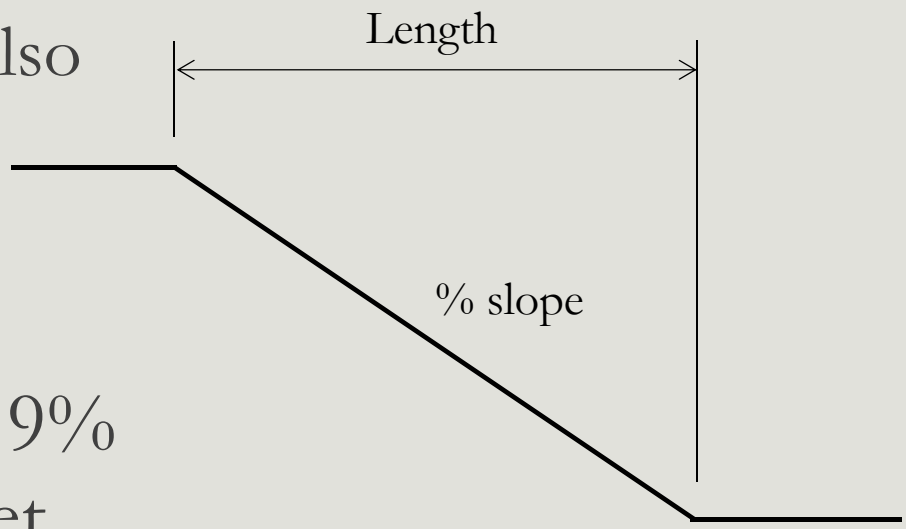
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
E0415A	Belfield-Daglum complex, 0 to 2 percent slopes	.37	20.1	0.9%
E0454B	Daglum-Rhoades complex, 0 to 6 percent slopes	.37	47.1	2.1%
E0515B	Rhoades-Daglum complex, 0 to 6 percent slopes	.37	27.0	1.2%
E0605A	Belfield-Grail clay loams, 0 to 2 percent slopes	.24	31.8	1.4%
E0617B	Belfield-Savage-Daglum complex, 2 to 6 percent slopes	.28	4.0	0.2%
E0651A	Regent-Janesburg complex, 0 to 3 percent slopes	.32	46.6	2.1%
E0651B	Regent-Janesburg complex, 3 to 6 percent slopes	.32	121.3	5.4%
E0651C	Regent-Janesburg complex, 6 to 9 percent slopes	.32	7.6	0.3%
E0701F	Dogtooth-Janesburg-Cabba complex, 6 to 35 percent slopes	.43	29.8	1.3%
E0727B	Barkof-Janesburg complex, 3 to 6 percent slopes	.24	31.6	1.4%
E0811A	Grail silty clay loam, 0 to 2 percent slopes	.32	12.4	0.6%
E0821A	Lawther silty clay, 0 to 2 percent slopes	.28	6.4	0.3%
E1009B	Moreau-Barkof silty clays, 3 to 6 percent slopes	.24	25.1	1.1%
E1025A	Regent-Savage silty clay loams, 0 to 3 percent slopes	.32	8.2	0.4%
E1333C	Vebar-Cohagen fine sandy loams, 6 to 9 percent slopes	.15	27.1	1.2%
E1355D	Vebar-Flasher-Tally complex, 9 to 15 percent slopes	.15	164.6	7.3%
E1423F	Flasher-Vebar-Parshall complex, 9 to 35 percent slopes	.20	7.4	0.3%
E1625A	Vebar-Parshall fine sandy loams, 0 to 3 percent slopes	.15	9.5	0.4%
E1625B	Vebar-Parshall fine sandy loams, 3 to 6 percent slopes	.15	492.9	22.0%
E1635C	Vebar-Tally fine sandy loams, 6 to 9 percent slopes	.15	59.4	2.6%
E1805B	Lihen-Parshall complex, 0 to 6 percent slopes	.17	21.3	0.9%
E1823A	Parshall fine sandy loam, 0 to 2 percent slopes	.17	21.7	1.0%
E2107A	Arnegard loam, 0 to 2 percent slopes	.24	44.0	2.0%
E2120A	Farnuf loam, 0 to 2 percent slopes	.24	60.5	2.7%
E2120B	Farnuf loam, 2 to 6 percent slopes	.24	25.2	1.1%
E2145A	Shambo loam, 0 to 2 percent slopes	.24	47.9	2.1%
E2439B	Sen-Janesburg silt loams, 3 to 6 percent slopes	.32	33.9	1.5%

