Part III
Attachment III-C
Appendix III - C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

Pescadito Environmental Resource Center
MSW No. 2374
Webb County, Texas

PESCADITO
ENVIRONMENTAL RESOURCE CENTER

March 2015

Prepared for:
Rancho Viejo Waste Management, LLC
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Prepared by:
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CB&I

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3-2-2015
STATE OF TEXAS
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ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

1. RAINFALL TOTALS AND DISTRUBUTIONS (III-C.3-1)

3-2-2015

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CB&I

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**MTE** **Date: 1/15/15**
Checked By:	**RDS** **Date: 1/21/15**

TITLE: RAINFALL TOTALS AND DISTRIBUTIONS

Problem Statement

Determine the rainfall volumes and distributions for the 24-hour storm events for the 25-year and 100-year frequencies. The rainfall totals and distributions are used in the HydroCAD computer model to determine rainfall runoff quantities. It is noted that the 100-year 24-hour storm is modeled to demonstrate that the proposed landfill design model results are consistent with the 100-year 24-hour storm events described within the Conditional Letter of Map Revision (CLOMR) that has been approved for the area surrounding this facility.

Given

All runoff calculations have been calculated based on Technical Paper No. 40, "Rainfall Frequency Atlas of the United States" (TP-40) and the SCS Type III storm (cumulative rainfall versus time) for the 24-hour, 25-year and 100-year storm events. Title 30 TAC §330.303(a) requires that the facility be "constructed, maintained, and operated to manage run-on and runoff during the peak discharge of a 25-year rainfall event". The stormwater management system for the facility has been designed to manage flows from the 100-year, 24-hour storm event.

Results

Pages 54 and 56 of TP-40 show the rainfall distribution figures for the 25-year, 24-hour and the 100-year, 24-hour storm events, respectively. The figures specify the maximum rain depth that is anticipated to fall during a given rain event. Rainfall depths for the 25-year and 100-year storm event were estimated based on these figures.

The 25-year, 24-hour rainfall total is **7.6 inches**. The 100-year, 24-hour rainfall total is 9.8 inches. However, it is noted that a correction factor of 97% was applied to this rainfall total as part of the CLOMR Modeling, resulting in a rainfall volume of 9.5 inches. Therefore, 100-year modeling for the proposed facility is based on this corrected rainfall total of **9.5 inches** for the purpose of demonstrating equivalency. The correction factor was not included for the 25-year, 24-hour storm to be consistent with Title 30 TAC §330.303(a).

Please refer to the CLOMR provided in Attachment A of Appendix III-C.1 for additional information.

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

2. STORMWATER MANAGEMENT FEATURES DELINEATION (III-C.3-2)

3-2-2015

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Project #:	**148866**
Calculated By:	**MTE** **Date: 1/15/15**
Checked By:	**RDS** **Date: 1/21/15**

TITLE: STORMWATER MANAGEMENT FEATURES DELINEATION

Problem Statement

Delineate the stormwater management features for existing, intermediate (post-CLOMR) and post-development conditions for the Pescadito Environmental Resource Center.

Given

Pre-Development Conditions

The subcatchment areas for the pre-development conditions were delineated by TRC in the CLOMR, which is included in Attachment A of Appendix III-C.1. The subcatchment areas are shown on Figure 2 of the CLOMR.

This model has been re-developed using HydroCAD to demonstrate equivalency with the CLOMR results. The model diagram is included in Appendix III-C.4-1. Additionally, Table C.3-2 provides the acreages associated with each subcatchment.

Intermediate-Development Conditions (Post-CLOMR)

The subcatchment areas for the intermediate development (post-CLOMR) conditions were delineated by TRC in the CLOMR, which is included in Attachment A of Appendix III-C.1. The subcatchment areas are shown on Figure 7 of the CLOMR.

This model has been re-developed using HydroCAD to demonstrate equivalency with the CLOMR results. Additionally, this model is utilized to compare the pre-development and post-development conditions, as further described in Appendix III-C.1. The model diagram is included in Appendix III-C.4-2. Additionally, Table C.3-2 provides the acreages associated with each subcatchment.

Post-Development Conditions

The post-development conditions have been delineated based on drainage areas and multiple stormwater features. The proposed subcatchment areas inside the landfill's stormwater management system will drain to the proposed detention basin at the south end of the facility prior to downstream discharge. The final landform has been divided into large catchment areas. Each catchment area is served with a downchute ditch. The catchment areas are described as Catchment A through P. The downchutes follow a similar naming convention. Smaller areas (subcatchments) are modeled within each major stormwater catchment area. These subcatchment areas were then modeled for each portion of the catchment that will drain into a terrace berm/check dam; the subcatchment areas were labeled numerically based on the terrace berm level to which they drain (Level 1 is the top terrace berm), and further sub-divided as upper left (UL), lower left (LL), lower right (LR), and upper right (UR) areas (e.g. The top row of subcatchment areas in the Catchment B model is, from left to right, 1ULS, 1LLS, 1LRS, 1URS). The proposed subcatchment areas for Catchments A through P are shown on the Figures within Attachment A of this Appendix (III-C.3-A).

The subcatchment areas for portions of the landfill that do not drain into downchute ditches (i.e. the bottom-most portions of the final landform, the perimeter roads, the perimeter ditches, and the stormwater detention basin) were modeled in the "Pescadito Perimeter" Model, which links all of the large catchment areas of the final landform described above.

The model layouts are provided with the HydroCAD output files in Appendix III-C.4-3.

Results

Delineations of the pre-development, intermediate-development, and post-development stormwater catchment areas for the landfill are provided in Attachment A of this Appendix. The HydroCAD model layout diagrams are included in Appendix III-C.4 to aid in understanding how the modeling is completed. Table C.3-2 lists the areas for all of the subcatchments. All runoff from the proposed landfill footprint, perimeter roads, and ditches will be directed to the stormwater detention basin located at the south end of the facility.

TABLE C.3-2 Subcatchment Area Summary Pescadito Environmental Resource Center	
Subcatchment Name	Total Area (acres)
Pre-Development Conditions (pre-CLOMR)	
DA1	6,950.97
DA2	772.40
DA3	2,948.12
DA4	3,978.63
Intermediate Conditions (post-CLOMR)	
DA1	5,238.87
DA2	1,182.89
DA3	3,526.39
DA4	3,978.61
DA5	198.88
DA6	134.18
DA7	390.23
Proposed Conditions (Post-Development)	
Watershed A	
1ULS	1.30
1URS	1.28
2ULS	1.79
2LLS	0.53
2LRS	0.52
2URS	1.76
3ULS	1.79
3LLS	1.60
3LRS	1.56
3URS	1.76
4ULS	1.79
4MLS	2.14
4LLS	0.53
4LRS	0.52
4MRS	2.08
4URS	1.76
Watershed B	
1ULS	0.91
1LLS	3.58
1LRS	3.80
1URS	1.05
2ULS	1.77
2LLS	1.58
2LRS	1.58
2URS	1.73
3ULS	1.58
3LLS	1.58
3LRS	1.58
3URS	1.58
4ULS	1.58
4LLS	1.58
4LRS	1.57
4URS	1.57
5ULS	1.58
5LLS	1.58
5LRS	1.57
5URS	1.57
6ULS	1.58
6LLS	1.59
6LRS	1.56
6URS	1.57

TABLE C.3-2 Subcatchment Area Summary Pescadito Environmental Resource Center	
Subcatchment Name	Total Area (acres)
Watershed C	
1ULS	1.26
1URS	1.27
2ULS	1.71
2LLS	0.49
2LRS	0.50
2URS	1.74
3ULS	1.71
3LLS	1.48
3LRS	1.51
3URS	1.74
4ULS	1.71
4MLS	1.97
4LLS	0.49
4LRS	0.50
4MRS	2.02
4URS	1.74
Watershed D	
1ULS	0.73
1LLS	2.76
1LRS	2.77
1URS	0.72
2ULS	1.52
2LLS	1.31
2LRS	1.31
2URS	1.51
3ULS	1.31
3LLS	1.32
3LRS	1.32
3URS	1.32
4ULS	1.31
4LLS	1.32
4LRS	1.32
4URS	1.31
5ULS	1.31
5LLS	1.32
5LRS	1.32
5URS	1.32
6ULS	1.32
6LLS	1.32
6LRS	1.32
6URS	1.32
Watershed E	
1ULS	1.24
1URS	1.27
2ULS	1.69
2LLS	0.49
2LRS	0.49
2URS	1.72
3ULS	1.69
3LLS	1.47
3LRS	1.47
3URS	1.72
4ULS	1.69
4MLS	1.96
4LLS	0.49
4LRS	0.49
4MRS	1.96
4URS	1.72

TABLE C.3-2 Subcatchment Area Summary Pescadito Environmental Resource Center	
Subcatchment Name	Total Area (acres)
Watershed F	
1ULS	1.02
1LLS	3.52
1LRS	3.35
1URS	0.89
2ULS	1.68
2LLS	1.45
2LRS	1.45
2URS	1.63
3ULS	1.46
3LLS	1.46
3LRS	1.46
3URS	1.46
4ULS	1.46
4LLS	1.45
4LRS	1.45
4URS	1.45
5ULS	1.46
5LLS	1.45
5LRS	1.45
5URS	1.45
6ULS	1.46
6LLS	1.45
6LRS	1.45
6URS	1.45
Watershed G	
1ULS	1.26
1URS	1.26
2ULS	1.69
2LLS	0.47
2LRS	0.47
2URS	1.69
3ULS	1.69
3LLS	1.41
3LRS	1.42
3URS	1.69
4ULS	1.69
4MLS	1.88
4LLS	0.47
4LRS	0.47
4MRS	1.89
4URS	1.68
Watershed H	
1ULS	0.52
1LLS	2.60
1LRS	3.02
1URS	0.85
2ULS	1.49
2LLS	1.33
2LRS	1.33
2URS	1.57
3ULS	1.34
3LLS	1.34
3LRS	1.34
3URS	1.34
4ULS	1.33
4LLS	1.33
4LRS	1.33
4URS	1.34
5ULS	1.33
5LLS	1.34
5LRS	1.33
5URS	1.34
6ULS	1.33
6LLS	1.34
6LRS	1.33
6URS	1.34

TABLE C.3-2 Subcatchment Area Summary Pescadito Environmental Resource Center	
Subcatchment Name	Total Area (acres)
Watershed I	
1ULS	1.27
1URS	1.25
2ULS	1.79
2LLS	0.53
2LRS	0.52
2URS	1.76
3ULS	1.74
3LLS	1.54
3LRS	1.50
3URS	1.72
4ULS	1.75
4MLS	2.04
4LLS	0.50
4LRS	0.49
4MRS	1.99
4URS	1.72
Watershed J	
1ULS	0.78
1LLS	2.86
1LRS	2.95
1URS	0.78
2ULS	1.59
2LLS	1.35
2LRS	1.37
2URS	1.59
3ULS	1.36
3LLS	1.36
3LRS	1.36
3URS	1.34
4ULS	1.39
4LLS	1.36
4LRS	1.37
4URS	1.39
5ULS	1.36
5LLS	1.36
5LRS	1.36
5URS	1.37
6ULS	1.36
6LLS	1.36
6LRS	1.36
6URS	1.36
Watershed K	
1ULS	1.31
1URS	1.35
2ULS	1.76
2LLS	0.50
2LRS	0.51
2URS	1.81
3ULS	1.76
3LLS	1.50
3LRS	1.53
3URS	1.81
4ULS	1.76
4MLS	2.00
4LLS	0.50
4LRS	0.51
4MRS	2.04
4URS	1.81

