Appendix C. Design Calculations

Prepared By: PDL	Date: 10/29/2008	Subject: Meyers Landfill Cover Quantities	Sheet No. 1
Checked By: EB	Date:	US Forest Service - Meyers Landfill OU-1	Project No. 28-072

Scope: Determine the soil volumes associated with the design for the proposed construction of the Meyers Landfill multilayer cap

Method: All the volumes are calculated using the average end area method except the final cap volumes which was determined simply by surface area multiplied by proposed cap thickness. The horizontal cut and fill areas for the excavations and fills measured off of Drawings from the Draft 35% Meyers Landfill Remedial Design using the area command in AutoCad 2009

- For the excavation volumes, the area between the existing topographic contours and the waste removal contours for each 10-foot elevation was determined.

- For the placement area volumes, the area between the existing topo and placement area contours for each elevation contour was determined. Then 2-foot across placement area was removed to represent existing cover soils being removed and stockpiled

- For the proposed multilayer cap volumes were determined based upon the surface area of Final cap and the planned layer thicknesses.

- For the regrading the cut area east of the landfill was based on cros section of the fill volume and length of fill area planned layer thicknesses.

Once the design areas were were developed for each contour, the average end area method was used to calculate the volumes between the elevations. The basic formula is given below:

V = (E2 - E1) x (A1 + A2) / 2

V = Volume between contours 1 and 2
E1 = Elevation of lower contour
E2 = Elevation of upper contour
A1 = Area of lower contour
A2 = Area of upper contour

The volumes for each contour interval were added cumulatively to get the total volumes associated with each activity.

Results:
The results of the calculations for each activity are provided below:

Waste Excavation Volumes on abvoe and east of Sewer Line, and north slope cut

Elevation (ft)	Cut Area (sf)	Interval Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (cy)	Notes
6350	2550				
6360	29000	157750	157750	5842.5926	
6370	49000	390000	547750	20287.037	north slope cut
6350	119000				
6380	103500	762500	1310250	48527.778	
				-14600	2' feet of existing cover soil removed prior to excavation of waste
				33927.778	total waste excavation

Prepared By: PDL	Date: 10/29/2008	Subject: Meyers Landfill Cover Quantities	Sheet No. 2
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Fill Volume of Waste Placement Area Plan (contours include waste plus 2' foundation layer)

Elevation (ft)	Cut Area (sf)	Interval Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (cy)	Notes
6375	40000				
6380	121000	402500	402500	14907.407	
6390	46000	835000	1237500	45833.333	
6395	8500	136250	1373750	50879.63	
				18800	2' feet of existing cover soil in placement area removed prior to waste placement
				69679.63	total capacity
				35481	2' foot foundation
				34198.63	waste capacity

Cover = 479,000 sf 17740.74
17,750 cy per foot

2' Foundation -	35481.48 cy	foundation included in cut and fill waste
1' Sand Layer -	3,500 cy	sand layer only under 4:1 slopes on north and west side of final grade (95,350 sf)
2' Cover Soil	35481.48 cy	
12" Veg. Cover	17740.74 cy	
Total	92,204 cy	
Existing cover	75,000 cy	
East Cut Regrade -	16,667 cy	triangular wedge 180 feet long 10 feet at high end, running 500 feet along the east side of the landfill.

Summary

2' Cover soil removec	33400 cy
Waste removed	33900 cy
2' Foundation -	35500 cy
1' Sand Layer -	3,500 cy
2' Cover Soil	35500 cy
12" Veg. Cover	17700 cy
East Cut Regrade -	16,700 cy

Objective: Estimate the quantity (by weight) of soil loss per acre per year due to erosion on representative post-remedial action construction surfaces at Meyers Landfill Site

Method: Universal Soil Loss Equation (USLE) A = R x K x LS x C x P

Reference: Soil Loss Equation Federal Register Notice, Natural Resources Conservation Service, USDA

Rainfall and Runoff Factor (R)

The Site is located in El Dorado County, CA. Due to the regional generality inherent in two sourced Rainfall Erosivity Index Maps (Attached), an online EPA calculator was used to generate the reported value for R. Site coordinates are: Lat – 38.874 Degrees and Long – 119.988 or 38° 52' 26.43" North, 119°59' 17.47" West. A full year construction cycle was used to estimate construction duration in order to incorporate the spectrum of weather events.

Source: http://cfpub.epa.gov/npdes/stormwater/LEW/site_name_proj_date.cfm

R Factor = 13 (see attached result)

Soil Erodibility Factor (K)

Based on ERRG's field investigation performed in July 2008, and samples taken from Test Pits 1 and 2 in the borrow area on the East side of the Site, the topsoil for the final cover system is characterized as a Well Graded Sand with Silt (SW-SM). 4.7% Gravel, 90.1% Sand, 5.2% Silt-Clay, 0% Organics. Permeability is $1.3*10^{-3}$ cm/sec (1.84 in/hr) and the soil structure is 2 (Fine Granular). The K Factor is thus obtained from NAVFAC DM 7.1 nomograph (Attached).

K Factor = 0.075

Slope Length-Gradient Factor (LS)

The Site area can be broken into three controlling surfaces in order to determine the LS Factor. The LS factor can be obtained through the following formula (referenced from Ontario Ministry of Agriculture, see attached Equation for Calculation of LS, Table 3B,):

$$LS = [0.065 + 0.0456(slope) + 0.006541(slope)^2] \times (slope\_length / const)^{NN}$$

Where (const) = 72.5 for imperial units, and (NN) varies with slope by Table 3B (attached)

Cover material - 6% slope, Slope_Length = 510 feet, NN = 0.5

North Slope – 25% slope, 125 feet (plan view), Slope_Length = 129 feet, NN = 0.5

Borrow Area – 3% slope, Slope_Length = 200 feet, NN = 0.4

Cover Material: $LS = [0.065 + 0.0456(6.0) + 0.006541(6.0)^2] \times (510 / 72.5)^{0.5}$

$LS_{CM} = 1.5$

North Slope: $LS = [0.065 + 0.0456(25) + 0.006541(25)^2] \times (129 / 72.5)^{0.5}$

$LS_{NS} = 7.1$

Borrow Area: $LS = [0.065 + 0.0456(3.0) + 0.006541(3.0)^2] \times (200 / 72.5)^{0.4}$

$LS_{BA} = 0.4$

Crop/Vegetation and Management Factor (C)

The Site shall have a vegetative cover resembling Hay and Pasture Crops (untilled) to control surface erosion over the cover and cut slopes (Table 4A). Based on this surface parameter, the C Factor is obtained from the crop type factor (Table 4A) and the tillage method factor (Table 4B).

