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Technical Memorandum

To:	Kathy Arnold	**From:**	Mike Thornbrue
Company:	Rosemont Copper Company	**Date:**	March 11, 2010
Re:	Soil Erosion Estimates	**Project #:**	075/10-320832-5.3
CC:	David Krizek, P.E. (Tetra Tech)		

This technical memorandum documents the calculations used to compare the potential soil erosion that could result from various closure configurations for the Rosemont Copper Project (Project). The main focus of the analysis is the reclamation of the outer slopes of the Rosemont Ridge Landform. The Rosemont Ridge Landform is the consolidated and contoured earthen structure consisting of waste rock from the Open Pit, a closed Heap Leach Facility encapsulated with waste rock, and a Dry Stack Tailings Facility, also encapsulated with waste rock. This analysis was performed for comparative purposes only.

1.0 Revised Universal Soil Loss Equation

Soil erosion potential was calculated using the Revised Universal Soil Loss Equation (RUSLE). RUSLE is a model for estimating soil loss from most undisturbed lands experiencing overland flow, from lands undergoing disturbance, and from reclaimed lands. RUSLE also may be used as a part of the procedures used to prepare permit applications and to assess reclamation success (Toy and Foster, 1998).

RUSLE estimates the average annual soil loss and sediment yield from a hillslope caused by interrill erosion and rill erosion. It does not estimate stream-channel erosion. RUSLE is a validated and documented equation derived from the theory of erosion processes, more than 10,000 plot-years of data from natural rainfall plots, and numerous rainfall-simulation plots.

RUSLE estimates the rate of soil loss based on site-specific conditions and is a guide for selecting and designing sediment and erosion-control systems for a site. RUSLE does not determine when soil loss is excessive or when erosion-control systems have failed.

In its basic form, RUSLE is:

$$A = R \times K \times LS \times C \times P$$

Where:

A = Average annual soil loss (tons per acre per year);

R = Rainfall / runoff erosivity;

K = Soil erodibility;

LS = Hillslope length and steepness;

C = Cover – management; and

P = Support practice.

The following sections describe each factor and its influence on erosion rates.

1.1 Terms

Soil is used in the broad context to include true soils and other surface materials serving as a plant-growth medium, sometimes referred to as soil substitute, resoil material, or other such terms.

Erosion includes a group of processes by which soil is entrained and transported across a surface.

Rill Erosion is the removal of soil by concentrated water running through small streamlets, or headcuts. Detachment in a rill occurs if the sediment in the flow is below the amount the flow can transport and the flow exceeds the soil's resistance to detachment. As detachment or flow increases, rills become wider and deeper.

Interrill Erosion is the removal of soil due to detachment and transport by raindrop impact and overland flow. Raindrops striking exposed soil detach the soil particles and splash them into the air and into shallow overland flows. Raindrops striking these shallow flows enhance the flow's turbulence and help to transport more of the detached sediment to a nearby rill or flow concentration path. Interrill detachment is affected by the cover provided by residues and plant canopy. Delivery of interrill sediment to the rill channels is a function of the slope, cover, and surface roughness.

Soil Loss is the material actually removed from the hillslope or hillslope segment. The soil loss may be less than erosion due to onsite deposition in micro-topographic depressions on the hillslope.

Sediment Yield from a surface is the sum of the soil losses minus deposition in macro-topographic depressions, at the toe of the hillslope, along field boundaries, or in terraces and channels sculpted into the hillslope.

1.2 Rainfall / Runoff Erosivity (R)

The erosivity of rainfall and runoff at a particular location is represented by R in the equation and increases as the amount and intensity of rainfall increases. The RUSLE software includes a database of precipitation data for various weather stations. However, in order to maintain consistency with other models used for Project engineering analysis, data derived from the

Nogales 6N weather station was selected to represent the long-term weather conditions at the Project site (Tetra Tech, 2009). Table 1.01 summarizes the data from the Nogales 6N weather station (Western Regional Climate Center, 2010).