TABLE C.3-2 Subcatchment Area Summary Pescadito Environmental Resource Center	
Subcatchment Name	Total Area (acres)
Watershed L	
1ULS	1.40
1LLS	4.67
1LRS	4.69
1URS	1.45
2ULS	1.98
2LLS	1.78
2LRS	1.77
2URS	1.99
3ULS	1.79
3LLS	1.79
3LRS	1.78
3URS	1.78
4ULS	1.78
4LLS	1.78
4LRS	1.78
4URS	1.78
5ULS	1.78
5LLS	1.78
5LRS	1.78
5URS	1.77
6ULS	1.78
6LLS	1.78
6LRS	1.78
6URS	1.78
Watershed M	
1ULS	1.31
1URS	1.29
2ULS	1.77
2LLS	0.50
2LRS	0.50
2URS	1.74
3ULS	1.76
3LLS	1.49
3LRS	1.49
3URS	1.74
4ULS	1.76
4MLS	1.98
4LLS	0.50
4LRS	0.50
4MRS	1.98
4URS	1.74
Watershed N	
1ULS	0.76
1LLS	2.79
1LRS	2.66
1URS	0.76
2ULS	1.54
2LLS	1.30
2LRS	1.28
2URS	1.53
3ULS	1.30
3LLS	1.30
3LRS	1.29
3URS	1.30
4ULS	1.30
4LLS	1.30
4LRS	1.29
4URS	1.29
5ULS	1.30
5LLS	1.30
5LRS	1.29
5URS	1.29
6ULS	1.30
6LLS	1.29
6LRS	1.30
6URS	1.29

TABLE C.3-2 Subcatchment Area Summary Pescadito Environmental Resource Center	
Subcatchment Name	Total Area (acres)
Watershed O	
1ULS	1.26
1URS	1.27
2ULS	1.76
2LLS	0.53
2LRS	0.53
2URS	1.75
3ULS	1.72
3LLS	1.54
3LRS	1.50
3URS	1.73
4ULS	1.72
4MLS	2.04
4LLS	0.50
4LRS	0.50
4MRS	1.99
4URS	1.73
Watershed P	
1ULS	1.39
1LLS	4.50
1LRS	4.59
1URS	1.46
2ULS	1.94
2LLS	1.71
2LRS	1.72
2URS	1.96
3ULS	1.67
3LLS	1.67
3LRS	1.68
3URS	1.68
4ULS	1.76
4LLS	1.76
4LRS	1.76
4URS	1.76
5ULS	1.72
5LLS	1.72
5LRS	1.72
5URS	1.72
6ULS	1.71
6LLS	1.72
6LRS	1.72
6URS	1.72

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

3. CURVE NUMBERS (III-C.3-3)

3-2-2015

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Project #:	**148866**
Calculated By:	**MTE** Date: 1/15/15
Checked By:	**RDS** Date: 1/21/15

TITLE: CURVE NUMBERS

Problem Statement

Determine the weighted curve number (CN) for the post-development conditions of the Pescadito Environmental Resource Center. The CN is used to determine stormwater runoff for subcatchment areas.

It is noted that the curve numbers for the pre-development and intermediate-development (post-CLOMR) conditions are outlined in the CLOMR application documents included in Attachment A of Appendix III-C.1.

Given

- ❑ Table 2-2d *Runoff curve numbers for arid and semiarid rangelands*
- ❑ HELP Model *Engineering Documentation for Version 3* regression equation for adjustment of curve number for surface slope

$$CN_{II} = 100 - \left(100 - CN_{II_0}\right) * \left(\frac{L^{*2}}{S^{*2}}\right)^{{CN_{II_0}}^{-0.81}}$$

Where,

CN_{II}	=	AMC Curve Number (adjusted for slope)
CN_{II_0}	=	AMC Curve Number (unadjusted)
L	=	Length (ft)
S	=	Slope (ft/ft)
L^*	=	Standardized dimensionless length ($L/500\ ft$)
S^*	=	Standardized dimensionless slope ($S/0.04$)

Assumptions

- ❑ Due to the fact that the proposed development has engineered construction features, surficial soils are not considered. Instead, an unadjusted curve number of 90 was conservatively assumed for the proposed conditions. It is noted that, based on the curve numbers listed in Table 2-2d from the TR-55 manual (see subsequent attached pages), a value of 90 for the final landform is conservative, assuming fair hydrologic conditions for Soil Group D with a grassed cover. Soil Group D characteristics are appropriately conservative for modeling due to their high runoff potential.

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TITLE: CURVE NUMBERS

- The detention basin was modeled with a curve number of 98, which is an appropriate curve number for water surfaces.
- A slope length of 206 feet and 4:1 slopes (0.25 ft/ft) are typical of final landform conditions. Due to the fact that the TR-55 curve numbers presented in Table 2-2d are applicable for moderate slopes (up to 0.04 ft/ft), a curve number adjustment for slope is needed for final cover conditions.

Calculation

Calculate the adjusted curve number based slope length, slope, and an unadjusted curve number.

$$CN_{II} = 100 - \left(100 - CN_{II_0}\right) * \left(\frac{L^{*2}}{S^{*2}}\right)^{CN_{II_0}^{-0.81}}$$

$$CN_{II} = 100 - (100 - 90) * \left(\frac{0.412^2}{6.25^2}\right)^{90^{-0.81}}$$

$$CN_{II} = 91.325\ (\approx 92)$$

Result

A calculated adjusted curve number based on slope and fair hydrologic conditions for Soil Group D with a grassed cover is 92.

USDA

United States
Department of
Agriculture

Natural Resources Conservation Service

Conservation Engineering Division

Technical Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2/]	A [3/]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-94/168b
September 1994

EPA

The Hydrologic Evaluation of Landfill Performance (HELP) Model

Engineering Documentation for Version 3

where

CN_{II_0}	=	AMC-II curve number for mild slope (unadjusted for slope)
C_0	=	regression constant for a given level of vegetation
C_1	=	regression constant for a given level of vegetation
C_2	=	regression constant for a given level of vegetation
IR	=	infiltration correlation parameter for given soil type

The relationship between CN_{II}, the vegetative cover and default soil texture is shown graphically in Figure 8. Table 7 gives values of C_0, C_1 and C_2 for the five types of vegetative cover built into the HELP program.

4.2.3 Adjustment of Curve Number for Surface Slope

A regression equation was developed to adjust the AMC-II curve number for surface slope conditions. The regression was developed based on kinematic wave theory where

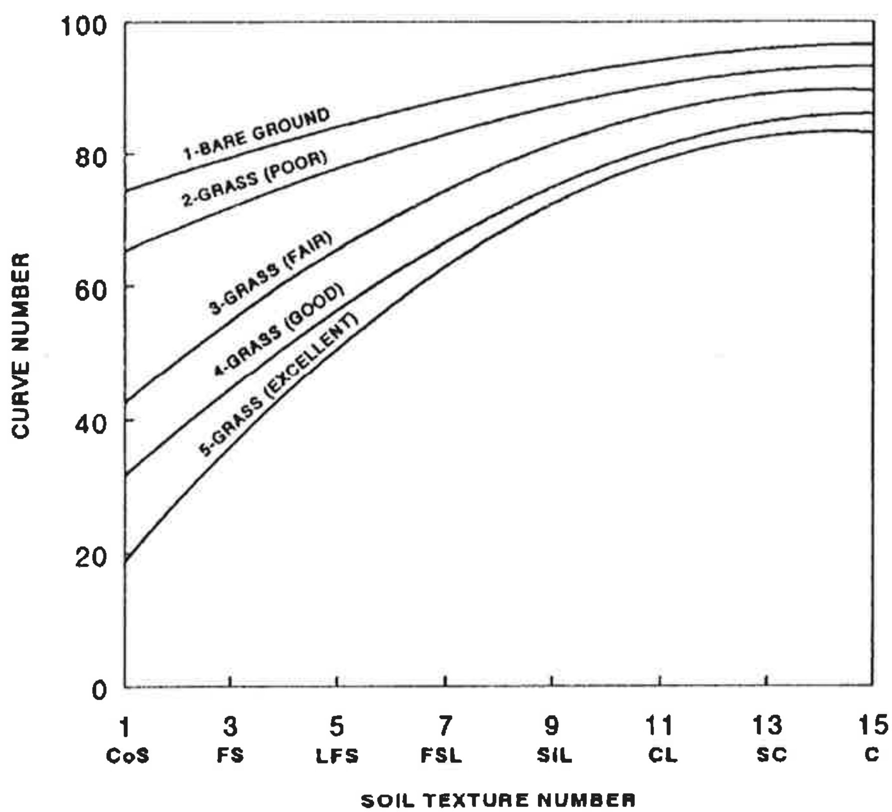

Figure 8. Relation between SCS Curve Number and Default Soil Texture Number for Various Levels of Vegetation

TABLE 7. CONSTANTS FOR USE IN EQUATION 32

Vegetative Cover	C_0	C_1	C_2
Bare Ground	96.77	-20.80	-54.94
Poor Grass	93.51	-24.85	-71.92
Fair Grass	90.09	-23.73	-158.4
Good Grass	86.72	-43.38	-151.2
Excellent Grass	83.83	-26.91	-229.4

the travel time of runoff from the top of a slope to the bottom of the slope is computed as follows:

$$t_{run} = \frac{1.5}{(i - I)^{1/3}} \left(\frac{L^2}{S}\right)^{1/3} \left(\frac{1.49}{n}\right)^{-2/3} \qquad (33)$$

where

t_{run} = runoff travel time (time of concentration), minutes

i = steady-state rainfall intensity (rate), inches/hour

I = steady-state infiltration rate, inches/hour

L = slope length, feet

S = surface slope, dimensionless

n = Manning's roughness coefficient, dimensionless

A decrease in travel time results in less infiltration because less time is available for infiltration to occur.

Using the KINEROS kinematic runoff and erosion model (Woolhiser, Smith, and Goodrich, 1990), hundreds of runoff estimates were generated using different combinations of soil texture class, level of vegetation, slope, slope length, and rainfall depth, duration and temporal distribution. Using these estimates, the curve number that would yield the estimated runoff was calculated from the rainfall depth and the runoff estimate. These curve numbers were regressed with the slope length, surface slope and the curve number that would be generated for the soil texture and level of vegetation placed at a mild slope. The four soil textures used included loamy sand, sandy loam,

loam, and clayey loam as specified by saturated hydraulic conductivity, capillary drive, porosity, and maximum relative saturation, Two levels of vegetation were described--a good stand of grass (bluegrass sod) and a poor stand of grass (clipped range). Slopes of 0.04,0.10,0.20,0.35, and 0.50 ft/ft and slope lengths of 50, 100, 250, and 500 ft were used. Rainfalls of 1.1 inches, l-hour duration and 2nd quartile Huff distribution and of 3.8 inches, 6-hour duration and balanced distribution were modeled.

The resulting regression equation used for adjusting the AMC-II curve number computed for default soils and vegetation placed at mild slopes, CN_{II_o}, is:

$$CN_{II} = 100 - (100 - CN_{II_o}) \cdot \left(\frac{L^{*2}}{S^*}\right)^{CN_{II_o}^{-0.81}} \tag{34}$$

where

L^* = standardized dimensionless length, (L/500 ft)

S^* = standardized dimensionless slope, (S/0.04)

This same equation is used to adjust user-specified AMC-II curve numbers for surface slope conditions by substituting the user value for CN_{II_o} in Equation 34.

4.2.4 Adjustment of Curve Number for Frozen Soil

When the HELP program predicts frozen conditions to exist, the value of CN_{II} is increased, resulting in a higher calculated runoff. Knisel et al. (1985) found that this type of curve number adjustment in the CREAMS model resulted in improved predictions of annual runoff for several test watersheds. If the CN_{II} for unfrozen soil is less than or equal to 80, the CN_{II} for frozen soil conditions is set at 95. When the unfrozen soil CN_{II} is greater than 80, the CN_{II} is reset to be 98 on days when the program has determined the soil to be frozen. This adjustment results in an increase in CN_I and consequently a decrease in S_{mx} and S' (Equations 19, 26, and 30).