Crop Type Factor for Hay and Pasture Crops = 0.02
Tillage Method Factor for spring plow = 0.25

C Factor = .02(hay and pasture)*0.25(no till) = 0.005

C = 0.005

Support Practice Factor (P)

Simple up/down slopes are considered for the representative surfaces on the Site. Thus, the P Factor was obtained from Table 5.

P = 1.0

Solution:

Since A = R x K x LS x C x P, and LS is variable for each surface,

$A = 13 \times 0.075 \times LS_x \times 0.005 \times 1.0 = (0.004875 \times LS_x)$

Therefore:

Cover Material: A = (0.004875 x 1.5) = 0.0074 tons/acre/year

A_{CM} = 0.0074 tons/acre/year

North Slope: A = (0.004875 x 7.1) = 0.0346 tons/acre/year

A_{NS} = 0.0346 tons/acre/year

Borrow Area: A = (0.004875 x 0.4) = 0.0020 tons/acre/year

A_{BA} = 0.0020 tons/acre/year

Values of A less than 3 tons/acre/year are considered “Very Low” soil loss rates. Values of A less than 2 tons/acre/year are considered acceptable for landfill sites according to DTSC in communication for Truckee Landfill construction in 2007. All values found above for this Site fall orders of magnitude below these recommended tolerable levels.

United States Department of Agriculture
NRCS Natural Resources Conservation Service

Soil Loss Equation Federal Register Notice

Notice from the Federal Register, Vol. 61, No. 108 of Tuesday, June 4, 1996 / Rules and Regulations

7 CFR Part 610

Technical Assistance

AGENCY:
Natural Resources Conservation Service, USDA.

ACTION:
Final rule.

SUMMARY:
Section 301(c) of the Federal Agriculture Improvement and Reform Act of 1996 (FAIRA) requires the Secretary of Agriculture to publish in the Federal Register, within 60 days of the enactment of FAIRA, the universal soil loss equation (USLE) and wind erosion equation (WEQ) used by the Department of Agriculture (the Department) as of the date of publication. The Natural Resources Conservation Service (NRCS) utilizes factors from the USLE, the revised universal soil loss equation (RUSLE) and the WEQ in equations to predict soil erosion due to water and wind. The Department was first required to use the factors from the USLE and WEQ to make highly erodible land (HEL) determinations under the Food Security Act (FSA) of 1985, Pub. L. 99-198. The FSA defined HEL as land that has the potential for an excessive annual rate of erosion in relation to the soil loss tolerance level as determined by the Secretary through application of factors from the USLE and WEQ.

This final rule sets forth the USLE and WEQ used by the Department as of this date and the circumstances under the equations are used. Since the first mandated use of the USLE in 1985, the technology used to predict soil erosion due to water has been refined. The refinement is reflected in a revised USLE (RUSLE) which will also be used under the circumstances described in this rule.

EFFECTIVE DATE:
This rule is effective June 3, 1996.

FOR FURTHER INFORMATION CONTACT:
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SUPPLEMENTARY INFORMATION:

Rulemaking Analyses

EO 12291: Not major.
Regulatory Flexibility Act: No significant impact.
Paperwork Reduction Act: Does not apply.
National Environmental Policy Act: Not applicable.
Civil Rights Impact Analysis: Not applicable.
Federalism Assessment: Does not have sufficient federalism implications to warrant an assessment.
Unfunded Mandate: Not applicable.

Background And Purpose

The Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture (the Department), utilizes the universal soil loss equation (USLE), the revised universal soil loss equation (RUSLE) and the wind erosion equation (WEQ) to predict soil erosion due to water and wind. Section 301(c) of the Federal Agriculture Improvement and Reform Act of 1996 (FAIRA), which was enacted April 4, 1996, requires the Secretary of Agriculture to publish in the Federal Register by June 3, 1996, the USLE and WEQ used by the Department as of the date of publication. NRCS is publishing the equations and the rules under which the USLE, RUSLE, and WEQ factors are used for administering programs.

The equation for predicting soil loss due to erosion for both the USLE and RUSLE is A=RxKxLSxCxP. The factors in the equation have the following definitions:
1. *A* is the estimation of average annual soil loss in tons per acre caused by sheet and rill erosion.
2. *R* is the rainfall erosivity factor.
3. *K* is the soil erodibility factor.
4. *LS* is the slope length and steepness factor.
5. *C* is the cover and management factor.
6. *P* is the support practice factor.

A paper published by K.G. Renard, et al., in the May-June, 1994 Journal of Soil and Water Conservation, volume 49(3), pages 213-220, entitled, "RUSLE revisited: Status, questions, answers, and the future", describes the revision. Primary differences between the USLE and RUSLE include the following:

R Factor: RUSLE includes more R values for the Western United States than the USLE. For the eastern United States, R values are generally the same as those used in the USLE but includes some revisions.

K Factor: Values used in RUSLE are similar to the USLE values but are adjusted to account for changes, such as freezing and thawing, and soil moisture. These adjustments are calculated at one-half month intervals for use in RUSLE and are applicable in the northern and southern plains, midwest, southern, and eastern United States.

LS Factor: USLE uses one LS table; RUSLE uses four LS tables, as determined by the relationship of rill to interrill erosion. Although both the USLE and RUSLE can account for the effects of complex slopes, RUSLE simplifies this LS determination through the use of computer technology.

C Factor: USLE provides estimates of soil changes for 4-5 crop stage periods throughout the year. RUSLE provides estimates of cover and soil changes on one-half month intervals, especially in relation to canopy, surface residue, residue just under the surface, and the effects of climate on residue decomposition, roughness, roots, and soil consolidation.