Table 1.01 Nogales 6N Weather Station Data

Month	Average Monthly Total Precipitation (Inches)	Average Monthly Maximum Temperature (°Fahrenheit)
January	1.10	64.3
February	0.85	66.7
March	0.90	70.7
April	0.39	78.1
May	0.22	86.3
June	0.47	95.2
July	4.34	94.1
August	4.13	91.7
September	1.55	90.2
October	1.33	82.5
November	0.66	71.7
December	1.43	64.6
Annual Total or Average	**17.37**	**79.7**

In addition to the weather station data, the 10-year, 24-hour event of 3.18 inches of precipitation was included in the models (Tetra Tech, 2009).

Additional information regarding site specific climate data can be found in the Technical Memorandum titled *Rosemont Copper Project Design Storm and Precipitation Data/Design Criteria* (Tetra Tech, 2009).

1.3 Soil Erodibility (K)

The inherent erodibility of the soil at a particular site is represented by the K factor in RUSLE. The value of the soil erodibility factor is a function of the particle-size distribution, organic-matter content, structure, and permeability of the soil. The soil-erodibility factor represents:

- The susceptibility of soil or surface material to erosion;
- Transportability of the sediment; and
- The amount and rate of runoff given a particular rainfall input.

The soil erodibility values reflect the rate of soil loss per rainfall-runoff (R) erosion index.

Fine-textured soils that are high in clay content have low K values because the particles are cohesive and resistant to detachment. Course-textured soils, such as sandy soils, also have low K values because of high infiltration results in low runoff even though these soils are easily detached. Medium-textured soils, such as silt loam, have moderate K values because they are moderately susceptible to particle detachment and they produce runoff at moderate rates. Soils having high silt content are especially susceptible to erosion and have high K values. Silt-size particles are easily detached and tend to crust, producing high rates and large volumes of runoff.

Organic matter (vegetation) in the soil reduces erodibility because it produces compounds that bind particles together. This increases aggregation and reduces the particles susceptibility to detachment from raindrop impact and surface runoff. Additionally, organic matter improves biological activity and increases infiltration rates. This reduces runoff and erosion potential.

There are several other factors that affect soil erodibility including:

- Permeability of the soil affects soil erodibility because it affects runoff rates;
- Soil structure affects soil erodibility because it affects detachment and infiltration rates; and
- Mineralogy of the soil affects soil erodibility because it affects permeability which affects runoff rates.

1.4 Hillslope Length and Steepness (LS)

The hillslope length and steepness factor represents the effect of topography on rates of soil loss at a site. The value of the hillslope length and steepness factor (LS) increases as hillslope length and steepness increases, under the assumption that runoff accumulates and accelerates in the downslope direction. This assumption is usually valid for overland flow but may not be valid for densely-vegetated areas such as forests.

Generally, as hillslope length and/or hillslope gradients increase, soil loss increases. As hillslope length increases, total soil loss and soil loss per unit area increases due to the progressive accumulation of runoff in the downslope direction. As the hillslope gradient increases, the velocity and erosivity of the runoff increases.

The effect of hillslope length on soil loss depends on the ratio of rill to interrill erosion. On steep hillslopes (greater than ten (10) percent [10H:1V]) more of the total erosion results from rill erosion rather that interrill erosion processes. The ratio of rill to interrill erosion is a function of soil texture and land use.

Soils with a high amount of silt (>85%) are assumed to have a high rill to interrill erosion ratio. Soils with a textural classification of silt loam are assumed to have a high to moderate rill to interrill erosion ratio. Soils with a high percentage of clay (>35%) are assumed to have a low rill to interrill erosion ratio.

The land use is also used to estimate the rill to interrill erosion ratio. Recently disturbed mine or construction lands are assumed to have a high rill to interrill erosion ratio. Farmlands and disturbed forests are assumed to have a moderate rill to interrill erosion ratio. No-till croplands, pastures, and range lands that have not been recently disturbed by mechanical operations usually have a low rill to interrill erosion ratio. This is because soil consolidation is assumed to have a greater effect on rill erosion than interrill erosion.