From Equations 19 and 21, it is apparent that as S' approaches zero, Q approaches P. In other words, as S' decreases, the calculated runoff becomes closer to being equal to the net rainfall which is most often, when frozen soil conditions exist, predominantly snowmelt. This will result in a decrease in infiltration under frozen soil conditions, which has been observed in numerous studies.

4.2.5 Summary of Daily Runoff Computation

The HELP model determines daily runoff by the following procedure:

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

4. LAG TIME DETERMINATION (III-C.3-4)

3-2-2015

STATE OF TEXAS
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67165
REGISTERED
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Client:	Rancho Viejo Waste Management, LTD
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	MTE	Date: 1/15/15
Checked By:	RDS	Date: 1/21/15

TITLE: LAG TIME DETERMINATION

Problem Statement

Summarize the input parameters for HydroCAD related to Time of Concentration lag time determination. These parameters are used to describe how stormwater runoff is distributed over time. The time of concentration is typically defined as the time required for a particle of water to travel from the most hydrologically remote point in a subcatchment area to the point of collection. HydroCAD automatically calculates the Time of Concentration based on the input values summarized in this document.

Given

- The time of concentration flow paths for the pre-development and intermediate development (post-CLOMR) conditions are outlined in the CLOMR application (see Attachment A of Appendix III-C.1).

- The time of concentration flow paths for the post-development conditions were calculated to be the flow paths from the uppermost points in each subcatchment area to the terrace benches collecting those respective subcatchment areas.

- The methodology that HydroCAD uses to calculate the SCS lag time is based on Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds, published by the Soil Conservation Service.

- Shallow concentrated flow determinations are based on the TR-55 Shallow Concentrated Flow procedure. Please see the attached Appendix G of the HydroCAD Technical Reference for a summary table of velocity factors for shallow concentrated flow determinations.

Assumptions

The following assumptions were made in the calculations:

- The Manning's coefficient "n" for sheet flow for the proposed conditions is assumed to 0.15, indicative of short-grass prairie vegetative cover. This number is appropriate for the type of grass anticipated to grow on the landform after final closure and is the HydroCAD default.

Client:	**Rancho Viejo Waste Management, LTD**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**MTE** — **Date:** **1/15/15**
Checked By:	**RDS** — **Date:** **1/21/15**

TITLE: LAG TIME DETERMINATION

- For each watershed the time of concentration, T_c, is the sum of the travel times, T_t, of various consecutive flow segments. There are three types of flow: sheet flow, shallow concentrated flow, and open channel flow.
- Sheet flow is assumed to become shallow concentrated flow at 300 feet. This assumption is used in the CLOMR application, as well as the pre-development, intermediate and post-development conditions and is based on the TR-55 procedures.
- For the proposed final landform and perimeter grading areas, an average flow velocity of 7 ft/sec was assumed in shallow concentrated flow calculations, which is the HydroCAD default for grass pasture. Please note that shallow concentrated flow will only be present in the subcatchment areas on the plateau of the final landform; the time of concentration flow paths located on the sideslopes of the final landform are all less than 300 feet.

The following formulas are used by HydroCAD to determine lag times for subcatchment areas:

Sheet Flow:

Sheet flow is flow over plane surfaces and is calculated by HydroCAD using the following equation.

$$T_t = \frac{0.007(nL)^{0.8}}{P_2^{\,0.5}S^{0.4}}$$

Where:

T_t = Travel time (hours)
P_2 = 2-year, 24-hour rainfall
S = Land slope along flow path (ft/ft)
L = Flow Length (ft)
N = Manning's coefficient

Client:	**Rancho Viejo Waste Management, LTD**		
Project:	**Pescadito Environmental Resource Center**		
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Checked By:	**RDS**	**Date:**	**1/21/15**

TITLE: LAG TIME DETERMINATION

Shallow Concentrated Flow:

Average velocity is calculated by HydroCAD using the following equation.

$$T_t = \frac{L}{3{,}600V}$$

Where:

L = Flow Length, ft
V = Average velocity, ft/sec
3,600 = Conversion factor from seconds to hours

Results

A summary of the flow lengths and slopes used to calculate the lag time for each subcatchment area is provided in the Table C.3-4. The table also includes the Time of Concentration calculated by HydroCAD for each subcatchment area.

Please note that the pre-development and intermediate-development (post-CLOMR) drainage areas use a direct input lag time in the models; the calculation methodology for these lag times is outlined in the CLOMR.

TABLE C.3-4 Subcatchment Lag Time Pescadito Environmental Resource Center					
Subcatchment Name	Sheet Flow Input Values		Shallow Concentrated Flow Input Values		Resultant Time of Concentration
	Length (ft)	Slope (%)	Length (ft)	Slope (%)	(Min)
Pre-Development Conditions (pre-CLOMR)					
DA1	N/A	N/A	N/A	N/A	205.2
DA2	N/A	N/A	N/A	N/A	80.2
DA3	N/A	N/A	N/A	N/A	147.6
DA4	N/A	N/A	N/A	N/A	249.3
Intermediate Conditions (post-CLOMR) - Subcatchments Outside of PERC Stormwater Management System					
DA1	N/A	N/A	N/A	N/A	172.8
DA2	N/A	N/A	N/A	N/A	163.8
DA3	N/A	N/A	N/A	N/A	147.6
DA4	N/A	N/A	N/A	N/A	249.3
DA5	N/A	N/A	N/A	N/A	52.2
DA6	N/A	N/A	N/A	N/A	35.1
DA7	N/A	N/A	N/A	N/A	47.8
Post-Development Conditions - Subcatchments Inside of PERC Stormwater Management System					
Watershed A					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
Watershed B					
1ULS	284	6%	N/A	6%	13.4
1LLS	300	6%	284	6%	16.8
1LRS	300	6%	284	6%	16.8
1URS	300	6%	13	6%	14.2
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9

TABLE C.3-4 Subcatchment Lag Time Pescadito Environmental Resource Center					
Subcatchment Name	Sheet Flow Input Values		Shallow Concentrated Flow Input Values		Resultant Time of Concentration
	Length (ft)	Slope (%)	Length (ft)	Slope (%)	(Min)
Watershed C					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
Watershed D					
1ULS	265	6%	N/A	6%	12.7
1LLS	300	6%	278	6%	16.7
1LRS	300	6%	278	6%	16.7
1URS	261	6%	N/A	6%	12.6
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9
Watershed E					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9

TABLE C.3-4 Subcatchment Lag Time Pescadito Environmental Resource Center					
Subcatchment Name	Sheet Flow Input Values		Shallow Concentrated Flow Input Values		Resultant Time of Concentration
	Length (ft)	Slope (%)	Length (ft)	Slope (%)	(Min)
Watershed F					
1ULS	300	6%	17	6%	14.2
1LLS	300	6%	285	6%	16.8
1LRS	300	6%	285	6%	16.8
1URS	292	6%	N/A	6%	13.7
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9
Watershed G					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
Watershed H					
1ULS	241	6%	N/A	6%	11.8
1LLS	300	6%	243	6%	16.4
1LRS	300	6%	243	6%	16.4
1URS	291	6%	N/A	6%	13.7
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9

TABLE C.3-4 Subcatchment Lag Time Pescadito Environmental Resource Center					
Subcatchment Name	Sheet Flow Input Values		Shallow Concentrated Flow Input Values		Resultant Time of Concentration
	Length (ft)	Slope (%)	Length (ft)	Slope (%)	(Min)
Watershed I					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
Watershed J					
1ULS	268	6%	N/A	6%	12.8
1LLS	300	6%	279	6%	16.8
1LRS	300	6%	279	6%	16.8
1URS	270	6%	N/A	6%	12.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9
Watershed K					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9

TABLE C.3-4 Subcatchment Lag Time Pescadito Environmental Resource Center					
Subcatchment Name	Sheet Flow Input Values		Shallow Concentrated Flow Input Values		Resultant Time of Concentration
	Length (ft)	Slope (%)	Length (ft)	Slope (%)	(Min)
Watershed L					
1ULS	300	6%	59	6%	14.6
1LLS	300	6%	295	6%	16.9
1LRS	300	6%	295	6%	16.9
1URS	300	6%	70	6%	14.7
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9
Watershed M					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
Watershed N					
1ULS	270	6%	N/A	6%	12.9
1LLS	300	6%	267	6%	16.6
1LRS	300	6%	267	6%	16.6
1URS	264	6%	N/A	6%	12.7
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9

TABLE C.3-4 Subcatchment Lag Time Pescadito Environmental Resource Center					
Subcatchment Name	Sheet Flow Input Values		Shallow Concentrated Flow Input Values		Resultant Time of Concentration
	Length (ft)	Slope (%)	Length (ft)	Slope (%)	(Min)
Watershed O					
1ULS	206	25%	N/A	N/A	5.9
1URS	206	25%	N/A	N/A	5.9
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4MLS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4MRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
Watershed P					
1ULS	300	6%	63	6%	14.7
1LLS	300	6%	294	6%	16.9
1LRS	300	6%	294	6%	16.9
1URS	300	6%	76	6%	14.8
2ULS	206	25%	N/A	N/A	5.9
2LLS	206	25%	N/A	N/A	5.9
2LRS	206	25%	N/A	N/A	5.9
2URS	206	25%	N/A	N/A	5.9
3ULS	206	25%	N/A	N/A	5.9
3LLS	206	25%	N/A	N/A	5.9
3LRS	206	25%	N/A	N/A	5.9
3URS	206	25%	N/A	N/A	5.9
4ULS	206	25%	N/A	N/A	5.9
4LLS	206	25%	N/A	N/A	5.9
4LRS	206	25%	N/A	N/A	5.9
4URS	206	25%	N/A	N/A	5.9
5ULS	206	25%	N/A	N/A	5.9
5LLS	206	25%	N/A	N/A	5.9
5LRS	206	25%	N/A	N/A	5.9
5URS	206	25%	N/A	N/A	5.9
6ULS	206	25%	N/A	N/A	5.9
6LLS	206	25%	N/A	N/A	5.9
6LRS	206	25%	N/A	N/A	5.9
6URS	206	25%	N/A	N/A	5.9

The Shallow Concentrated Flow procedure (a.k.a. Upland Method) uses a *velocity factor*, K_V, as listed below. The first two surfaces (paved and unpaved) are the basis for TR-55 Figure 3-1, and the factors were originally obtained from TR-55 Appendix F. The remaining surfaces were taken from NEH-4 Figure 15.2, with the factors derived from that chart. Subsequent revisions to NEH Part 630 provide *numerical* K_V values which are in good agreement with the original chart, except for "Grassed Waterways", which appears to have changed from 15.0 to 16.13, making it the same as the TR-55 "Unpaved" condition. For compatibility with previous calculations, the HydroCAD lookup table continues to supply the original K_V values as listed below. If different values are required for any reason, HydroCAD allows direct K_V entry instead of using the lookup table. See page 55 for further details on Shallow Concentrated Flow.

Surface Description	K_V [ft/sec]	K_V [m/sec]
Paved	20.33	6.2
Unpaved	16.13	4.92
Grassed Waterway	15.0	4.57
Nearly Bare & Untilled	10.0	3.05
Cultivated Straight Rows	9.0	2.74
Short Grass Pasture	7.0	2.13
Woodland	5.0	1.52
Forest w/Heavy Litter	2.5	0.76

Some descriptions have been abbreviated. Velocity factors have the same units as a velocity, and may be converted between English and metric as described on page 43.

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

5. SUBCATCHMENT AREA DISCHARGE RATES (III-C.3-5)

3-2-2015

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER

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Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**MTE**	**Date:**	**1/15/15**
Checked By:	**RDS**	**Date:**	**1/21/15**

TITLE: SUBCATCHMENT AREA DISCHARGES RATES

Problem Statement

Determine the stormwater runoff rates for the post-development conditions for the Pescadito Environmental Resource Center. Stormwater discharge rates from the various catchment and subcatchment areas are used to determine the adequacy of terrace berms, downchutes, and other stormwater controls.