P Factor: USLE uses P factors for contouring, contour stripcropping, and terracing from table values established for field slope ranges; and for terraces, the P factor is also based on channel gradients. RUSLE uses P factors for farming across the slope and includes new process-based routines to determine the effect of stripcropping and buffer strips. Values for farming across the slope are based on slope length and steepness, row grade, ridge height, storm severity, soil infiltration, and the cover and roughness conditions. The stripcropping P factor is based on the amount and location of soil deposition.

The equation for predicting soil loss due to wind erosion is E=f(IKCLV). The factors in the equation have the following definitions:
1. *E* is the estimation of average annual soil loss in tons per acre.
2. *f* indicates the equation includes functional relationships that are not straight-line mathematical calculations. 3. I is the soil erodibility index.
4. *K* is the ridge roughness factor.
5. *C* is the climatic factor. All climatic factor values are expressed as a percentage of the value established at Garden City, Kansas. Garden City, Kansas was the location of early research in the WEQ and established the standard for climatic factors against which the other locations are measured.
6. *L* is the unsheltered distance across an erodible field, measured along the prevailing wind erosion direction.
7. *V* is the vegetative cover factor.

The Department was first statutorily required to use the factors from the USLE and WEQ to make highly erodible land (HEL) determinations under the Food Security Act (FSA) of 1985, Pub. L. 99-198. The Department published the equations used to determine HEL during promulgation of the regulations implementing the HEL and wetland conservation provisions of the FSA, 7 CFR Part 12 (see Federal Register, Vol. 52, No. 180, page 35194, September 17, 1987). Section 12.21 provides that land in a soil map unit will be considered to be highly erodible if the quotient of either the RKLS/T or the CI/T equals or exceeds 8. The factors, R, K, and LS are from the USLE. The USLE factors are explained in the U.S. Department of Agriculture Handbook 537. The factors C and I are from the WEQ. The WEQ factors are explained in a paper by N.P. Woodruff and F.H. Siddaway, 1965. The soil loss tolerance (T) value represents the average annual rate of soil erosion that could occur without causing a decline in long term productivity. The specific factors values which are used for determining whether soil map units are considered to be highly erodible are published in the local Field Office Technical Guide (FOTG) which is maintained in each NRCS field office. The values published as of January 1, 1990, in the FOTG are the basis for all HEL determinations. The FOTG is

U.S. ENVIRONMENTAL PROTECTION AGENCY

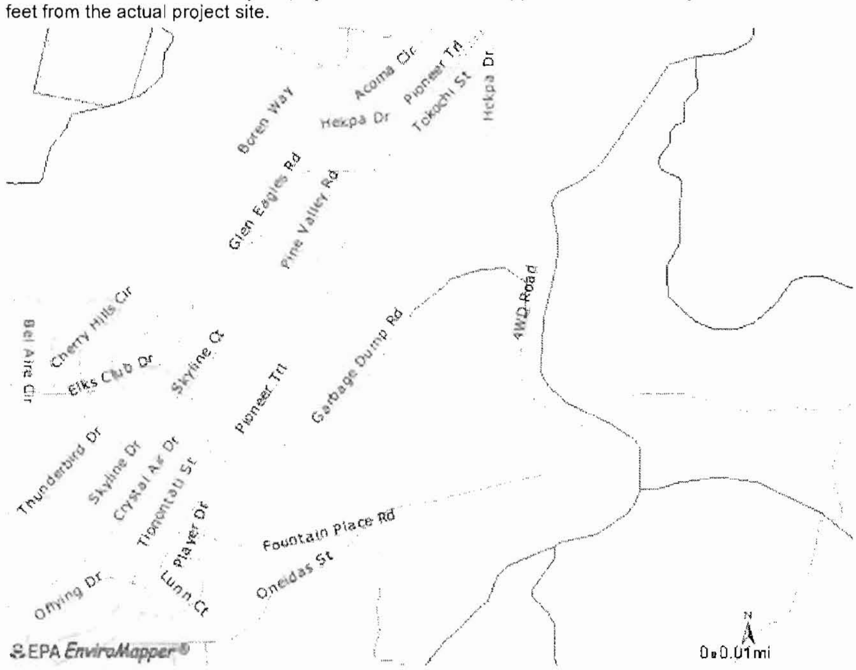
National Pollutant Discharge Elimination System (NPDES)

Rainfall Erosivity Factor Calculator for Small Construction Sites

Facility Information

Facility Name: Meyers Landfill
Start Date: 06/01/2009
End Date: 06/01/2010
Latitude: 38.874
Longitutde: -119.988

Disclaimer: Please note that your project site location is an approximation and may be around 500 feet from the actual project site.



Erosivity Index Calculator Results

AN EROSIVITY INDEX VALUE OF 12.01 HAS BEEN DETERMINED FOR THE CONSTRUCTION PERIOD OF **06/01/2009 - 06/01/2010**.

A rainfall erosivity factor of 5.0 or greater has been calculated for your site and period of construction. **You do not qualify for a waiver from NPDES permitting requirements.**

