Changed Pages

Part III, Appendix III-C.3

Facility Surface Water Drainage Analysis

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

Initial Submittal March 2015
Supplement April 2015
Technically Complete March 11, 2016
Modified November 2016
Updated August 2017

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

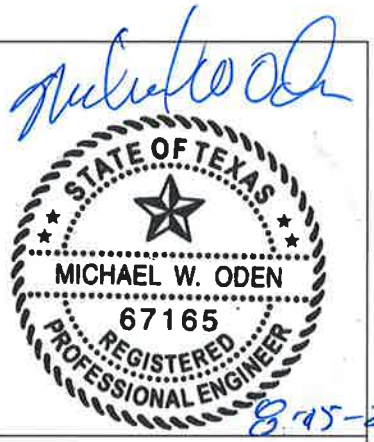
Prepared for:
Rancho Viejo Waste Management, LLC
1116 Calle del Norte
Laredo, TX 78041

Prepared by:
APTIM Environmental and Infrastructure, Inc.
(f/k/a CB&I Environmental and Infrastructure, Inc.)

APTIM

12005 Ford Rd, Suite 600
Dallas, TX 75234

Table of Contents



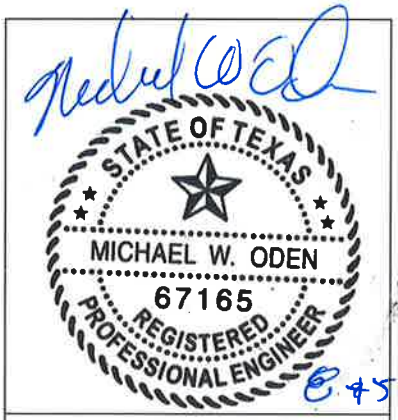
This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

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



This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**RDS** **Date: 8/09/2017**
Checked By:	**MWO** **Date: 8/10/2017**

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.

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 (See attached excerpts) 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**.

U.S. DEPARTMENT OF COMMERCE
LUTHER H. HODGES, Secretary

WEATHER BUREAU
F. W. REICHELDERFER, Chief

TECHNICAL PAPER NO. 40

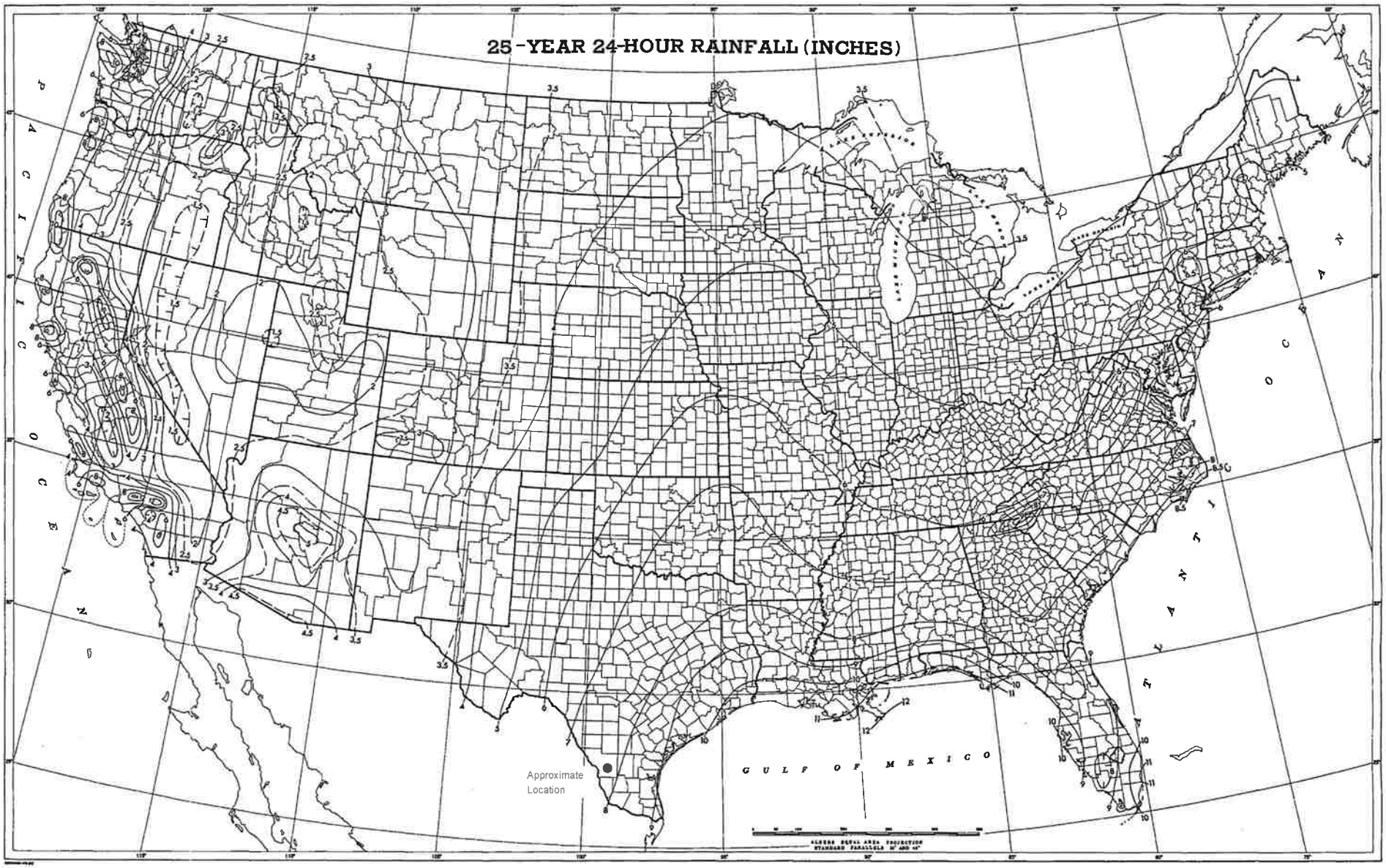
RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