Given

The stormwater runoff was calculated using HydroCAD. Various parameters, such as rainfall, drainage area, flow lengths within catchments, and discharge and storage volume of the stormwater detention basins are entered into the program. This calculation provides a summary of these input values and the model results. Equations to determine these parameters are described in previous portions of this Appendix (III-C.3-1 through III-C.3-4).

Storm Model Setup

The stormwater methodology and base information was defined as follows:

Runoff Calculation Method:	SCS TR-20
Reach Routing Method:	Storage Indication Method (also known as Modified-Puls)
Pond Routing Method:	Storage Indication Method (also known as Modified-Puls)
Storm Distribution:	SCS Type III 24-hour storm
Unit Hydrograph:	SCS

Model Calculations and Results

The stormwater model was analyzed for the 24-hour storm events for the 25-year and 100-year frequencies. Table C.3-5 summarizes the discharge rates for the 25-year and 100-year storm events, respectively. In addition, reports summarizing the results of the HydroCAD model runs for each storm event are provided in Appendix III-C.4.

TABLE C.3-5 Subcatchment Area Discharge Summary Pescadito Environmental Resource Center		
Subcatchment Name	Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm
Existing Conditions		
DA1	5,577.72	7,899.97
DA2	1,194.90	1,687.61
DA3	2,631.28	3,835.91
DA4	2,669.37	3,819.68
Proposed Conditions - Subcatchments Outside of Stormwater Management System		
DA1	4,896.53	6,885.92
DA2	622.69	882.57
DA3	2,896.20	4,191.47
DA4	2,669.42	3,819.89
DA5	317.73	471.92
DA6	255.01	380.18
DA7	703.60	1,024.74
Proposed Conditions - Subcatchments Inside of Stormwater Management System		
Watershed A		
1ULS	9.38	11.87
1URS	9.25	11.70
2ULS	12.94	16.38
2LLS	3.86	4.88
2LRS	3.76	4.75
2URS	12.70	16.08
3ULS	12.94	16.38
3LLS	11.57	14.64
3LRS	11.27	14.26
3URS	12.70	16.07
4ULS	12.95	16.39
4MLS	15.42	19.52
4LLS	3.85	4.88
4LRS	3.75	4.75
4MRS	15.02	19.01
4URS	12.69	16.07
Watershed B		
1ULS	5.19	6.58
1LLS	18.84	23.86
1LRS	20.00	25.33
1URS	5.91	7.49
2ULS	12.80	16.20
2LLS	11.39	14.42
2LRS	11.39	14.42
2URS	12.50	15.82
3ULS	11.42	14.45
3LLS	11.41	14.44
3LRS	11.41	14.44
3URS	11.42	14.46
4ULS	11.41	14.45
4LLS	11.43	14.46
4LRS	11.35	14.37
4URS	11.35	14.37
5ULS	11.41	14.44
5LLS	11.45	14.49
5LRS	11.33	14.34
5URS	11.35	14.36
6ULS	11.41	14.44
6LLS	11.46	14.51
6LRS	11.25	14.24
6URS	11.35	14.36

TABLE C.3-5 Subcatchment Area Discharge Summary Pescadito Environmental Resource Center		
Subcatchment Name	Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed C		
1ULS	9.06	11.47
1URS	9.19	11.63
2ULS	12.34	15.62
2LLS	3.56	4.50
2LRS	3.64	4.61
2URS	12.54	15.87
3ULS	12.33	15.61
3LLS	10.68	13.51
3LRS	10.92	13.82
3URS	12.55	15.88
4ULS	12.33	15.61
4MLS	14.24	18.02
4LLS	3.56	4.50
4LRS	3.64	4.61
4MRS	14.56	18.42
4URS	12.55	15.89
Watershed D		
1ULS	4.27	5.41
1LLS	14.55	18.42
1LRS	14.59	18.47
1URS	4.19	5.31
2ULS	10.97	13.89
2LLS	9.47	11.99
2LRS	9.49	12.01
2URS	10.92	13.82
3ULS	9.49	12.01
3LLS	9.51	12.04
3LRS	9.53	12.06
3URS	9.54	12.07
4ULS	9.49	12.01
4LLS	9.51	12.04
4LRS	9.53	12.06
4URS	9.53	12.07
5ULS	9.48	12.00
5LLS	9.51	12.04
5LRS	9.52	12.06
5URS	9.54	12.08
6ULS	9.54	12.07
6LLS	9.51	12.04
6LRS	9.52	12.05
6URS	9.54	12.07
Watershed E		
1ULS	8.94	11.31
1URS	9.16	11.59
2ULS	12.19	15.43
2LLS	3.54	4.48
2LRS	3.54	4.48
2URS	12.40	15.69
3ULS	12.20	15.44
3LLS	10.62	13.44
3LRS	10.62	13.44
3URS	12.41	15.70
4ULS	12.20	15.44
4MLS	14.16	17.93
4LLS	3.54	4.48
4LRS	3.54	4.48
4MRS	14.16	17.93
4URS	12.39	15.69

TABLE C.3-5 Subcatchment Area Discharge Summary Pescadito Environmental Resource Center		
Subcatchment Name	Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed F		
1ULS	5.70	7.22
1LLS	18.50	23.43
1LRS	17.60	22.29
1URS	5.05	6.39
2ULS	12.15	15.38
2LLS	10.45	13.23
2LRS	10.46	13.24
2URS	11.78	14.91
3ULS	10.57	13.37
3LLS	10.56	13.36
3LRS	10.56	13.37
3URS	10.57	13.38
4ULS	10.54	13.34
4LLS	10.50	13.29
4LRS	10.51	13.30
4URS	10.50	13.29
5ULS	10.55	13.35
5LLS	10.50	13.29
5LRS	10.51	13.30
5URS	10.50	13.29
6ULS	10.57	13.37
6LLS	10.50	13.29
6LRS	10.50	13.30
6URS	10.50	13.29
Watershed G		
1ULS	9.12	11.55
1URS	9.13	11.56
2ULS	12.20	15.44
2LLS	3.39	4.30
2LRS	3.41	4.32
2URS	12.20	15.44
3ULS	12.19	15.44
3LLS	10.18	12.88
3LRS	10.23	12.94
3URS	12.18	15.41
4ULS	12.20	15.44
4MLS	13.57	17.18
4LLS	3.39	4.29
4LRS	3.41	4.31
4MRS	13.63	17.26
4URS	12.16	15.39
Watershed H		
1ULS	3.12	3.95
1LLS	13.78	17.46
1LRS	16.05	20.32
1URS	4.83	6.12
2ULS	10.77	13.63
2LLS	9.58	12.12
2LRS	9.62	12.18
2URS	11.33	14.34
3ULS	9.67	12.24
3LLS	9.68	12.25
3LRS	9.70	12.27
3URS	9.70	12.28
4ULS	9.62	12.18
4LLS	9.64	12.20
4LRS	9.64	12.20
4URS	9.65	12.22
5ULS	9.62	12.18
5LLS	9.65	12.21
5LRS	9.62	12.18
5URS	9.65	12.21
6ULS	9.62	12.18
6LLS	9.66	12.23
6LRS	9.61	12.16
6URS	9.65	12.21

TABLE C.3-5 Subcatchment Area Discharge Summary Pescadito Environmental Resource Center		
Subcatchment Name	Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed I		
1ULS	9.17	11.60
1URS	9.03	11.43
2ULS	12.94	16.37
2LLS	3.83	4.85
2LRS	3.74	4.73
2URS	12.74	16.13
3ULS	12.60	15.95
3LLS	11.11	14.07
3LRS	10.85	13.73
3URS	12.40	15.70
4ULS	12.64	16.00
4MLS	14.76	18.68
4LLS	3.64	4.61
4LRS	3.56	4.50
4MRS	14.41	18.23
4URS	12.43	15.73
Watershed J		
1ULS	4.53	5.73
1LLS	15.09	19.11
1LRS	15.54	19.68
1URS	4.53	5.74
2ULS	11.51	14.57
2LLS	9.79	12.39
2LRS	9.89	12.52
2URS	11.46	14.51
3ULS	9.82	12.43
3LLS	9.83	12.44
3LRS	9.82	12.43
3URS	9.66	12.23
4ULS	9.81	12.42
4LLS	9.82	12.42
4LRS	9.92	12.55
4URS	10.05	12.72
5ULS	9.83	12.45
5LLS	9.83	12.44
5LRS	9.85	12.46
5URS	9.86	12.48
6ULS	9.81	12.42
6LLS	9.84	12.46
6LRS	9.83	12.45
6URS	9.86	12.48
Watershed K		
1ULS	9.49	12.01
1URS	9.72	12.30
2ULS	12.75	16.13
2LLS	3.61	4.57
2LRS	3.69	4.67
2URS	13.06	16.53
3ULS	12.73	16.11
3LLS	10.83	13.71
3LRS	11.07	14.01
3URS	13.07	16.54
4ULS	12.74	16.12
4MLS	14.47	18.32
4LLS	3.58	4.53
4LRS	3.69	4.67
4MRS	14.76	18.68
4URS	13.06	16.53

TABLE C.3-5 Subcatchment Area Discharge Summary Pescadito Environmental Resource Center		
Subcatchment Name	Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed L		
1ULS	7.74	9.80
1LLS	24.52	31.05
1LRS	24.64	31.21
1URS	8.04	10.18
2ULS	14.32	18.12
2LLS	12.83	16.25
2LRS	12.76	16.15
2URS	14.38	18.20
3ULS	12.92	16.36
3LLS	12.92	16.36
3LRS	12.87	16.30
3URS	12.85	16.27
4ULS	12.86	16.27
4LLS	12.86	16.28
4LRS	12.84	16.25
4URS	12.82	16.23
5ULS	12.86	16.28
5LLS	12.84	16.26
5LRS	12.85	16.26
5URS	12.82	16.22
6ULS	12.87	16.29
6LLS	12.83	16.25
6LRS	12.86	16.28
6URS	12.83	16.24
Watershed M		
1ULS	9.46	11.97
1URS	9.29	11.76
2ULS	12.77	16.17
2LLS	3.58	4.53
2LRS	3.58	4.53
2URS	12.57	15.91
3ULS	12.70	16.08
3LLS	10.73	13.58
3LRS	10.73	13.59
3URS	12.57	15.92
4ULS	12.74	16.13
4MLS	14.31	18.12
4LLS	3.58	4.53
4LRS	3.58	4.53
4MRS	14.31	18.11
4URS	12.59	15.93
Watershed N		
1ULS	4.40	5.58
1LLS	14.71	18.63
1LRS	14.02	17.75
1URS	4.42	5.60
2ULS	11.10	14.05
2LLS	9.38	11.87
2LRS	9.23	11.69
2URS	11.02	13.95
3ULS	9.40	11.90
3LLS	9.40	11.89
3LRS	9.29	11.76
3URS	9.32	11.80
4ULS	9.42	11.93
4LLS	9.39	11.88
4LRS	9.32	11.80
4URS	9.31	11.79
5ULS	9.41	11.92
5LLS	9.38	11.87
5LRS	9.35	11.83
5URS	9.32	11.79
6ULS	9.38	11.87
6LLS	9.35	11.83
6LRS	9.35	11.84
6URS	9.31	11.79

TABLE C.3-5 Subcatchment Area Discharge Summary Pescadito Environmental Resource Center		
Subcatchment Name	Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed O		
1ULS	9.08	11.50
1URS	9.20	11.65
2ULS	12.73	16.11
2LLS	3.84	4.86
2LRS	3.84	4.86
2URS	12.64	15.99
3ULS	12.39	15.68
3LLS	11.10	14.05
3LRS	10.80	13.67
3URS	12.48	15.80
4ULS	12.40	15.70
4MLS	14.72	18.64
4LLS	3.62	4.58
4LRS	3.62	4.58
4MRS	14.34	18.15
4URS	12.49	15.81
Watershed P		
1ULS	7.68	9.73
1LLS	23.62	29.92
1LRS	24.12	30.54
1URS	8.09	10.24
2ULS	14.00	17.72
2LLS	12.34	15.62
2LRS	12.41	15.70
2URS	14.17	17.93
3ULS	12.08	15.30
3LLS	12.09	15.30
3LRS	12.13	15.36
3URS	12.11	15.33
4ULS	12.69	16.06
4LLS	12.73	16.11
4LRS	12.75	16.13
4URS	12.74	16.13
5ULS	12.41	15.70
5LLS	12.42	15.73
5LRS	12.42	15.72
5URS	12.42	15.72
6ULS	12.38	15.68
6LLS	12.44	15.74
6LRS	12.40	15.69
6URS	12.42	15.72

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

6. TERRACE BENCHES (III-C.3-6)

3-2-2015

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER

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CB&I

Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**MTE**	**Date:**	**1/15/15**
Checked By:	**RDS**	**Date:**	**1/21/15**

TITLE: TERRACE BENCHES

Problem Statement

Demonstrate that the proposed terrace benches are sized to handle the peak flow volumes anticipated for the 100-year, 24-hour and 25-year, 24-hour storm events and determine the proper sizing for the check dam outlet pipes.