1.5 Cover – Management (C)

The effects of surface covers and roughness, soil biomass, and soil-disturbing activities on rates of soil loss at a site are represented by the cover – management factor. The value of the cover – management factor decreases as surface cover and soil biomass increase because the soil is protected from raindrop impact and runoff. The sub-factors that influence the cover – management factor change through time, causing accompanying changes in soil protection.

The cover – management factor represents the effects of vegetation, management, and erosion control practices on soil loss. The sub-factors used to compute a soil-loss ratio value are prior land use, canopy cover, surface cover, surface roughness, and soil moisture.

The prior land-use sub-factor represents the effects of soil loosening by soil disturbance, and soil biomass (residue and plant roots) on soil-loss rates. The prior land-use sub-factor would be high during and immediately following mining and construction because the topsoil will be stripped and stockpiled for reclamation, decreasing the biomass. Soil disturbance makes the soil more erodible because the soil is less consolidated, and aggregates are reduced in size. Soil disturbance associated with mining or construction activities also reduce stable-aggregate size and reduce the soil's ability to resist erosive forces. This reduction of aggregate size is offset somewhat by increases in the surface roughness, which slows runoff, increases infiltration, and traps sediment transported by overland flow.

Canopy cover is the vegetative cover above the soil surface that intercepts raindrops but does not contact the soil surface. Two (2) characteristics of canopy are utilized in the RUSLE calculations:

- The percent of surface covered by the canopy; and
- The height within the canopy from which intercepted rain drops re-form into water droplets and fall to the ground; this fall distance is known as the "effective fall height."

Open spaces in a canopy, whether within the perimeter of a plant canopy or between adjacent plants, are not considered as canopy.

Surface cover is material in contact with the soil that both intercepts raindrops and slows surface runoff. It includes all types of cover, such as mulches, rock fragments, live vegetation in contact with the soil surface, cryptogrammic crusts (which are formed by mosses or fungi in the soil), and plant litter.

The effectiveness of surface cover varies depending on several factors, including the dominant type of soil erosion occurring on the slope, the slope gradient, the extent of contact between the surface cover and the soil, and the type of surface-cover material itself. In general, surface cover does a better job of reducing rill erosion rates than it does in reducing interrill erosion rates. Therefore, if erosion of a bare soil is primarily due to rill erosion, the addition of cover material will reduce erosion more than if the cover material were placed on a soil that erodes primarily by interrill erosion.

As previously discussed, on steep hillslopes (greater than 10% gradient) more of the total erosion results from rill erosion rather than interrill erosion. Conversely, on flatter hillslopes (less than 3% gradient), more of the total erosion often results from interrill erosion. Again, because surface cover reduces the rill erosion rates more than the interrill erosion rates, a given amount of cover material results in a greater reduction in soil loss on steep slopes than on flat hillslopes.

1.6 Support Practice (P)

The support practice factor represents the effects of conservation practices, such as contouring, buffer strips of close-growing vegetation, and terracing on soil loss. The value of the support practice factor decreases with these practices because they reduce runoff volume and velocity and encourage the deposition of sediment on the hillslope surface. The effectiveness of certain erosion-control practices varies substantially due to local conditions. For example, contouring is far more effective in low-rainfall areas than in high-rainfall areas.

An overall support practice value is computed as a product of sub-factors for individual support practices, which are typically used in combination. For example, contouring almost always accompanies terracing. On mined land or construction-site reclamation projects, a Towner disk or chisel plow is often used in combination with a rangeland drill. Additionally, many structures such as straw-bale barriers, gravel filters, silt fences, continuous berms, and bench terraces are used on mined land and construction sites to control or minimize sediment transport from reclamation areas.