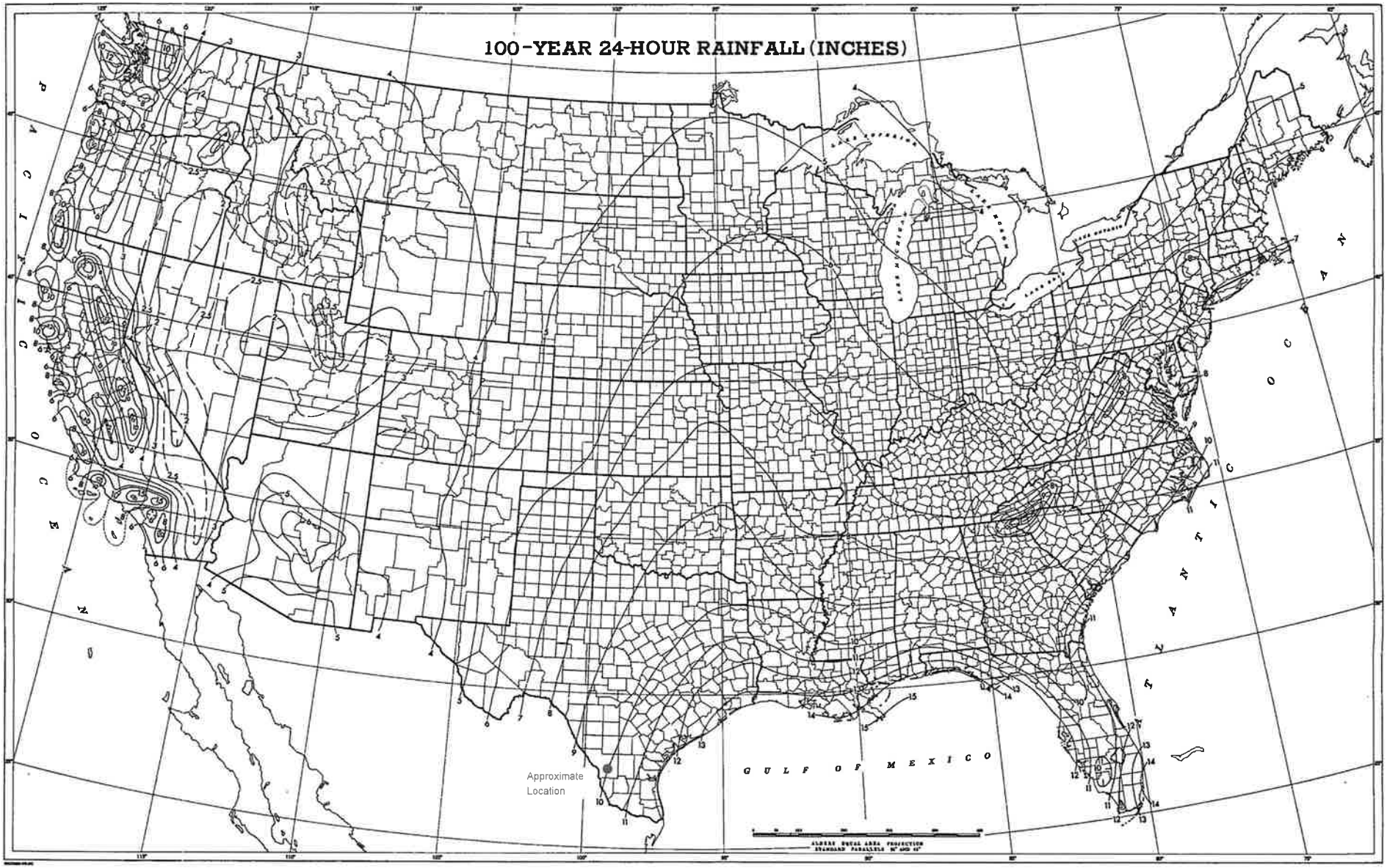
for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years