Given

- ❑ The locations of the terrace benches are shown on Drawing 6 in Appendix III-C.2.
- ❑ The model configuration of the terrace benches are shown in the HydroCAD output files in Appendix III-C.4
- ❑ The details of the terrace benches are shown on Drawing 7 in Appendix III-C.2.

Assumptions

- ❑ Terrace benches will be constructed with a 2% channel slope.
- ❑ Terrace benches will have a 2% slope downhill perpendicular to the terrace bench channel slope; this will facilitate drainage of all stormwater to the check dam outlet pipes.
- ❑ Terrace bench sideslopes will have 3H:1V sideslopes on the downslope side and will follow the final landform slope on the upslope side (i.e. 4H:1V on sideslopes).
- ❑ The check dams will be constructed to a height of 4 feet above the channel bottom at the end of each terrace bench section.
- ❑ Terrace bench sections and check dams are conservatively sized to detain the peak discharge rate associated with the entire subcatchment area that they serve.
- ❑ All terrace benches will be lined with vegetation.

Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**MTE**	**Date:**	**1/15/15**
Checked By:	**RDS**	**Date:**	**1/21/15**

TITLE: TERRACE BENCHES

- ❑ Terrace bench elevation-area input parameters were determined using a Microsoft Excel spreadsheet to calculate the surface area of the terrace bench at two elevations: 1) The end (bottom) of the terrace bench at the channel bottom (0 ft elevation), and 2) The end of the terrace bench (bottom) and 0.5 ft above the peak of the check dam (4.5 feet above bottom of the terrace bench). These two elevation-area relationships were input into HydroCAD for each terrace bench, allowing HydroCAD to interpolate the storage volume at any elevation within each terrace bench.

- ❑ Outlet pipes in each check dam will be 6-inch diameter HDPE pipes (or equivalent, at the discretion of the engineer) and will allow all stormwater to drain from the terrace benches and will prevent ponding of stormwater between storm events.

Calculations

Table C.3-6 summarizes the peak discharge rates, and peak water depths in the terrace benches for the 25-year, 24-hour storm and the 100-year, 24-hour storm.

Please refer to Appendix III-C.4 for HydroCAD output files that supplement these summary tables.

Results

Based on the results presented in Table C.3-6, the critical findings are noted:

1. The peak depth for all vegetated terrace benches is less than the design depth for the 100-year and 25-year storm events. Therefore, stormwater will not overtop the terrace berms.

2. The check dam outlet pipes are adequately sized to handle the flows through the terrace benches without the terrace berms overtopping during the 100-year and 25-year storm events.

3. Check dams overtop during the 100 year, 24 hour storm event. When overtopping, stormwater flows into the downchute with the discharge from the terrace bench outlet pipe and never exceeds the height of the terrace berm (4.5 feet).

TABLE C.3-6 Terrace Bench Summary Pescadito Environmental Resource Center				
Terrace Name	Peak Depth (ft)		Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed A				
1ULT	2.62	3.05	1.15	1.25
1URT	2.62	3.05	1.15	1.25
2ULT	3.21	3.74	1.28	1.39
2LLT	3.13	3.63	1.27	1.37
2LRT	3.12	3.62	1.26	1.37
2URT	3.20	3.73	1.28	1.39
3ULT	3.21	3.74	1.28	1.39
3LLT	3.72	4.03	1.39	2.18
3LRT	3.70	4.03	1.39	2.15
3URT	3.20	3.73	1.28	1.39
4ULT	3.21	3.74	1.28	1.39
4MLT	4.03	4.11	2.11	6.18
4LLT	4.01	4.08	1.71	4.13
4LRT	4.01	4.07	1.65	4.02
4MRT	4.02	4.11	2.07	6.00
4URT	3.20	3.73	1.28	1.39
Watershed B				
1ULT	2.39	2.8	1.09	1.19
1LLT	4.25	4.32	16.92	24.15
1LRT	4.27	4.33	18.94	25.78
1URT	2.58	3.01	1.14	1.24
2ULT	2.92	3.4	1.22	1.32
2LLT	4.01	4.08	1.70	4.49
2LRT	4.01	4.08	1.65	4.39
2URT	2.87	3.34	1.21	1.31
3ULT	3.14	3.65	1.27	1.38
3LLT	4.01	4.08	1.76	4.58
3LRT	4.01	4.08	1.74	4.51
3URT	3.13	3.65	1.27	1.38
4ULT	3.14	3.65	1.27	1.38
4LLT	4.01	4.09	1.77	4.64
4LRT	4.01	4.08	1.71	4.38
4URT	3.12	3.64	1.27	1.37
5ULT	3.14	3.65	1.27	1.38
5LLT	4.01	4.09	1.78	4.69
5LRT	4.01	4.08	1.70	4.32
5URT	3.12	3.64	1.26	1.37
6ULT	3.14	3.65	1.27	1.38
6LLT	4.01	4.09	1.79	4.74
6LRT	4.01	4.08	1.66	4.15
6URT	3.12	3.64	1.26	1.37
Watershed C				
1ULT	3.19	3.71	1.28	1.39
1URT	2.62	3.05	1.15	1.25
2ULT	3.18	3.71	1.28	1.39
2LLT	3.10	3.60	1.26	1.37
2LRT	3.11	3.61	1.26	1.37
2URT	3.19	3.72	1.28	1.39
3ULT	3.18	3.71	1.28	1.39
3LLT	3.68	4.03	1.38	2.09
3LRT	3.69	4.03	1.39	2.12
3URT	3.19	3.72	1.28	1.39
4ULT	3.18	3.71	1.28	1.39
4MLT	4.02	4.10	2.01	5.70
4LLT	4.00	4.07	1.53	3.82
4LRT	4.01	4.07	1.59	3.91
4MRT	4.02	4.11	2.04	5.84
4URT	3.19	3.72	1.28	1.39

TABLE C.3-6
Terrace Bench Summary
Pescadito Environmental Resource Center

Terrace Name	Peak Depth (ft)		Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed D				
1ULT	2.20	2.59	1.04	1.14
1LLT	4.19	4.26	11.89	18.51
1LRT	4.19	4.26	11.94	18.56
1URT	2.18	2.56	1.04	1.13
2ULT	2.79	3.25	1.19	1.29
2LLT	3.94	4.06	1.43	3.51
2LRT	3.94	4.06	1.43	3.54
2URT	2.78	3.24	1.19	1.29
3ULT	3.03	3.52	1.24	1.35
3LLT	3.96	4.06	1.44	3.62
3LRT	3.97	4.07	1.44	3.67
3URT	3.03	3.53	1.24	1.35
4ULT	3.02	3.52	1.24	1.35
4LLT	3.96	4.06	1.44	3.61
4LRT	3.97	4.07	1.44	3.66
4URT	3.03	3.53	1.24	1.35
5ULT	3.02	3.52	1.24	1.35
5LLT	3.96	4.06	1.44	3.61
5LRT	3.97	4.07	1.44	3.66
5URT	3.03	3.53	1.24	1.35
6ULT	3.03	3.53	1.25	1.35
6LLT	3.97	4.06	1.44	3.63
6LRT	3.97	4.07	1.44	3.65
6URT	3.03	3.53	1.24	1.35
Watershed E				
1ULT	2.61	3.04	1.15	1.25
1URT	2.63	3.06	1.15	1.25
2ULT	3.18	3.70	1.28	1.39
2LLT	3.10	3.60	1.26	1.37
2LRT	3.11	3.61	1.26	1.37
2URT	3.19	3.71	1.28	1.39
3ULT	3.18	3.70	1.28	1.39
3LLT	3.68	4.02	1.38	2.09
3LRT	3.69	4.03	1.38	2.10
3URT	3.19	3.71	1.28	1.39
4ULT	3.18	3.70	1.28	1.39
4MLT	4.02	4.10	2.00	5.69
4LLT	4.00	4.07	1.53	3.82
4LRT	4.00	4.07	1.54	3.84
4MRT	4.02	4.10	2.01	5.71
4URT	3.19	3.71	1.28	1.39
Watershed F				
1ULT	2.58	3.01	1.14	1.24
1LLT	4.25	4.31	17.61	23.97
1LRT	4.24	4.3	15.99	22.71
1URT	2.36	2.76	1.08	1.18
2ULT	2.88	3.35	1.21	1.32
2LLT	4.00	4.07	1.54	4.03
2LRT	4.00	4.07	1.45	3.96
2URT	2.83	3.3	1.20	1.30
3ULT	3.09	3.6	1.26	1.37
3LLT	4.01	4.08	1.64	4.22
3LRT	4.01	4.08	1.65	4.23
3URT	3.10	3.61	1.26	1.37
4ULT	3.09	3.6	1.26	1.37
4LLT	4.01	4.07	1.61	4.11
4LRT	4.01	4.07	1.61	4.11
4URT	3.08	3.59	1.26	1.36
5ULT	3.09	3.6	1.26	1.37
5LLT	4.01	4.07	1.61	4.11
5LRT	4.01	4.07	1.61	4.11
5URT	3.08	3.59	1.26	1.36
6ULT	3.09	3.6	1.26	1.37
6LLT	4.01	4.08	1.61	4.12
6LRT	4.01	4.07	1.61	4.11
6URT	3.08	3.59	1.26	1.36