Tillage and planting operations performed on the contour are very effective in reducing erosion from storms of low to moderate intensity that are common in many areas of the United States. However, contouring provides little protection against high-intensity, long- duration storms.

Terracing in combination with contouring in the Western United States is more effective as an erosion-control practice than is contouring alone. The beneficial effects of terracing are reflected in the hillslope length and gradient (LS) factor because the length of the hillslope is reduced.

2.0 RUSLE Models

Several models were generated using RUSLE 2.0 software to represent the site conditions at the Project before, during, and after reclamation. The models include:

- A model representing cut to fill gila conglomerate with minimal contouring;
- A model representing Gila Conglomerate that has been contoured, and rolled smooth without revegetation;
- A model representing established Gila Conglomerate covered with thin range grass; and
- A model representing waste rock without vegetation.

The modeling conditions were chosen to best represent possible reclamation scenarios for the Project. Gila Conglomerate was chosen for modeling because there is a large source available onsite for use as capping material. As a note, Arkose is also planned as a potential capping material.

For each scenario, a range of hillslope gradients were evaluated with various bench heights. Additionally, the inputs for slope length and steepness were varied to generate a range of erosion rates. The slope steepness was varied between 1.5H:1V and 5.0H:1V with bench heights varied between 25 feet vertical to 150 feet vertical. From these criteria, the two-dimensional slope lengths were calculated and input into the RUSLE 2.0 software.

2.1 Gila Conglomerate Minimal Contouring

For this scenario, it was assumed that the Gila Conglomerate was placed with minimal contouring and left unrolled and unvegetated.

The inputs into the RUSLE model included:

- Weather data from the Nogales 6N Weather Station;
- A gradation representative of Gila Conglomerate which consisted of no rock cover, 75% sand and aggregate, 5.0% silt, and 20% clay. The hydrologic classification for the area is class C, as determined by the National Resource Conservation Service (NRCS);
- A management scenario of bare soil with a rough surface was selected to represent the final surface; and
- The slope steepness was varied between 1.5H:1V and 5.0H:1V with bench heights varied between 25 feet vertical to 150 feet vertical. The two-dimensional slope lengths were calculated from these variable combinations.

The results of the modeling are listed on Table 1 of Attachment 1. The erosion rates for the slope sections ranged from 28 tons per acre per year for a 5.0H:1V slope with a bench height of 25 feet (125 feet length) to 140 tons per acre per year for a 1.5H:1V slope with a bench height of 150 feet (225 feet length).

2.2 Gila Conglomerate, Contoured and Smooth Rolled

For this scenario, it was assumed that the Gila Conglomerate would be placed with minimal contouring, rolled smooth, and unvegetated.

The inputs into the RUSLE model included:

- Weather data from the Nogales 6N Weather Station;
- A gradation representative of Gila Conglomerate which consisted of no rock cover, 75% sand and aggregate, 5.0% silt, and 20% clay. The hydrologic classification for the area is class C, as determined by the National Resource Conservation Service (NRCS);
- A management scenario of bare soil with a cut, smooth surface was selected to represent the final surface; and
- The slope steepness was varied between 1.5H:1V and 5.0H:1V with bench heights varied between 25 feet vertical to 150 feet vertical. The two-dimensional slope lengths were calculated from these variable combinations.

The results of the modeling are listed on Table 3 of Attachment 1. The erosion rates for the slope sections ranged from 20 tons per acre per year for a 5.0H:1V slope with a bench height of 25 feet (125 feet length) to 96 tons per acre per year for a 1.5H:1V slope with a bench height of 150 feet (225 feet length).

2.3 Gila Conglomerate covered with Thin Range Grass

For this scenario, it was assumed that the Gila Conglomerate would be seeded with native grass and mulched with native hay in one operation in the spring. In order to represent minimal interference with the growth of vegetation, mowing was not considered for maintenance to allow the slope to reach a natural vegetation level.