12:43 PM
8/4/2014

Soil loss prediction

The erosion of soil from a slope increases with slope length

- Increase in % slope also increases erosion potential



An *LS* factor of 1 represents a slope of 9% and a length of 73 feet

LS factors for construction sites and other highly disturbed soils (little to no cover)																	
	Slope Length (ft)																
Slope (%)	**< 3**	**6**	**9**	**12**	**15**	**25**	**50**	**75**	**100**	**150**	**200**	**250**	**300**	**400**	**600**	**800**	**1000**
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.5	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.12	0.12	0.13
1.0	0.09	0.09	0.09	0.09	0.09	0.10	0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.22	0.24	0.26	0.27
2.0	0.13	0.13	0.13	0.13	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.40	0.43	0.48	0.56	0.63	0.69
3.0	0.17	0.17	0.17	0.17	0.17	0.21	0.30	0.36	0.41	0.50	0.57	0.64	0.69	0.80	0.96	1.10	1.23
4.0	0.20	0.20	0.20	0.20	0.20	0.26	0.38	0.47	0.55	0.68	0.79	0.89	0.98	1.14	1.42	1.65	1.86
5.0	0.23	0.23	0.23	0.23	0.23	0.31	0.46	0.58	0.68	0.86	1.02	1.16	1.28	1.51	1.91	2.25	2.55
6.0	0.26	0.26	0.26	0.26	0.26	0.36	0.54	0.69	0.82	1.05	1.25	1.43	1.60	1.90	2.43	2.89	3.30
8.0	0.32	0.32	0.32	0.32	0.32	0.45	0.70	0.91	1.10	1.43	1.72	1.99	2.24	2.70	3.52	4.24	4.91
10.0	0.35	0.37	0.38	0.39	0.40	0.57	0.91	1.20	1.46	1.92	2.34	2.72	3.09	3.75	4.95	6.03	7.02
12.0	0.36	0.41	0.45	0.47	0.49	0.71	1.15	1.54	1.88	2.51	3.07	3.60	4.09	5.01	6.67	8.17	9.57
14.0	0.38	0.45	0.51	0.55	0.58	0.85	1.40	1.87	2.31	3.09	3.81	4.48	5.11	6.30	8.45	10.40	12.23
16.0	0.39	0.49	0.56	0.62	0.67	0.98	1.64	2.21	2.73	3.68	4.56	5.37	6.15	7.60	10.26	12.69	14.96
20.0	0.41	0.56	0.67	0.76	0.84	1.24	2.10	2.86	3.57	4.85	6.04	7.16	8.23	10.24	13.94	17.35	20.57
25.0	0.45	0.64	0.80	0.93	1.04	1.56	2.67	3.67	4.59	6.30	7.88	9.38	10.81	13.53	18.57	23.24	27.66
30.0	0.48	0.72	0.91	1.08	1.24	1.86	3.22	4.44	5.58	7.70	9.67	11.55	13.35	16.77	23.14	29.07	34.71
40.0	0.53	0.85	1.13	1.37	1.59	2.41	4.24	5.89	7.44	10.35	13.07	15.67	18.17	22.95	31.89	40.29	48.29
50.0	0.58	0.97	1.31	1.62	1.91	2.91	5.16	7.20	9.13	12.75	16.16	19.42	22.57	28.60	39.95	50.63	60.84
60.0	0.63	1.07	1.47	1.84	2.19	3.36	5.97	8.37	10.63	14.89	18.92	22.78	26.51	33.67	47.18	59.93	72.15

Source: Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K, and Yoder, D.C. (1997). Predicting soil erosion by water: a guide to conservation planning with the revised soil loss equation (RUSLE). USDA Ag. Handbook No. 703, 404 pp.