Start Over

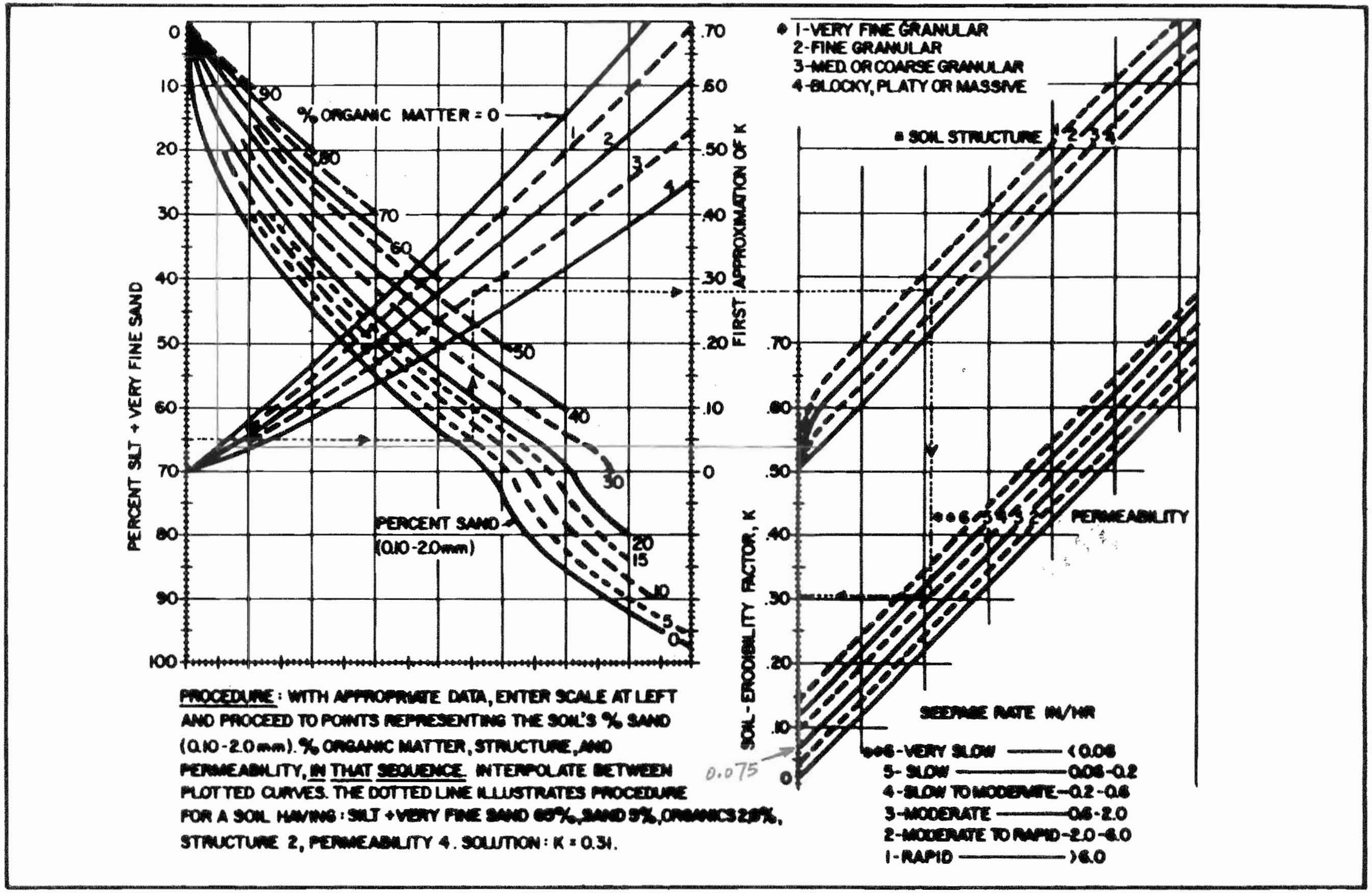


FIGURE 12
Nomograph for Determining Soil Erodibility (K) for
Universal Soil Loss Equation

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FACTSHEET

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Order#: 00-001 Last Reviewed: 05/00

Title: Universal Soil Loss Equation (USLE)

History: Original Factsheet

Written by: Robert P. Stone - Soil Management Specialist/OMAF; Don Hilborn - Byproduct Management Specialist/OMAF

Table of Contents

Background

The Universal Soil Loss Equation (USLE) predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, crop system and management practices. USLE only predicts the amount of soil loss that results from sheet or rill erosion on a single slope and does not account for additional soil losses that might occur from gully, wind or tillage erosion. This erosion model was created for use in selected cropping and management systems, but is also applicable to non-agricultural conditions such as construction sites. The USLE can be used to compare soil losses from a particular field with a specific crop and management system to "tolerable soil loss" rates. Alternative management and crop systems may also be evaluated to determine the adequacy of conservation measures in farm planning.

Five major factors are used to calculate the soil loss for a given site. Each factor is the numerical estimate of a specific condition that affects the severity of soil erosion at a particular location. The erosion values reflected by these factors can vary considerably due to varying weather conditions. Therefore, the values obtained from the USLE more accurately represent long-term averages.

A calculation of soil losses using the USLE may also be done in OMAF's Nutrient Management (NMAN 2000 or upgrade) computer program, SOF001. The soil loss value generated from the USLE equation is used to determine the "soil erosion rating value" in the calculation of the Phosphorus Index.

Universal Soil Loss Equation (USLE)

	1	0.2407
	0	0.1051
1600 ft (488 m)	10	5.5203
	8	3.9857
	6	2.6969
	5	2.1446
	4	1.2137
	3	0.8987
	2	0.4614
	1	0.2964
	0	0.1207
3200 ft (975 m)	10	7.8069
	8	5.6366
	6	3.8140
	5	3.0330
	4	1.6015
	3	1.1858
	2	0.5680
	1	0.3649
	0	0.1386

Equation for Calculation of LS (if not using Table 3A above)

$$LS = [0.065 + 0.0456(slope) + 0.006541(slope)^2] \text{ x } (\text{slope\_length} \div \text{const})^{NN}$$

Where:

slope = slope steepness (%)

slope length = length of slope (ft.)

constant = 72.5 Imperial or 22.1 metric

NN = see Table 3B below

Table 3B. NN Values

S	< 1	1 ≤ Slope < 3	3 ≤ Slope < 5	≥ 5
NN	0.2	0.3	0.4	0.5

Table 4A. Crop Type Factor

Crop Type	Factor
Grain Corn	0.40
Silage Corn, Beans & Canola	0.50

Cereals (Spring & Winter)	0.35
Seasonal Horticultural Crops	0.50
Fruit Trees	0.10
Hay and Pasture	0.02

→ Table 4B. Tillage Method Factor

Tillage Method	Factor
Fall Plow	1.0
Spring Plow	0.90
Mulch Tillage	0.60
Ridge Tillage	0.35
Zone Tillage	0.25
No-Till	0.25

→ Table 5. P Factor Data

Support Practice	P Factor
Up & Down Slope	1.0
Cross Slope	0.75
Contour farming	0.50
Strip cropping, cross slope	0.37
Strip cropping, contour	0.25