The inputs into the RUSLE model included:

- Weather data from the Nogales 6N Weather Station;
- A gradation representative of Gila Conglomerate which consisted of no rock cover, 75% sand and aggregate, 5.0% silt, and 20% clay. The hydrologic classification for the area is class C, as determined by the National Resource Conservation Service (NRCS);
- Thin range grass was selected as the vegetation;
- Native hay was selected as the mulching material; and
- The slope steepness was varied between 1.5H:1V and 5.0H:1V with bench heights varied between 25 feet vertical to 150 feet vertical. The two-dimensional slope lengths were calculated from these variable combinations.

The results of the modeling are listed on Table 3 of Attachment 1. The erosion rates for the slope sections ranged from 17 tons per acre per year for a 5.0H:1V slope with a bench height of 25 feet (125 feet length) to 83 tons per acre per year for a 1.5H:1V slope with a bench height of 150 feet (225 feet length).

2.4 Waste Rock Without Vegetation

Waste Rock was chosen for modeling to evaluate the erosion potential for slope that are not capped with additional material. For this scenario, it was assumed that the waste rock would be placed, contoured, and left unvegetated.

The inputs into the RUSLE model included:

- Weather data from the Nogales 6N Weather Station;
- An assumed gradation representing waste rock which consisted of 75% rock cover, 90% sand and aggregate, 5.0% silt, and 5.0% clay. The hydrologic classification for the area is class C, as determined by the National Resource Conservation Service (NRCS);
- A management scenario of bare soil with a very rough surface was selected to represent the final surface; and
- The slope steepness was varied between 1.5H:1V and 5.0H:1V with bench heights varied between 25 feet vertical to 150 feet vertical. The two-dimensional slope lengths were calculated from these variable combinations.

The results of the modeling are listed on Table 4 of Attachment 1. The erosion rates for the slope sections ranged from 1.1 tons per acre per year for a 5.0H:1V slope with a bench height of 25 feet (125 feet length) to 4.6 tons per acre per year for a 1.5H:1V slope with a bench height of 150 feet (225 feet length).

3.0 References

Tetra Tech, Carrasco, J. (2009) *Rosemont Copper Project Design Storm and Precipitation Data/Design Criteria.* Technical Memorandum to Daniel Roth – M3 Engineering & Technology Corporation. Technical Memorandum dated January 5, 2009.

Toy, T. and Foster, G. (1998) *Guidelines for the Use of the Revised Universal Soil Loss Equation (RUSLE) Version 1.06 on Mined Lands, Construction Sites, and Reclaimed Lands:* J.R. Galetovic (Technical Coordinator), The Office of Technology Transfer, Western Regional Coordinating Center, Office of Surface Mining. August 1998.

Western Regional Climate Center (2010). Monthly Climate Summary for Nogales 6 N, Arizona: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?az5924 Visited March 11, 2010.

ATTACHMENT 1

Gila Conglometate Without Vegetation (Bare, Rough)