TABLE C.3-6 Terrace Bench Summary Pescadito Environmental Resource Center				
Terrace Name	Peak Depth (ft)		Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed G				
1ULT	2.65	3.08	1.16	1.26
1URT	2.64	3.08	1.16	1.26
2ULT	3.18	3.70	1.28	1.39
2LLT	3.10	3.60	1.26	1.37
2LRT	3.11	3.61	1.26	1.37
2URT	3.18	3.70	1.28	1.39
3ULT	3.65	4.07	1.38	4.08
3LLT	3.76	4.04	1.40	2.55
3LRT	3.67	4.02	1.38	2.06
3URT	3.18	3.70	1.28	1.39
4ULT	3.18	3.70	1.28	1.39
4MLT	4.01	4.09	1.82	4.63
4LLT	3.95	4.06	1.44	3.36
4LRT	4.00	4.07	1.51	3.72
4MRT	4.02	4.10	1.96	5.49
4URT	3.18	3.70	1.28	1.39
Watershed H				
1ULT	1.78	2.1	0.92	1.01
1LLT	4.16	4.24	9.83	16.62
1LRT	4.22	4.28	14.31	20.77
1URT	2.38	2.79	1.09	1.19
2ULT	2.77	3.22	1.18	1.29
2LLT	3.93	4.06	1.43	3.51
2LRT	3.96	4.07	1.44	3.66
2URT	2.83	3.29	1.20	1.30
3ULT	3.04	3.54	1.25	1.35
3LLT	3.98	4.07	1.44	3.78
3LRT	3.99	4.07	1.44	3.79
3URT	3.04	3.54	1.25	1.35
4ULT	3.03	3.53	1.25	1.35
4LLT	3.97	4.07	1.44	3.71
4LRT	3.97	4.07	1.44	3.67
4URT	3.03	3.53	1.25	1.35
5ULT	3.03	3.53	1.25	1.35
5LLT	3.98	4.07	1.44	3.72
5LRT	3.97	4.07	1.44	3.64
5URT	3.03	3.53	1.24	1.35
6ULT	3.03	3.53	1.25	1.35
6LLT	3.98	4.07	1.44	3.75
6LRT	3.97	4.06	1.44	3.61
6URT	3.03	3.53	1.25	1.35
Watershed I				
1ULT	2.61	3.04	1.15	1.25
1URT	2.60	3.03	1.15	1.24
2ULT	3.24	3.78	1.29	1.40
2LLT	3.16	3.67	1.27	1.38
2LRT	3.16	3.66	1.27	1.38
2URT	3.24	3.77	1.29	1.40
3ULT	3.19	3.72	1.28	1.39
3LLT	3.70	4.03	1.39	2.14
3LRT	3.69	4.03	1.38	2.12
3URT	3.18	3.71	1.28	1.39
4ULT	3.20	3.72	1.28	1.39
4MLT	4.02	4.09	1.90	5.00
4LLT	4.00	4.06	1.45	3.60
4LRT	4.00	4.07	1.55	3.86
4MRT	4.02	4.10	2.02	5.76
4URT	3.19	3.71	1.28	1.39

TABLE C.3-6 Terrace Bench Summary Pescadito Environmental Resource Center				
Terrace Name	Peak Depth (ft)		Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed J				
1ULT	2.25	2.64	1.06	1.15
1LLT	4.20	4.27	12.53	19.24
1LRT	4.20	4.28	13.13	19.86
1URT	2.26	2.64	1.06	1.15
2ULT	2.82	3.29	1.20	1.30
2LLT	3.97	4.07	1.44	3.73
2LRT	3.97	4.07	1.44	3.77
2URT	2.82	3.28	1.20	1.30
3ULT	3.04	3.54	1.25	1.35
3LLT	3.99	4.07	1.44	3.78
3LRT	3.96	4.06	1.44	3.60
3URT	3.00	3.5	1.24	1.35
4ULT	3.64	4.07	1.37	3.66
4LLT	4.01	4.11	1.75	6.14
4LRT	4.00	4.07	1.52	3.94
4URT	3.08	3.59	1.26	1.36
5ULT	3.04	3.55	1.25	1.35
5LLT	3.98	4.07	1.44	3.74
5LRT	3.99	4.07	1.44	3.76
5URT	3.04	3.55	1.25	1.36
6ULT	3.04	3.54	1.25	1.35
6LLT	3.98	4.07	1.44	3.74
6LRT	3.98	4.07	1.44	3.76
6URT	3.04	3.55	1.25	1.35
Watershed K				
1ULT	2.61	3.04	1.15	1.25
1URT	2.67	3.11	1.16	1.26
2ULT	3.20	3.73	1.28	1.39
2LLT	3.12	3.62	1.27	1.37
2LRT	3.14	3.64	1.27	1.37
2URT	3.22	3.75	1.29	1.40
3ULT	3.20	3.73	1.28	1.39
3LLT	3.70	4.03	1.39	2.12
3LRT	3.71	4.03	1.39	2.15
3URT	3.22	3.75	1.29	1.40
4ULT	3.20	3.73	1.28	1.39
4MLT	4.02	4.09	1.89	4.90
4LLT	4.00	4.06	1.44	3.55
4LRT	4.01	4.07	1.68	4.01
4MRT	4.02	4.11	2.08	5.98
4URT	3.22	3.75	1.29	1.40
Watershed L				
1ULT	2.91	3.4	1.22	1.32
1LLT	4.32	4.38	24.18	31.40
1LRT	4.32	4.38	24.43	31.58
1URT	2.97	3.46	1.23	1.34
2ULT	3.00	3.49	1.24	1.34
2LLT	4.02	4.1	1.86	5.18
2LRT	4.02	4.1	2.05	5.57
2URT	3.45	4.01	1.34	1.69
3ULT	3.22	3.75	1.29	1.40
3LLT	4.02	4.1	1.96	5.41
3LRT	4.02	4.1	1.96	5.40
3URT	3.22	3.74	1.29	1.40
4ULT	3.21	3.73	1.28	1.39
4LLT	1.68	1.93	0.89	0.97
4LRT	4.02	4.1	1.94	5.32
4URT	3.21	3.74	1.28	1.39
5ULT	3.21	3.73	1.28	1.39
5LLT	4.02	4.1	1.93	5.26
5LRT	4.02	4.1	1.94	5.34
5URT	3.21	3.74	1.28	1.39
6ULT	3.21	3.74	1.28	1.39
6LLT	4.02	4.1	1.92	5.25
6LRT	4.02	4.1	1.95	5.37
6URT	3.21	3.74	1.28	1.39

TABLE C.3-6 Terrace Bench Summary Pescadito Environmental Resource Center				
Terrace Name	Peak Depth (ft)		Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed M				
1ULT	2.65	3.09	1.16	1.26
1URT	2.64	3.08	1.15	1.25
2ULT	3.21	3.74	1.28	1.39
2LLT	3.13	3.63	1.27	1.37
2LRT	3.12	3.62	1.26	1.37
2URT	3.20	3.72	1.28	1.39
3ULT	3.20	3.72	1.28	1.39
3LLT	3.70	4.03	1.39	2.12
3LRT	3.70	4.03	1.39	2.12
3URT	3.20	3.72	1.28	1.39
4ULT	3.20	3.73	1.28	1.39
4MLT	4.02	4.09	1.89	4.96
4LLT	4.00	4.06	1.46	3.56
4LRT	4.01	4.07	1.60	3.90
4MRT	4.02	4.11	2.03	5.81
4URT	3.20	3.73	1.28	1.39
Watershed N				
1ULT	2.24	2.63	1.05	1.15
1LLT	4.19	4.26	12.30	18.83
1LRT	4.18	4.25	11.34	17.84
1URT	2.26	2.65	1.06	1.16
2ULT	2.80	3.26	1.19	1.30
2LLT	3.94	4.06	1.43	3.51
2LRT	3.93	4.06	1.43	3.46
2URT	2.80	3.26	1.19	1.29
3ULT	3.02	3.51	1.24	1.35
3LLT	3.95	4.06	1.44	3.55
3LRT	3.95	4.06	1.44	3.52
3URT	3.02	3.52	1.24	1.35
4ULT	3.02	3.52	1.24	1.35
4LLT	3.96	4.06	1.44	3.58
4LRT	3.95	4.06	1.44	3.55
4URT	3.02	3.51	1.24	1.35
5ULT	3.02	3.52	1.24	1.35
5LLT	3.96	4.06	1.44	3.58
5LRT	3.95	4.06	1.44	3.56
5URT	3.02	3.51	1.24	1.35
6ULT	3.02	3.52	1.24	1.35
6LLT	3.95	4.06	1.44	3.55
6LRT	3.95	4.06	1.44	3.55
6URT	3.02	3.51	1.24	1.35
Watershed O				
1ULT	2.62	3.05	1.15	1.25
1URT	2.64	3.08	1.15	1.25
2ULT	3.24	3.78	1.29	1.40
2LLT	3.16	3.67	1.27	1.38
2LRT	3.18	3.69	1.28	1.38
2URT	3.22	3.75	1.29	1.40
3ULT	3.19	3.71	1.28	1.39
3LLT	3.70	4.03	1.39	2.15
3LRT	3.70	4.03	1.39	2.13
3URT	3.19	3.72	1.28	1.39
4ULT	3.19	3.71	1.28	1.39
4MLT	4.02	4.09	1.90	5.01
4LLT	4.00	4.06	1.44	3.61
4LRT	4.01	4.07	1.64	3.97
4MRT	4.02	4.10	2.03	5.79
4URT	3.19	3.72	1.28	1.39

TABLE C.3-6 Terrace Bench Summary Pescadito Environmental Resource Center				
Terrace Name	Peak Depth (ft)		Discharge Rate (cfs)	
	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm
Watershed P				
1ULT	2.92	3.41	1.22	1.33
1LLT	4.31	4.37	23.40	30.32
1LRT	4.31	4.38	23.99	30.96
1URT	2.99	3.49	1.24	1.34
2ULT	2.99	3.48	1.24	1.34
2LLT	4.01	4.09	1.81	4.95
2LRT	4.01	4.09	1.83	4.99
2URT	3.00	3.49	1.24	1.34
3ULT	3.14	3.65	1.27	1.38
3LLT	4.01	4.08	1.75	4.45
3LRT	4.01	4.08	1.75	4.46
3URT	3.14	3.65	1.27	1.38
4ULT	3.23	3.77	1.29	1.40
4LLT	4.02	4.1	2.01	5.67
4LRT	4.02	4.1	2.02	5.68
4URT	3.24	3.77	1.29	1.40
5ULT	3.19	3.71	1.28	1.39
5LLT	4.02	4.09	1.88	5.08
5LRT	4.02	4.09	1.88	5.06
5URT	3.19	3.71	1.28	1.39
6ULT	3.18	3.71	1.28	1.39
6LLT	4.02	4.09	1.88	5.06
6LRT	4.02	4.09	1.88	5.06
6URT	3.19	3.71	1.28	1.39

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

7. DOWNCHUTES (III-C.3-7)

3-2-2015

STATE OF TEXAS
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CB&I

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**MTE** — **Date:** **1/15/15**
Checked By:	**RDS** — **Date:** **1/21/15**

TITLE: **DOWNCHUTES**

Problem Statement

Determine whether the proposed downchutes are sized to handle the peak flow velocities and depths anticipated for the 100-year, 24-hour storm event, which produces the highest peak discharge rate of all modeled storm events.

Given

- The locations of the downchutes are shown in the Drawing 6 of Appendix III-C.2.
- The details of the downchutes are provided in Drawing 7 of Appendix III-C.2.

Assumptions

- Downchutes have a maximum slope of 25%, a width of 15 feet, and a depth of 2 feet.
- Downchutes will be lined with riprap.
- A Manning's coefficient of 0.035, representative of a typical riprap open channel, is used for both critical velocity and depth determination.

Results

The peak velocities, depths, and discharge rates for each downchute for the 25-year, 24-hour storm and the 100-year, 24-hour storm were determined using HydroCAD. The results are presented in Table C.3-7. Please note that the results presented in Table C.3-7 represent the peak velocities, depths, and discharge rates at the bottom of each downchute (e.g. the results for the Watershed A downchute are determined from the "4DC" node in the Watershed A HydroCAD model). Please see Appendix III-C.4 for the associated catchment HydroCAD output files.

The peak velocity of all downchutes is greater than 5 ft/sec for the 100-year, 24-hour storm event using a Manning's coefficient of 0.035. However, due to the fact that the lining material is riprap, scour and erosion are not anticipated. Based on the 100-year, 24-hour peak depths determined in the modeled downchutes using a Manning's coefficient of 0.035, overtopping will not occur for storm events equal to or less than the 100-year storm event.