Table 6. Soil Loss Tolerance Rates

Soil Erosion Class	Potential Soil Loss (tons/acre/year)
Very Low (tolerable)	<3
Low	3 - 5
Moderate	5 - 10
High	10 - 15
Severe	>15

Table 7. Management Strategies to Reduce Soil Losses

Factor	Management Strategies	Example
R	The R Factor for a field cannot be altered.	--

Prepared By: PDL	Date: 11/22/2008	Subject: Surface Runoff from Design Storm Events	Page No.: 1
Checked By: EB	Date: 12/1/08	Client/Project: USDA Forest Service / Meyers Landfill	Project No. 28-072

SCOPE: The proposed surface water control system for the Meyers Landfill is designed to minimize the surface water flow leaving the site while still removing it from the cap . This calculation determines the quantity of runoff generated by a 100-yr, 24-hour rainfall event and demonstrates how the infiltration areas in the current design will handle the flow quantities. Also the 100-yr, 1-hour design storm event was used to size the stormwater channels. The design storms used for sizing storage capacity (100-yr, 24-hr) and conveyance capacity (100-yr, 1-hr) meet or exceed the design storms specified by the following:

- Title 27 CCR, Table 4.1, "Construction Standards for Units", precipitation and drainage control facilities for a municipal solid waste landfill = 100-year 24-hour storm(1)
- RWQCB Lahontan Region design storm for stormwater control facilities = 20-yr, 1-hr storm(2)
- TRPA design storm for infiltration, conveyance and treatment = 20-yr, 1-hr storm(3)

- Drainage areas calculated from final grading plan using the area command in AutoCad 2009.

Main Swale	52,500 ft^2
Southeast Sediment and Infiltration Area	42,000 ft^2
North Sediment and Infiltration Area	15,000 ft^2
Check Dam Area	13,600 ft^2

- Runoff Coefficient of 0.5 would be appropriate based on open field/pasture setting, however a more conservative value of 1.0 was used. This reflects better reflects conditions prior to vegetation being established, when erosion and sediment would be most likely. It also accounts for a possible rain on snow event by designing the conveyance structures and infiltration areas for 2 times the runoff and flow rates.

Storm Events Requirements:

1. California Code of Regulations,Title 27 Chapter 3,requires drainage control facilities\ for a Class III municipal landfill be designed for 100-yr 24-hour storm
2. The CIWMB guidance calls for stormwater storage faclilties for a Class III MSW landfill be designed for 100-yr 24-hour storm and Conveyance structures be designed for 100-yr, 1 hour storm.
3. Tahoe Regional Planning Agency (TRPA) Code of Ordinances, Chapter 25, requires infiltration faclilities accommodate the volume from a 20-yr, 1 hr storm event, but allow use of an average intensity of 1 inch per hour for the calculation.
4. The Lahontan RWQCB Storm Water Planning Guidance refers back to the TRPA Code of Ordinances Chapter 25, for conveying and infiltrating groundwater.

Based on this the 100-yr 24 hr storm will be used to size the storage and infiltration structures and the 100-yr, 1 hr storm will be used to design the conveyance structures. The 1 in per hour will be checked to make sure the storage features can contain it

- Precipitation (as both rain and snow) taken from:

Figure 31 - Isopluvials of 100-yr 24-hr Precipitation for Northern Half of California in tenths of an Inch, NOAA Atlas 2,Volume XI
Prepared for U.S. Department of Agriculture
Soil Conservation Service, Engineering Division

from figure 31:
Meyers 90 tenths of an inch = 9 inches

The 100-yr 1-hour storm was determined using the methodology outlined in NOAA Atlas 2

Y_{100} =-0.30+0.103x(X_3/X_1)+0.458x[(X_1x(X_1/X_2)]+0.063x(X_5)

Y_{100} =100-yr,1 hour storm precipitation
X_1 = 2yr, 6 hour storm precipitation = 1.6 inches (Figure 23, NOAA Atlas 2)
X_2 = 2yr, 24 hour storm precipitation = 3.5 inches (Figure 26, NOAA Atlas 2)
X_3 = 100yr, 6 hour storm precipitation = 3.5 inches (Figure 25, NOAA Atlas 2)
X_4 = 100yr, 24 hour storm precipitation = 9.0 inches (Figure 31, NOAA Atlas 2)
X_5 = Site Latitude - 32° = 39.92° - 32° = 7.92°

Y_{100} = 0.76 inches

Percolation Rate: 30 min/inch from perc test (ML-TP-02 PERC-1) performed by ERRG in July, 2008

METHOD:

Rational Method to calculate the flows from each subarea. This method uses the following basic formula:

Q = C * I*A
Where:
Q = the storm runoff flow rate
C = the developed runoff coefficient, dimensionless
I_t = the rainfall intensity, inches/hr
A = the area of the drainage subarea, acres

CALCULATION:
Spreadsheet 1 shows the results of the 100-yr 1-hour storm event indicating channel type and flow rates. The velocities and flow depths are derived from the the interpolation of the tables in Spreadsheet 4 which show the relationship between depth, velocity, and flow rate based upon Mannings equation and ditch configuration and liner materials. Attachment A provides description of the vaious columns in Spreadsheet 1

Spreadsheet 2 shows the results of the 100-yr 24-hour storm event indicating flow rates. Attachment A provides description of the vaious columns in Spreadsheet 2.