Slope Grade (H:V)			Bench Height (Feet)					
			25	50	75	100	125	150
	1.5:1 (66.7%)	Horizontal Length	37.5	75.0	112.5	150.0	187.5	225.0
		Slope Length	45.1	90.1	135.2	180.3	225.3	270.4
		Erosion Rate (Tons per Acre per Year)	42	67	88	110	130	140
		Sediment Load (Lbs per Foot Width per Year)	71.5	230	455	740	1080	1470
	2.0:1 (50.0%)	Horizontal Length	50.0	100.0	150.0	200.0	250.0	300.0
		Slope Length	55.9	111.8	167.7	223.6	279.5	335.4
		Erosion Rate (Tons per Acre per Year)	40	64	84	100	120	130
		Sediment Load (Lbs per Foot Width per Year)	92.8	295	580	938	1360	1850
	2.5:1 (40.0%)	Horizontal Length	62.5	125.0	187.5	250.0	312.5	375.0
		Slope Length	67.3	134.6	201.9	269.3	336.6	403.9
		Erosion Rate (Tons per Acre per Year)	38	60	79	95	110	120
		Sediment Load (Lbs per Foot Width per Year)	110	347	678	1090	1580	2140
	3.0:1 (33.3%)	Horizontal Length	75.0	150.0	225.0	300.0	375.0	450.0
		Slope Length	79.057	158.11	237.17	316.23	395.28	474.34
		Erosion Rate (Tons per Acre per Year)	36	56	73	88	100	110
		Sediment Load (Lbs per Foot Width per Year)	125	388	754	1210	1740	2350
	3.5:1 (28.6%)	Horizontal Length	87.5	175.0	262.5	350.0	437.5	525.0
		Slope Length	91.001	182	273	364.01	455.01	546.01
		Erosion Rate (Tons per Acre per Year)	34	52	68	81	93	100
		Sediment Load (Lbs per Foot Width per Year)	137	422	815	1300	1870	2520
	4.0:1 (25.0%)	Horizontal Length	**100.0**	**200.0**	**300.0**	**400.0**	**500.0**	**600.0**
		Slope Length	103.1	206.2	309.2	412.3	515.4	618.5
		Erosion Rate (Tons per Acre per Year)	32	49	62	75	85	96
		Sediment Load (Lbs per Foot Width per Year)	147	447	860	1370	1960	2630
	4.5:1 (22.2%)	Horizontal Length	112.5	225.0	337.5	450.0	562.5	675.0
		Slope Length	115.2	230.5	345.7	461.0	576.2	691.5
		Erosion Rate (Tons per Acre per Year)	30	45	58	69	78	88
		Sediment Load (Lbs per Foot Width per Year)	155	467	894	1420	2030	2710
	5.0:1 (20.0%)	Horizontal Length	125.0	250.0	375.0	500.0	625.0	750.0
		Slope Length	127.5	255.0	382.4	509.9	637.4	764.9
		Erosion Rate (Tons per Acre per Year)	28	42	53	63	72	81
		Sediment Load (Lbs per Foot Width per Year)	161	484	921	1450	2070	2770

Gila Conglometate Without Vegetation (Bare, Cut, Smooth)

Slope Grade (H:V)			Bench Height (Feet)					
			25	50	75	100	125	150
	1.5:1 (66.7%)	Horizontal Length	37.5	75.0	112.5	150.0	187.5	225.0
		Slope Length	45.1	90.1	135.2	180.3	225.3	270.4
		Erosion Rate (Tons per Acre per Year)	33	49	63	75	86	96
		Sediment Load (Lbs per Foot Width per Year)	56.0	170	326	516	738	988
	2.0:1 (50.0%)	Horizontal Length	50.0	100.0	150.0	200.0	250.0	300.0
		Slope Length	55.9	111.8	167.7	223.6	279.5	335.4
		Erosion Rate (Tons per Acre per Year)	31	46	59	69	79	88
		Sediment Load (Lbs per Foot Width per Year)	71.1	213	404	637	906	1210
	2.5:1 (40.0%)	Horizontal Length	62.5	125.0	187.5	250.0	312.5	375.0
		Slope Length	67.3	134.6	201.9	269.3	336.6	403.9
		Erosion Rate (Tons per Acre per Year)	29	43	54	63	71	79
		Sediment Load (Lbs per Foot Width per Year)	83.1	245	462	724	1030	1360
	3.0:1 (33.3%)	Horizontal Length	75.0	150.0	225.0	300.0	375.0	450.0
		Slope Length	79.06	158.1	237.2	316.2	395.3	474.3
		Erosion Rate (Tons per Acre per Year)	27	39	49	57	64	71
		Sediment Load (Lbs per Foot Width per Year)	92.4	269	504	785	1110	1470
	3.5:1 (28.6%)	Horizontal Length	87.5	175.0	262.5	350.0	437.5	525.0
		Slope Length	91	182	273	364	455	546
		Erosion Rate (Tons per Acre per Year)	25	36	44	52	58	64
		Sediment Load (Lbs per Foot Width per Year)	99.9	288	536	831	1170	1540
	4.0:1 (25.0%)	Horizontal Length	100.0	200.0	300.0	400.0	500.0	600.0
		Slope Length	103.1	206.2	309.2	412.3	515.4	618.5
		Erosion Rate (Tons per Acre per Year)	23	33	40	47	53	58
		Sediment Load (Lbs per Foot Width per Year)	106	301	557	860	1210	1590
	4.5:1 (22.2%)	Horizontal Length	112.5	225.0	337.5	450.0	562.5	675.0
		Slope Length	115.2	230.5	345.7	461.0	576.2	691.5
		Erosion Rate (Tons per Acre per Year)	21	30	37	42	47	52
		Sediment Load (Lbs per Foot Width per Year)	110	311	570	878	1230	1610
	5.0:1 (20.0%)	Horizontal Length	125.0	250.0	375.0	500.0	625.0	750.0
		Slope Length	127.5	255.0	382.4	509.9	637.4	764.9
		Erosion Rate (Tons per Acre per Year)	20	28	34	39	43	47
		Sediment Load (Lbs per Foot Width per Year)	113	317	580	889	1240	1620