Soil loss prediction

Cover management factor, *C*, represents the protection the soil surface has from rainfall energy and runoff

Values range from 0.0001 to 1.0

- A value of 1.0 is assigned to active areas of a construction site with no cover

Soil loss prediction

Supporting practices factor, *P*, is typically set to 1.0 for active construction sites

Type of Protection	Rate of Application	Land Slope	*C* Factor
Straw/hay (tied down by anchoring or tacking)	2.0 tons/acre	≤ 2H:1V	0.06 – 0.20
Crushed stone (1/4 to 1-1/2 inch)	135 – 240 tons/acre	≤ 2H:1V	0.05 – 0.02
Wood chips	12 tons/acre	≤ 3H:1V	0.05
Bonded Fiber Matrix (BFM)	3,000 – 4,000 lbs./acre	≤ 2H:1V	0.001 – 0.10
Flexible Growth Medium (FGM)	3,000 – 4,500 lbs./acre	≤ 1H:1V	0.001 – 0.01
Erosion Control Blankets (ECB)	N/A	≤ 2H:1V	0.001 – 0.20

Source: Wischmeier, W. H. and Smith, D. D. (1978). Predicting rainfall erosion losses – a guide to conservation planning, *USDA Ag. Handbook No. 537*, 67 pgs.

Note: The *C* factor values listed in this table are for illustrative purposes only. Other factors, such as soil erodibility, slope length, installation methods, etc., will alter these values. Always thoroughly evaluate the site and type of cover to be used before selecting a *C* factor value.

Soil loss prediction

The prediction of soil loss using the *RUSLE* equation should be made at the following points in the project timeline:

1. Initial clearing and grubbing at the site
2. Rough grading and contouring
3. Final grading and phases of construction

Soil loss prediction

RUSLE2 is a software program that allows for more accuracy and greater flexibility

- Topography
- Slope configuration
- Climate data
- Soils

Initial Clearing and Grubbing

Site Area	Area Description	Land Area (acres)	*R* for Phase Period (May 1 to June 1)	Soil Factor, *K*	Length Slope Factor, *LS*	Cover Factor, *C*	Calculated Unit Area Soil Loss, *A* (tons/acre/period)	Calculated Total Area Soil Loss (tons/period)
1	Undisturbed area (L=100, S=4%)	3.2	2.84	0.15	0.55	0.01	0.002	0.01
2	Ramp (L=1,000, S=4%)	0.92	2.84	0.32	1.86	0.05	0.08	0.08
3	Main embankment, active construction (L=300, S=10%)	2.1	2.84	0.28	3.09	1.0	2.46	5.2
4	Side slope (L=50, S=15%)	0.7	2.84	0.21	1.52	0.07	0.06	0.0
							Total Tons =	**5.29**

Rough Grading

Site Area	Area Description	Land Area (acres)	*R* for Phase Period (June 1 to Sept 30)	Soil Factor, *K*	Length Slope Factor, *LS*	Cover Factor, *C*	Calculated Unit Area Soil Loss, *A* (tons/acre/period)	Calculated Total Area Soil Loss (tons/period)
1	Undisturbed area (L=100, S=4%)	3.2	63.19	0.15	0.55	0.01	0.05	0.17
2A	Ramp, active construction (L=500, S=5%)	0.46	63.19	0.47	1.71	1.0	50.79	23.36
2B	Ramp (L=250, S=3%)	0.23	63.19	0.39	0.64	0.2	3.15	0.73
2C	Ramp (L=250, S=1%)	0.23	63.19	0.33	0.19	0.2	0.79	0.18
3A	Main embankment, active construction (L=300, S=15%)	1.6	63.19	0.25	5.63	1.0	88.94	142.30
3B	Main embankment (L=100, S=25%)	0.5	63.19	0.22	4.59	0.02	1.28	0.64
4	Side slope (L=50, S=15%)	0.7	63.19	0.21	1.52	0.06	1.21	0.85
							Total Tons =	**168.23**

Erosion and Sediment Control

It can't be found on a chart, it must be designed.

QUESTIONS?