Below calculations for the 100-yr 24-hour flows into the various infiltration areas compared to infiltration rate over the areas:

Infiltration in main swale from north and east side of landfill

Time to fill drainage swale area 12 inches deep
Swale Surface Area * depth / Q (section 14 flow) =
52,500 ft^2 x 1 foot / (2.81 ft^3/sec x 60 sec/min x 60 min/hour) = 5.2 hours

Time to drain 12-inches of water from swale through infiltration
12 inches x 30 min/in = 360 minutes = 6 hours

Time to fill 1 foot / time to drain 1 foot = 90%

Infiltration in check dam area

Time to fill check dam area 12 inches deep
Check Dam Area * depth / Q (section 4 flow) =
13,600 ft^2 x 1 foot / (5.76 ft^3/sec x 60 sec/min x 60 min/hour) = 0.7 hours

Time to drain 12-inches of water from swale through infiltration
12 inches x 30 min/in = 360 minutes = 6 hours

Time to fill 1 foot / time to drain 1 foot = 10%

Infiltration in southeast sediment and infiltration area

Time to fill south east area 12 inches deep
Surface Area * depth / Q (section 6 flow) =
42,000 ft^2 x 1 foot / (6.13 ft^3/sec x 60 sec/min x 60 min/hour) = 1.9 hours

Time to drain 12-inches of water from swale through infiltration
12 inches x 30 min/in = 360 minutes = 6 hours

Time to fill 1 foot / time to drain 1 foot = 30%

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Infiltration in south east sediment and infiltration area (assuming main swale captures all flow from upper north and east area)

Time to fill south east area 12 inches deep
Surface Area * depth / Q (section 6 flow- section 14 flow) =
42,000 ft^2 x 1 foot x [(6.13-2.81) ft^3/sec x 60 sec/min x 60 min/hour] = 3.5 hours

Time to drain 12-inches of water from swale through infiltration
12 inches x 30 min/in = 360 minutes = 6 hours

Time to fill 1 foot / time to drain 1 foot = 60%

Infiltration area along north sediment area

Time to fill drainage swale area 12 inches deep
length of channel * depth / Q (section 24) =
15,000 ft^2 x 1 foot x (0.85) ft^3/sec / 60 sec/min / 60 min/hour = 4.9 hours

Time to drain 12-inches of water from swale through infiltration
12 inches x 30 min/in = 360 minutes = 6 hours

Time to fill 1 foot / time to drain 1 foot = 80%

TRPA requirements

Flow into main swale through section 14 =	7.38	cfs =	26568	cfh
Area of swale =	52500	sf		
Depth in swale	0.51	feet		
Infiltration in hour = 2 inches, so net depth =	0.34	feet		
Flow into southeast area through section 6 =	16.12	cfs =	58032	cfh
Area of swale =	42000	sf		
Depth in swale	1.38	feet		
Infiltration in hour = 2 inches, so net depth =	1.22	feet		
Flow into north area through section 6 =	2.23	cfs =	8028	cfh
Area of swale =	15000	sf		
Depth in swale	0.54	feet		
Infiltration in hour = 2 inches, so net depth =	0.37	feet		

SUMMARY:

1. The main swale east of the landfill will collect runoff from the east and upper north sides of the landfill. The culvert at the south end will be elevated above the bottom of the swale area to provide storage capacity for this runoff. This area should be able to store/infiltrate approximately 90% of the 100-yr 24-hour runoff and prevent sediment from leaving the site.

2. The check dam area and southeast sedimentation and infiltration area will slow and store the runoff from the west and south side of the landfill cap as well as any overflow from the main swale area. The outlet culvert from the southeast infiltration area will be elevated above the bottom to provide storage capacity. This area should be able to store/infiltrate 70% of the 100-yr 24-hour runoff and prevent sediment from leaving the site.

3. The north sedimentation and infiltration areas will remove seidment and and infiltrate the runoff from the lower north end of the landfill before allowing it offsite toward Saxon Creek. This area should be able to store/infiltrate 80% of the 100-yr 24-hour runoff and prevent sediment from leaving the site.

4. All of the channels around the landfill and between the landfill, main swale and infiltration areas will accommodate the 100-year 1-hour storm event with a maximum required channel depth of 1-foot though ditches depths will vary depending on surrounding grades. The start and end elevations for each are included in Spreadsheets 1 and 2.

5. The Designed basins outlets have been set so that the storage and infiltration capcity of each basin will meet the TRPA requirements in containing the 1 in per hour storm event.

REFERENCES:

(1) California Integrated Waste Management Board, California Code of Regulations, Title 27, Environmental Protection--Division 2, Solid Waste, Table 4.1 Construction Standards for Units.
(2) State of California Regional Water Quality Control Board (RWQCB), Lahontan Region, 2005. "Water Quality Control Plan for the Lahontan Region, North and South Basins," March.
(3) Tahoe Regional Planning Agency Code of Ordinances, Chapter 25, "Best Management Practice Requirements."

Spreadsheet #1 100-yr, 1-hour storm event flow rates, channel velocities, and flow depths