Gila Conglometate Revegetated with Thin Range Grass and Native Hay Mulch

Slope Grade (H:V)			Bench Height (Feet) 25	50	75	100	125	150
	1.5:1 (66.7%)	Horizontal Length	37.5	75.0	112.5	150.0	187.5	225.0
		Slope Length	45.1	90.1	135.2	180.3	225.3	270.4
		Erosion Rate (Tons per Acre per Year)	27	41	53	64	74	83
		Sediment Load (Lbs per Foot Width per Year)	45.9	142	276	442	637	859
	2.0:1 (50.0%)	Horizontal Length	50.0	100.0	150.0	200.0	250.0	300.0
		Slope Length	55.9	111.8	167.7	223.6	279.5	335.4
		Erosion Rate (Tons per Acre per Year)	26	39	50	60	69	77
		Sediment Load (Lbs per Foot Width per Year)	58.8	180	346	552	791	1060
	2.5:1 (40.0%)	Horizontal Length	62.5	125.0	187.5	250.0	312.5	375.0
		Slope Length	67.3	134.6	201.9	269.3	336.6	403.9
		Erosion Rate (Tons per Acre per Year)	24	36	46	55	63	70
		Sediment Load (Lbs per Foot Width per Year)	69.1	209	399	632	903	1210
	3.0:1 (33.3%)	Horizontal Length	75.0	150.0	225.0	300.0	375.0	450.0
		Slope Length	79.06	158.1	237.2	316.2	395.3	474.3
		Erosion Rate (Tons per Acre per Year)	22	34	42	50	57	64
		Sediment Load (Lbs per Foot Width per Year)	77.3	231	438	691	983	1310
	3.5:1 (28.6%)	Horizontal Length	87.5	175.0	262.5	350.0	437.5	525.0
		Slope Length	91	182	273	364	455	546
		Erosion Rate (Tons per Acre per Year)	21	31	39	46	52	58
		Sediment Load (Lbs per Foot Width per Year)	84.1	249	469	736	1040	1390
	4.0:1 (25.0%)	Horizontal Length	100.0	200.0	300.0	400.0	500.0	600.0
		Slope Length	103.1	206.2	309.2	412.3	515.4	618.5
		Erosion Rate (Tons per Acre per Year)	19	28	36	42	47	52
		Sediment Load (Lbs per Foot Width per Year)	89.3	261	490	766	1080	1440
	4.5:1 (22.2%)	Horizontal Length	112.5	225.0	337.5	450.0	562.5	675.0
		Slope Length	115.2	230.5	345.7	461.0	576.2	691.5
		Erosion Rate (Tons per Acre per Year)	18	26	33	38	43	47
		Sediment Load (Lbs per Foot Width per Year)	93.3	271	505	785	1110	1470
	5.0:1 (20.0%)	Horizontal Length	125.0	250.0	375.0	500.0	625.0	750.0
		Slope Length	127.5	255.0	382.4	509.9	637.4	764.9
		Erosion Rate (Tons per Acre per Year)	17	24	30	35	39	43
		Sediment Load (Lbs per Foot Width per Year)	96.7	278	515	799	1120	1480