TABLE C.3-7 Downchute Summary Pescadito Environmental Resource Center						
Downchute Name	Peak Depth (ft)		Discharge Rate (cfs)		Peak Velocity (ft/sec)	
	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm	25-year, 24-hour Storm	100-year, 24-hour Storm
A	0.14	0.18	10.44	16.01	4.79	5.65
B	0.32	0.43	48.98	79.06	9.54	11.38
C	0.14	0.18	10.17	15.75	4.74	5.61
D	0.27	0.36	37.12	59.87	8.61	10.28
E	0.14	0.18	10.09	15.52	4.73	5.58
F	0.31	0.40	46.68	72.02	9.38	11.00
G	0.14	0.18	10.07	15.87	4.73	5.63
H	0.27	0.37	36.05	60.80	8.51	10.34
I	0.14	0.18	10.08	15.19	4.73	5.54
J	0.28	0.38	38.93	65.26	8.76	10.61
K	0.14	0.18	10.26	15.22	4.76	5.54
L	0.37	0.48	61.30	95.59	10.37	12.19
M	0.14	0.18	10.11	15.16	4.73	5.53
N	0.27	0.36	36.87	58.49	8.58	10.19
O	0.14	0.18	10.16	15.24	4.74	5.54
P	0.36	0.47	60.62	93.79	10.33	12.11

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

8. DITCH SIZING (III-C.3-8)

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED PROFESSIONAL ENGINEER

3-2-2015

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CBI

Client:	Rancho Viejo Waste Management, LLC		
Project:	Pescadito Environmental Resource Center		
Project #:	148866		
Calculated By:	MTE	Date:	1/15/15
Checked By:	RDS	Date:	1/21/15

TITLE: DITCH SIZING

Problem Statement

Determine whether the proposed stormwater ditches are sized to handle the peak flow velocities and depths associated with the 100-year, 24-hour storm event.

Design Assumptions

- ❑ The ditches will be designed to convey run-off from the 100-year, 24-hour storm event without overtopping. The 100-year, 24-hour storm event is selected because it produces the highest peak discharge rates of all modeled storm events.
- ❑ The HydroCAD Model layout for the stormwater ditches is shown on the "Pescadito Perimeter" HydroCAD Model Diagram in Appendix III-C.4.
- ❑ The locations of the stormwater ditches are shown in Drawing 6 of Appendix III-C.2.
- ❑ The stormwater ditches will be vegetated earthen open channels.
- ❑ A Manning's coefficient of 0.030, representative of a typical grassed, earthen, open channel was selected for all ditches. This value is used to calculate the critical velocity and depth within the terrace benches.
- ❑ All perimeter ditches have sideslopes of 4H:1V on the inside and outside slopes.
- ❑ All perimeter ditches are 4 feet deep and have bottom widths of 15 feet.

Calculations

Calculations were performed using the computer program, HydroCAD. The program uses Manning's equation.

$$V = (1.49/n)R^{2/3}S^{1/2}$$

where:

V = mean velocity, ft/sec
n = Manning's roughness coefficient
R = hydraulic radius, ft
S = slope, ft/ft

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By: MTE	Date: 1/15/15
Checked By: RDS	Date: 1/21/15

TITLE: DITCH SIZING

Manning's n, peak flow, sideslope, and channel slope were entered into the program and the program calculates depth and velocity.

Table C.3-8 lists the length and slope of each ditch segment in the HydroCAD model. Table C.3-8 also lists the peak depth and peak velocity in each ditch segment for the 25-year, 24-hour storm and the 100-year, 24-hour storm. Please refer to Appendix III-C.4 for the associated HydroCAD output files.

Conclusions

Based on the results presented in Table C.3-8, the critical findings are noted:

1. The peak velocities of all vegetated stormwater ditches is less than 5 ft/sec for the 100-year and 25-year, 24-hour storm events. As a result, scour and erosion are not anticipated.

2. The peak depths for all channels are less than the design depth for the 100-year and 25-year, 24-hour storm events. As a result, stormwater ditches will not overtop.

TABLE C.3-8
Perimeter Channel Peak Depth and Velocity Summary
Pescadito Environmental Resource Center

Perimeter Ditch Identification	Length	Slope	25-year, 24-hour Storm		100-year, 24-hour Storm	
	Length (ft)	Slope (ft/ft)	Peak Velocity (ft/sec)	Peak Depth (ft)	Peak Velocity (ft/sec)	Peak Depth (ft)
NDE01	432.7	0.0030	2.83	1.36	3.09	1.60
NDE02	428.5	0.0030	2.89	1.41	3.11	1.62
NDE03	370.9	0.0030	2.93	1.46	3.15	1.66
NDE04	287.4	0.0030	2.97	1.49	3.19	1.70
NDE05	286.6	0.0030	3.29	1.80	3.61	2.13
NDE06	286.4	0.0030	3.32	1.82	3.63	2.14
NDE07	285.3	0.0030	3.34	1.84	3.65	2.16
NDE08	373.6	0.0030	3.36	1.87	3.66	2.18
NDE09	426.3	0.0030	3.38	1.88	3.69	2.21
NDE10	474.2	0.0030	3.39	1.89	3.70	2.23
NDNE01	346.6	0.0030	2.50	1.09	2.87	1.40
NDNE02	343.9	0.0030	2.55	1.14	2.90	1.43
NDNE03	378.5	0.0030	2.60	1.17	2.93	1.45
NDNE04	439.0	0.0030	2.62	1.19	2.96	1.48
NDNE05	443.2	0.0030	2.78	1.32	3.07	1.58
NDNW01	340.7	0.0046	1.77	0.42	1.92	0.48
NDNW02	342.4	0.0046	2.22	0.62	2.42	0.71
NDNW03	391.3	0.0046	2.54	0.77	2.76	0.90
NDNW04	465.7	0.0046	2.77	0.90	3.01	1.05
NDNW05	473.9	0.0046	3.03	1.05	3.26	1.21
NDSE01	316.3	0.0030	1.59	0.51	1.74	0.58
NDSE02	316.0	0.0030	1.98	0.73	2.15	0.84
NDSE03	367.3	0.0030	2.25	0.91	2.44	1.06
NDSE04	426.3	0.0030	2.44	1.05	2.65	1.22
NDSE05	474.2	0.0030	2.54	1.13	2.76	1.31
NDSW01	316.1	0.0042	2.78	0.98	3.14	1.22
NDSW02	319.3	0.0042	2.85	1.03	3.18	1.25
NDSW03	365.0	0.0042	2.92	1.07	3.25	1.30
NDSW04	410.6	0.0042	3.04	1.15	3.33	1.36
NDSW05	468.0	0.0042	3.14	1.22	3.39	1.39
NDW01	460.4	0.0030	2.68	1.24	2.89	1.42
NDW02	452.4	0.0030	2.76	1.30	2.97	1.49
NDW03	290.0	0.0030	2.82	1.36	3.04	1.56
NDW04	290.0	0.0030	2.86	1.39	3.09	1.60
NDW05	291.8	0.0030	3.22	1.71	3.55	2.05
NDW06	288.6	0.0030	3.24	1.74	3.57	2.07
NDW07	290.1	0.0030	3.26	1.76	3.58	2.09
NDW08	367.6	0.0030	3.28	1.79	3.60	2.11
NDW09	408.5	0.0030	3.31	1.81	3.64	2.14
NDW10	465.6	0.0030	3.32	1.82	3.65	2.16
EMC	517.4	0.0030	3.71	2.23	3.99	2.55
WMC	185.0	0.0030	3.77	2.28	4.15	2.72
SDE01	428.5	0.0030	4.09	2.66	4.38	3.01
SDE02	438.9	0.0030	4.11	2.68	4.39	3.03
SDE03	383.3	0.0030	4.12	2.70	4.40	3.05
SDE04	386.2	0.0030	4.13	2.71	4.42	3.07
SDE05	387.7	0.0030	4.29	2.91	4.67	3.41
SDE06	385.4	0.0030	4.30	2.92	4.69	3.42
SDE07	386.2	0.0030	4.31	2.93	4.70	3.43
SDE08	379.0	0.0030	4.32	2.94	4.71	3.44
SDE09	430.4	0.0030	4.32	2.95	4.71	3.45
SDE10	478.3	0.0030	4.32	2.95	4.71	3.46
SDNE01	297.6	0.0030	2.76	1.31	2.96	1.49
SDNE02	296.5	0.0030	2.78	1.32	2.99	1.50
SDNE03	393.6	0.0030	2.80	1.34	3.01	1.53
SDNE04	445.0	0.0030	2.82	1.36	3.03	1.55
SDNE05	443.2	0.0030	2.93	1.46	3.16	1.67
SDNW01	295.8	0.0035	3.12	1.41	3.49	1.73

TABLE C.3-8 Perimeter Channel Peak Depth and Velocity Summary Pescadito Environmental Resource Center						
Perimeter Ditch Identification			**25-year, 24-hour Storm**		**100-year, 24-hour Storm**	
	Length (ft)	**Slope (ft/ft)**	**Peak Velocity (ft/sec)**	**Peak Depth (ft)**	**Peak Velocity (ft/sec)**	**Peak Depth (ft)**
SDNW02	297.1	0.0035	3.14	1.44	3.51	1.75
SDNW03	381.5	0.0035	3.18	1.46	3.53	1.77
SDNW04	445.5	0.0035	3.20	1.48	3.55	1.79
SDNW05	446.1	0.0035	3.30	1.57	3.63	1.87
SDSE01	282.6	0.0051	2.88	0.88	3.25	1.09
SDSE02	280.1	0.0051	1.91	0.44	2.08	0.51
SDSE03	383.9	0.0030	1.76	0.60	1.91	0.69
SDSE04	430.5	0.0030	2.13	0.83	2.32	0.96
SDSE05	478.3	0.0030	2.28	0.93	2.48	1.08
SDSW01	279.9	0.0051	2.96	0.92	3.35	1.15
SDSW02	280.2	0.0051	3.14	1.02	3.44	1.20
SDSW03	377.2	0.0051	3.34	1.14	3.59	1.30
SDSW04	431.0	0.0030	4.59	3.30	5.02	3.88
SDSW05	478.0	0.0030	4.46	3.14	4.86	3.66
SDW01	434.6	0.0030	4.23	2.85	4.62	3.33
SDW02	434.0	0.0030	4.24	2.85	4.62	3.34
SDW03	373.6	0.0030	4.25	2.86	4.63	3.35
SDW04	374.0	0.0030	4.25	2.87	4.64	3.36
SDW05	378.1	0.0030	4.39	3.05	4.79	3.57
SDW06	370.1	0.0030	4.41	3.06	4.80	3.58
SDW07	374.6	0.0030	4.41	3.07	4.80	3.59
SDW08	373.1	0.0030	4.42	3.08	4.81	3.59
SDW09	443.4	0.0030	4.43	3.09	4.82	3.60
SDW10	489.9	0.0030	4.46	3.13	4.86	3.65

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

9. CULVERT SIZING (III-C.3-9)

3-2-2015

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER

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CB&I

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**MTE** — **Date: 1/15/2015**
Checked By:	**RDS** — **Date: 1/21/2015**

TITLE: CULVERT SIZING

Problem Statement

Determine whether the proposed stormwater culverts are sized to handle the peak flow velocities and depths associated with the 100-year, 24-hour storm event.

Design Assumptions

- The culverts will be designed to convey run-off from the 100-year, 24-hour storm event without restricting upland flow. The 100-year, 24-hour storm event is selected because it produces the highest peak discharge rates of all modeled storm events.
- The locations of the culverts between the perimeter ditches and the south detention basin are shown on Drawing 6 of Appendix III-C.2. Details of the perimeter ditch culverts are provided in Drawing 8 of Appendix III-C.2.
- The design parameters of each culvert are included in Table C.3-9, including culvert type and material, inlet invert elevation, outlet invert elevation, slope, and dimensions.