						New Drainage Areas				Elevations									
location	section no.s	contributing upstream sections	channel length	channel slope	type	ID No.	Area (sq. ft.)	Area (acres)	Slope Factor (K)	change in elevation	start elevation	end elevation	Runoff Coefficient	Intensity (in/hr)	Flow from new drainage area (cfs)	flow from upstream drainage areas (cfs)	Flow (cfs)	Velocity (ft/s)	Depth of Flow (ft)
SOUTHEAST																			
westside landfill	1		800	1.5	concrete	A	119,300	2.74	1.00	12.00	6384.00	6372.00	1.00	0.76	2.08	0.00	2.08	5.21	0.51
south side landfill	2	1	500	1	concrete	B	143,500	3.29	1.00	5.00	6372.00	6367.00	1.00	0.76	2.50	2.08	4.59	5.48	0.74
south side	3	2	85	12	rock lined		0	0.00	1.00	10.20	6367.00	6356.80	1.00	0.76	0.00	4.59	4.59	7.25	0.62
south side	4	3,16	190	6	earth	C	29,000	0.67	1.00	11.40	6356.80	6345.40	1.00	0.76	0.51	11.02	11.52	8.01	0.96
south side	5	4	80	12	rock lined		0	0.00	1.00	9.60	6345.40	6335.80	1.00	0.76	0.00	11.52	11.52	9.26	0.89
south side	6	5	250	1	earth	D	42,000	0.96	1.00	2.50	6335.80	6333.30	1.00	0.76	0.73	11.52	12.25	4.15	1.38
south side	7	6	40	4	culvert		0	0.00	1.00	1.60	6334.50	6332.90	1.00	0.76	0.00	12.25	12.25		
									1.00										
East side landfill	8a		500	1	concrete	E	125,000	2.87	1.00	5.00	6378.60	6373.60	1.00	0.76	2.18	0.00	2.18	4.47	0.55
									1.00										
northside landfill (upper)	8		400	2	concrete	F	71,200	1.63	1.00	8.00	6384.00	6376.00	1.00	0.76	1.24	0.00	1.24	4.76	0.36
northside landfill (upper)	9	8	40	6	concrete		0	0.00	1.00	2.40	6376.00	6373.60	1.00	0.76	0.00	1.24	1.24	7.24	0.3
east side	10	8a, 9	40	5	culvert		0	0.00	1.00	2.00	6373.60	6371.60	1.00	0.76	0.00	3.42	3.42		
east side	11	10	70	3	earth		0	0.00	1.00	2.10	6371.60	6369.50	1.00	0.76	0.00	3.42	3.42	4.51	0.69
eastside	12	11	100	3	earth		0	0.00	1.00	3.00	6369.50	6366.50	1.00	0.76	0.00	3.42	3.42	4.51	0.69
eastside	13		200	1	earth	G	54,000	1.24	1.00	2.00	6368.50	6366.50	1.00	0.76	0.94	0.00	0.94	2.16	0.52
eastside	14	12,13	370	1	earth	H	71,400	1.64	1.00	3.70	6366.50	6362.80	1.00	0.76	1.25	4.37	5.61	3.42	1.03
eastside	15	14	40	11.5	culvert		0	0.00	1.00	4.60	6367.00	6362.40	1.00	0.76	0.00	5.61	5.61		
eastside	16	15	100	6	rock lined	I	47,000	1.08	1.00	6.00	6362.40	6356.40	1.00	0.76	0.82	5.61	6.43	6.17	0.81
									1.00										
NORTH									1.00										
westside landfil	17		120	4	concrete	J	11,500	0.26	1.00	4.80	6380.20	6375.40	1.00	0.76	0.20	0.00	0.20	1.98	0.09
westside landfill	18	17	250	10	concrete	K	32,500	0.75	1.00	25.00	6375.40	6350.40	1.00	0.76	0.57	0.20	0.77	7.72	0.23
northside landfill (lower)	19	18	70	1	concrete	L	19,500	0.45	1.00	0.70	6350.40	6349.70	1.00	0.76	0.34	0.77	1.11	3.66	0.41
east side landfill (north)	20		300	7.5	concrete	M	27,000	0.62	1.00	22.50	6373.00	6350.50	1.00	0.76	0.47	0.00	0.47	5.01	0.17
northside landfill (lower)	21	20	80	1	concrete	N	6,500	0.15	1.00	0.80	6350.50	6349.70	1.00	0.76	0.11	0.47	0.58	3.07	0.31
north	22	19,21	35	20	concrete		0	0.00	1.00	7.00	6349.70	6342.70	1.00	0.76	0.00	1.69	1.69	12.55	0.27
north	23	22	40	15	culvert		0	0.00	1.00	6.00	6342.70	6336.70	1.00	0.76	0.00	1.69	1.69		
north	24	23	50	6	concrete			0.00	1.00	3.00	6336.70	6333.70	1.00	0.76	0.00	1.69	1.69	7.76	0.33

Spreadsheet #2 100-yr, 24-hour storm event flow rates

						New Drainage Areas				Elevations							
location	section no.s	contributing upstream sections	channel length	channel slope	type	ID No.	Area (sq. ft.)	Area (acres)	Slope Factor (K)	change in elevation	start elevation	end elevation	Runoff Coefficient	Intensity (in/hr)	Flow from new drainage area (cfs)	flow from upstream drainage areas (cfs)	Flow (cfs)
SOUTHEAST																	
westside landfill	1		800	1.5	concrete	A	119,300	2.74	1.00	12.00	6384.00	6372.00	1.00	0.38	1.04	0.00	1.04
south side landfill	2	1	500	1	concrete	B	143,500	3.29	1.00	5.00	6372.00	6367.00	1.00	0.38	1.25	1.04	2.29
south side	3	2	85	12	rock lined		0	0.00	1.00	10.20	6367.00	6356.80	1.00	0.38	0.00	2.29	2.29
south side	4	3,16	190	6	earth	C	29,000	0.67	1.00	11.40	6356.80	6345.40	1.00	0.38	0.25	5.51	5.76
south side	5	4	80	12	rock lined		0	0.00	1.00	9.60	6345.40	6335.80	1.00	0.38	0.00	5.76	5.76
south side	6	5	250	1	earth	D	42,000	0.96	1.00	2.50	6335.80	6333.30	1.00	0.38	0.37	5.76	6.13
south side	7	6	40	4	culvert		0	0.00	1.00	1.60	6334.50	6332.90	1.00	0.38	0.00	6.13	6.13
									1.00								
East side landfill	8a		500	1	concrete	E	125,000	2.87	1.00	5.00	6378.60	6373.60	1.00	0.38	1.09	0.00	1.09
									1.00								
northside landfill (upper)	8		400	2	concrete	F	71,200	1.63	1.00	8.00	6384.00	6376.00	1.00	0.38	0.62	0.00	0.62
northside landfill (upper)	9	8	40	6	concrete		0	0.00	1.00	2.40	6376.00	6373.60	1.00	0.38	0.00	0.62	0.62
east side	10	8a, 9	40	5	culvert		0	0.00	1.00	2.00	6373.60	6371.60	1.00	0.38	0.00	1.71	1.71
east side	11	10	70	3	earth		0	0.00	1.00	2.10	6371.60	6369.50	1.00	0.38	0.00	1.71	1.71
eastside	12	11	100	3	earth		0	0.00	1.00	3.00	6369.50	6366.50	1.00	0.38	0.00	1.71	1.71
eastside	13		200	1	earth	G	54,000	1.24	1.00	2.00	6368.50	6366.50	1.00	0.38	0.47	0.00	0.47
eastside	14	12,13	370	1	earth	H	71,400	1.64	1.00	3.70	6366.50	6362.80	1.00	0.38	0.62	2.18	2.81
eastside	15	14	40	11.5	culvert		0	0.00	1.00	4.60	6367.00	6362.40	1.00	0.38	0.00	2.81	2.81
eastside	16	15	100	6	rock lined	I	47,000	1.08	1.00	6.00	6362.40	6356.40	1.00	0.38	0.41	2.81	3.22
									1.00								
NORTH									1.00								
westside landfil	17		120	4	concrete	J	11,500	0.26	1.00	4.80	6380.20	6375.40	1.00	0.38	0.10	0.00	0.10
westside landfill	18	17	250	10	concrete	K	32,500	0.75	1.00	25.00	6375.40	6350.40	1.00	0.38	0.28	0.10	0.38
northside landfill (lower)	19	18	70	1	concrete	L	19,500	0.45	1.00	0.70	6350.40	6349.70	1.00	0.38	0.17	0.38	0.55
east side landfill (north)	20		300	7.5	concrete	M	27,000	0.62	1.00	22.50	6373.00	6350.50	1.00	0.38	0.24	0.00	0.24
northside landfill (lower)	21	20	80	1	concrete	N	6,500	0.15	1.00	0.80	6350.50	6349.70	1.00	0.38	0.06	0.24	0.29
north	22	19,21	35	20	concrete		0	0.00	1.00	7.00	6349.70	6342.70	1.00	0.38	0.00	0.85	0.85
north	23	22	40	15	culvert		0	0.00	1.00	6.00	6342.70	6336.70	1.00	0.38	0.00	0.85	0.85
north	24	23	50	6	concrete			0.00	1.00	3.00	6336.70	6333.70	1.00	0.38	0.00	0.85	0.85