Waste Rock Without Vegetation (Bare, Very Rough)

Slope Grade (H:V)			Bench Height (Feet)					
			25	50	75	100	125	150
	1.5:1 (66.7%)	Horizontal Length	37.5	75.0	112.5	150.0	187.5	225.0
		Slope Length	45.1	90.1	135.2	180.3	225.3	270.4
		Erosion Rate (Tons per Acre per Year)	1.3	2.1	2.8	3.4	4.0	4.6
		Sediment Load (Lbs per Foot Width per Year)	2.21	7.22	14.5	23.7	34.7	47.4
	2.0:1 (50.0%)	Horizontal Length	50.0	100.0	150.0	200.0	250.0	300.0
		Slope Length	55.9	111.8	167.7	223.6	279.5	335.4
		Erosion Rate (Tons per Acre per Year)	1.3	2.1	2.8	3.4	4.0	4.5
		Sediment Load (Lbs per Foot Width per Year)	2.99	9.68	19.3	31.4	45.9	62.5
	2.5:1 (40.0%)	Horizontal Length	62.5	125.0	187.5	250.0	312.5	375.0
		Slope Length	67.3	134.6	201.9	269.3	336.6	403.9
		Erosion Rate (Tons per Acre per Year)	1.3	2.1	2.7	3.3	3.9	4.4
		Sediment Load (Lbs per Foot Width per Year)	3.70	11.8	23.4	38.0	55.3	75.2
	3.0:1 (33.3%)	Horizontal Length	75.0	150.0	225.0	300.0	375.0	450.0
		Slope Length	79.06	158.1	237.2	316.2	395.3	474.3
		Erosion Rate (Tons per Acre per Year)	1.3	2.0	2.6	3.2	3.7	4.2
		Sediment Load (Lbs per Foot Width per Year)	4.33	13.7	27.0	43.6	63.3	85.8
	3.5:1 (28.6%)	Horizontal Length	87.5	175.0	262.5	350.0	437.5	525.0
		Slope Length	91	182	273	364	455	546
		Erosion Rate (Tons per Acre per Year)	1.2	1.9	2.5	3.0	3.5	3.9
		Sediment Load (Lbs per Foot Width per Year)	4.91	15.4	30.1	48.5	70.1	94.8
	4.0:1 (25.0%)	Horizontal Length	100.0	200.0	300.0	400.0	500.0	600.0
		Slope Length	103.1	206.2	309.2	412.3	515.4	618.5
		Erosion Rate (Tons per Acre per Year)	1.2	1.8	2.4	2.9	3.3	3.7
		Sediment Load (Lbs per Foot Width per Year)	5.41	16.8	32.7	52.4	75.7	102
	4.5:1 (22.2%)	Horizontal Length	112.5	225.0	337.5	450.0	562.5	675.0
		Slope Length	115.2	230.5	345.7	461.0	576.2	691.5
		Erosion Rate (Tons per Acre per Year)	1.1	1.7	2.3	2.7	3.1	3.5
		Sediment Load (Lbs per Foot Width per Year)	5.85	18.0	34.9	55.7	80.2	108
	5.0:1 (20.0%)	Horizontal Length	125.0	250.0	375.0	500.0	625.0	750.0
		Slope Length	127.5	255.0	382.4	509.9	637.4	764.9
		Erosion Rate (Tons per Acre per Year)	1.1	1.7	2.1	2.6	2.9	3.3
		Sediment Load (Lbs per Foot Width per Year)	6.24	19.1	36.8	58.6	84.1	113