Calculations

Calculations were performed using the computer program HydroCAD. The program uses Manning's equation.

$$V = (1.49/n)R^{2/3}S^{1/2}$$

where:

V = mean velocity, ft/sec
n = Manning's roughness coefficient
R = hydraulic radius, ft
S = slope, ft/ft

Manning's n, peak flow, sideslope, and channel slope were entered into the program and the program calculates depth and velocity.

Table C.2-9 summarizes the design of the culverts and provides the peak depths and flow velocities for the 25-year, 24-hour storm and the 100-year, 24-hour storm. Please see Appendix III-C.4 for the associated HydroCAD output files.

Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**MTE**	**Date:**	**1/15/2015**
Checked By:	**RDS**	**Date:**	**1/21/2015**

TITLE: CULVERT SIZING

Conclusions

A summary of the key design features, including the modeled peak discharge velocities and depths within the culverts, are shown in Table C.3-9. Based on the results, all proposed design dimensions for the culverts/structures are appropriately sized to convey the required discharge rates for the 100-year, 24-hour storm event. Erosion control materials will be placed at the outlets of all culverts that exhibit a peak discharge velocity greater than 5 ft/sec.

TABLE C.3-9
Culvert Depth and Velocity Summary
Pescadito Environmental Resource Center

Culvert Identification	Design Parameters									25-year, 24-hour Storm		100-year, 24-hour Storm	
	Culvert Design	Culvert Material	Manning's Coefficient	Inlet Invert Elevation	Outlet Invert Elevation	Depth	Width	Length	Slope	Peak Velocity	Peak Depth	Peak Velocity	Peak Depth
	(Box or Circular)	(description)	(unitless)	(ft MSL)	(ft MSL)	(ft)	(ft)	(ft)	(ft/ft)	(ft/sec)	(ft)	(ft/sec)	(ft)
NUWOC	Box	Concrete	0.012	552.25	552.04	2.80	15.0	70.0	0.003	8.3	1.66	9.4	2.08
NUEOC	Box	Concrete	0.012	554.48	554.27	2.50	15.0	70.0	0.003	8.2	1.62	9.0	1.91
SUWIC	Box	Concrete	0.012	551.46	551.25	2.50	15.0	70.0	0.003	8.3	1.66	9.4	2.08
SUEIC	Box	Concrete	0.012	552.71	552.50	2.50	15.0	70.0	0.003	8.2	1.61	9.0	1.90
SBWIC	Box	Concrete	0.012	539.40	538.00	2.00	15.0	70.0	0.020	19.8	1.44	22.3	1.78
SBEIC	Box	Concrete	0.012	540.19	538.19	2.00	15.0	102.0	0.020	18.7	1.29	20.9	1.58

NUWOC	North Unit West Outlet Culvert
NUEOC	North Unit East Outlet Culvert
SUWIC	South Unit West Inlet Culvert
SUEIC	South Unit East Inlet Culvert
SBWIC	South Basin West Inlet Culvert
SBEIC	South Basin East Inlet Culvert

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

10. DETENTION BASIN SIZING (III-C.3-10)

3-2-2015

STATE OF TEXAS
MICHAEL W. ODEN
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CB&I

Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**MTE**	**Date:**	**1/15/15**
Checked By:	**RDS**	**Date:**	**1/21/15**

TITLE: DETENTION BASIN SIZING

Problem Statement

Determine whether the detention basin that detains stormwater for the proposed PERC is adequately sized. The basin shall be considered to be adequately sized if the following conditions are met, based on best management practices:

1. The release rate from the detention basin for the 100-year, 24-hour storm results in an overall site discharge that is substantially similar to the overall discharge calculated in the CLOMR.

2. One foot of freeboard exists between the 100-year, 24-hour storm event peak elevation and the crest elevation of the detention basin.

Given

- ❑ Mannings Coefficient HydroCAD default value of 0.012 for concrete culverts

- ❑ The south detention basin will have two discharge points, located approximately at the southwest and southeast corners of the basin. Each discharge point will consist of two (2) 24"x120" box culverts at invert elevation 535ft NGVD. The culvert discharge areas will be reinforced with rip-rap or an erosion control alternative to prevent erosion and scour. The basin outlet design may be changed at the owner/operator's discretion, as long as the new design is equivalent.

- ❑ The size, outlet structures, and model results for the proposed stormwater detention basin is provided in Table C.3-10. Design values were calculated using AutoCAD Civil 3D 2014.

- ❑ Drawings 5 and 6 of Appendix III-C.2 show the location of the south detention basin.

Calculations

HydroCAD was used to model the peak storage volume of the detention basin. The storage volume considers both the inflow (which generally includes stormwater collection from the landfill and surrounding area), elevation-storage relationships of the detention basin, and outflow from the basin discharge structures.

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	MTE	Date: 1/15/15
Checked By:	RDS	Date: 1/21/15

TITLE: DETENTION BASIN SIZING

AutoCAD Civil 3D 2014 was used to determine the design dimensions and volumes for the detention basin. Please refer to Appendix III-C.4 for the HydroCAD output files.

Results

Based on the HydroCAD model for the Pescadito Environmental Resource Center, the proposed detention basin is adequately sized. Table C.3-10 summarizes the results of the HydroCAD calculations. The discharge rate comparison (Criteria #1 above) is discussed in Appendix III-C.1.

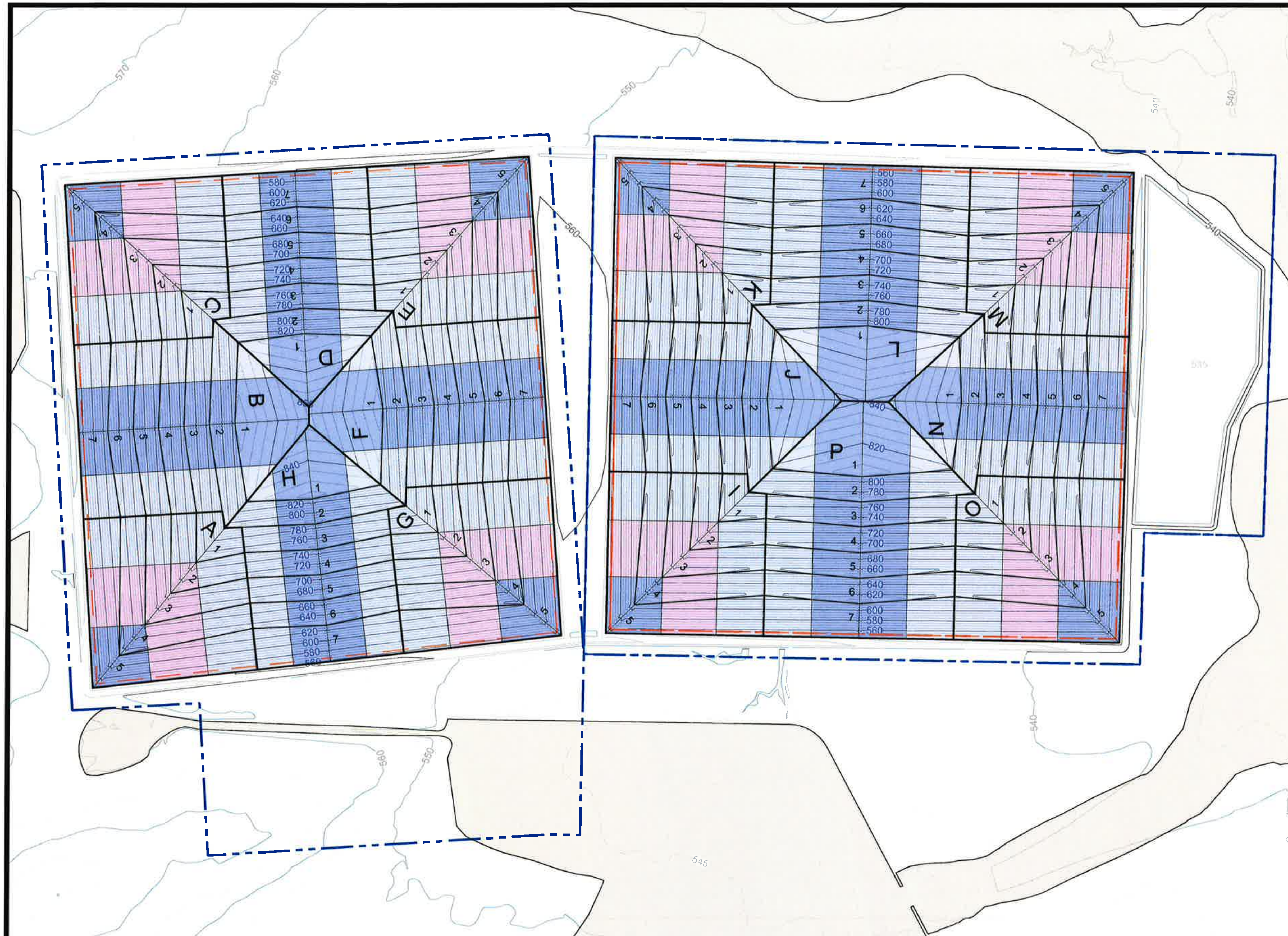
TABLE C.3-10 Detention Basin Design Summary Pescadito Environmental Resource Center			
Detention Basin General Design	Capture Area	acres	757.9
	Basin Sideslopes	H:V	5:1
	Normal Water Level	ft MSL	535
	Crest Elevation	ft MSL	540
Outlet Structures	Culvert Height	in	24
	Culvert Width	in	120
	Number of Outlet Culverts	Quantity	4
	Outlet Structure Elevation	ft MSL	535
Modeling Results	Maximum Discharge Rate 25-year, 24-hour Storm	cfs	415.7
	Maximum Discharge Rate 100-year, 24-hour Storm	cfs	522.1
	Peak Water Elevation 25-year, 24-hour Storm	ft MSL	537.6
	Peak Water Elevation 100-year, 24-hour Storm	ft MSL	538.4

Attachment III-C

Appendix III-C.3

Facility Surface Water Drainage Analysis

ATTACHMENT A - FACILITY STORMWATER FEATURE DELINEATION FIGURE



400' 0 400'
GRAPHIC SCALE

LEGEND

- PERMIT BOUNDARY
- WASTE UNIT BOUNDARY
- SUBCATCHMENT BOUNDARY
- UPPER TERRACE (UL/UR)
- MIDDLE TERRACE (ML/MR)
- LOWER TERRACE (LL/LR)
- CLOMR 100-YEAR FLOODPLAIN

NOTES

1. EXISTING CONTOURS DEVELOPED FROM SITE AERIAL TOPOGRAPHIC SURVEY BY DALLAS AERIAL SURVEYS ON FEBRUARY 15, 2010.
2. BOUNDARY AND IMPROVEMENT SURVEY DEVELOPED BY MEJIA ENGINEERING COMPANY ON AUGUST 15, 2011 AND JUNE 9, 2014.
3. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
4. THE NEED FOR FLEXIBILITY TO ACCOMMODATE ADJUSTMENTS AND MODIFICATIONS IS ANTICIPATED CONSIDERING THE SIZE, COMPLEXITY, AND LIFE OF THE PROJECT.

REV. NO.	DATE	DESCRIPTION

CB&I Environmental & Infrastructure, Inc.
TBPE FIRM F-5650

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED PROFESSIONAL ENGINEER

3-2-2015

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF PERMITTING UNDER THE AUTHORITY OF MICHAEL W. ODEN, P.E. 67165.

PESCADITO ENVIRONMENTAL RESOURCE CENTER
WEBB COUNTY, TEXAS
MSW 2374

ATTACHMENT A
FACILITY STORMWATER FEATURE DELINEATION

PROJ. NO.:	148866
DESIGNED BY:	-
DRAWN BY:	MTE
CHECKED BY:	RDS
APPROVED BY:	MWO

DATE: MARCH 2015

DRAWING NO.
III
C.3-A

1 OF 1 SHEETS