Spreadsheet #3 25-yr, 1-hour storm event flow rates

						New Drainage Areas				Elevations							
location	section no.s	contributing upstream sections	channel length	channel slope	type	ID No.	Area (sq. ft.)	Area (acres)	Slope Factor (K)	change in elevation	start elevation	end elevation	Runoff Coefficient	Intensity (in/hr)	Flow from new drainage area (cfs)	flow from upstream drainage areas (cfs)	Flow (cfs)
SOUTHEAST																	
westside landfill	1		800	1.5	concrete	A	119,300	2.74	1.00	12.00	6384.00	6372.00	1.00	1.00	2.74	0.00	2.74
south side landfill	2	1	500	1	concrete	B	143,500	3.29	1.00	5.00	6372.00	6367.00	1.00	1.00	3.29	2.74	6.03
south side	3	2	85	12	rock lined		0	0.00	1.00	10.20	6367.00	6356.80	1.00	1.00	0.00	6.03	6.03
south side	4	3,16	190	6	earth	C	29,000	0.67	1.00	11.40	6356.80	6345.40	1.00	1.00	0.67	14.49	15.16
south side	5	4	80	12	rock lined		0	0.00	1.00	9.60	6345.40	6335.80	1.00	1.00	0.00	15.16	15.16
south side	6	5	250	1	earth	D	42,000	0.96	1.00	2.50	6335.80	6333.30	1.00	1.00	0.96	15.16	16.12
south side	7	6	40	4	culvert		0	0.00	1.00	1.60	6334.50	6332.90	1.00	1.00	0.00	16.12	16.12
									1.00								
East side landfill	8a		500	1	concrete	E	125,000	2.87	1.00	5.00	6378.60	6373.60	1.00	1.00	2.87	0.00	2.87
									1.00								
northside landfill (upper)	8		400	2	concrete	F	71,200	1.63	1.00	8.00	6384.00	6376.00	1.00	1.00	1.63	0.00	1.63
northside landfill (upper)	9	8	40	6	concrete		0	0.00	1.00	2.40	6376.00	6373.60	1.00	1.00	0.00	1.63	1.63
east side	10	8a, 9	40	5	culvert		0	0.00	1.00	2.00	6373.60	6371.60	1.00	1.00	0.00	4.50	4.50
east side	11	10	70	3	earth		0	0.00	1.00	2.10	6371.60	6369.50	1.00	1.00	0.00	4.50	4.50
eastside	12	11	100	3	earth		0	0.00	1.00	3.00	6369.50	6366.50	1.00	1.00	0.00	4.50	4.50
eastside	13		200	1	earth	G	54,000	1.24	1.00	2.00	6368.50	6366.50	1.00	1.00	1.24	0.00	1.24
eastside	14	12,13	370	1	earth	H	71,400	1.64	1.00	3.70	6366.50	6362.80	1.00	1.00	1.64	5.74	7.38
eastside	15	14	40	11.5	culvert		0	0.00	1.00	4.60	6367.00	6362.40	1.00	1.00	0.00	7.38	7.38
eastside	16	15	100	6	rock lined	I	47,000	1.08	1.00	6.00	6362.40	6356.40	1.00	1.00	1.08	7.38	8.46
									1.00								
NORTH									1.00								
westside landfil	17		120	4	concrete	J	11,500	0.26	1.00	4.80	6380.20	6375.40	1.00	1.00	0.26	0.00	0.26
westside landfill	18	17	250	10	concrete	K	32,500	0.75	1.00	25.00	6375.40	6350.40	1.00	1.00	0.75	0.26	1.01
northside landfill (lower)	19	18	70	1	concrete	L	19,500	0.45	1.00	0.70	6350.40	6349.70	1.00	1.00	0.45	1.01	1.46
east side landfill (north)	20		300	7.5	concrete	M	27,000	0.62	1.00	22.50	6373.00	6350.50	1.00	1.00	0.62	0.00	0.62
northside landfill (lower)	21	20	80	1	concrete	N	6,500	0.15	1.00	0.80	6350.50	6349.70	1.00	1.00	0.15	0.62	0.77
north	22	19,21	35	20	concrete		0	0.00	1.00	7.00	6349.70	6342.70	1.00	1.00	0.00	2.23	2.23
north	23	22	40	15	culvert		0	0.00	1.00	6.00	6342.70	6336.70	1.00	1.00	0.00	2.23	2.23
north	24	23	50	6	concrete			0.00	1.00	3.00	6336.70	6333.70	1.00	1.00	0.00	2.23	2.23