Prepared by
DAVID M. HERSHFIELD
Cooperative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

WASHINGTON, D.C.
May 1961
Repaginated and Reprinted January 1963

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $1.25


25-YEAR 24-HOUR RAINFALL (INCHES)
Approximate Location
GULF OF MEXICO


100-YEAR 24-HOUR RAINFALL (INCHES)
Approximate
Location
GULF OF MEXICO

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

2. SUBCATCHMENT DELINEATION (III-C.3-2)

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: SUBCATCHMENT DELINEATION

Problem Statement

Delineate all subcatchment areas draining into and out of the permit boundary of the proposed Pescadito Environmental Resource Center for pre-development and post-development conditions, including the proposed landfill development. All subcatchment areas draining into and out of the permit boundary are considered to ensure that the proposed landfill development does not adversely alter existing flow patterns for upstream or downstream drainage areas. Define specific points of comparison to evaluate pre-development and post-development flow patterns to ensure that existing flow patterns are not adversely altered as a result of the proposed landfill development.

Given

Subcatchment areas (also known as watersheds) were delineated using AutoCAD based on topographic divides for all areas that drain into or out of the permit boundary of the proposed landfill development. Additionally, points of comparison were defined within the subcatchment areas to demonstrate that pre-development flow patterns will not be adversely altered by the proposed landfill development, in accordance with 30 Texas Admin. Code 330.63(c) and 330.305(a).

In order to demonstrate that pre-development flow patterns will not be adversely altered by the proposed landfill development, points of comparison where stormwater passes through the permit boundary are used to demonstrate that peak flow rates, runoff volumes, and runoff velocities associated with stormwater run-on and run-off from the north and south areas have been maintained or decreased as a result of the proposed landfill development.

Pre-Development Conditions

Subcatchment areas for the pre-development conditions were delineated using AutoCAD based on topographic divides. Subcatchment areas were delineated for all areas of the proposed facility, including areas that are not currently proposed to be developed, as well as off-site areas that contribute to stormwater run-on into the permit boundary.

Subcatchment areas were further delineated into two primary groups; areas contributing stormwater run-on into the permit boundary and areas contributing stormwater run-off from the permit boundary. A comprehensive evaluation of stormwater flow rates, volumes, and velocities for the pre-development and post-development conditions is provided in the stormwater drainage compliance evaluation calculation within **Appendix III-C.3-11**. A description of each point of comparison using to analyze pre-development and post-development conditions as well as an explanation of the methodology used in determining each point is provided in **Table III-C.3-2.1**.

Run-on subcatchment areas and run-off subcatchment areas for pre-development conditions are depicted in **Appendix III-C.2**. It is noted that **Drawing III-C.2-1** provides a regional overview of all subcatchment areas draining into and out of the permit boundary of the proposed landfill development.

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: SUBCATCHMENT DELINEATION

Drawing III-C.2-2 through **Drawing III-C.2-5** provide additional detail for each run-on and run-off subcatchment area draining into and out of the permit boundary of the proposed landfill development for pre-development conditions.

Post-Development Conditions

The post-development conditions have been delineated based on drainage areas and grade breaks associated with existing topography in unmodified areas, as well as multiple stormwater management features, including terrace benches, downchute ditches, and perimeter ditches associated with the landfill. The proposed subcatchment areas inside the landfill's stormwater management system will drain to the proposed detention basin at the south end of the proposed landfill development prior to discharging off-site.

Subcatchment areas were further delineated into two primary groups; areas contributing stormwater run-on into the permit boundary and areas contributing stormwater run-off from the permit boundary. A comprehensive evaluation of stormwater flow rates, volumes, and velocities for the pre-development and post-development conditions is provided in the stormwater drainage compliance evaluation calculation within **Appendix III-C.3-11**. A description of each point of comparison using to analyze pre-development and post-development conditions as well as an explanation the methodology used in determining each point is provided in **Table III-C.3-2.1**.

Run-on subcatchment areas and run-off subcatchment areas for post-development conditions are depicted in **Appendix III-C.2**. It is noted that **Drawing III-C.2-1** provides a regional overview of all subcatchment areas draining into and out of the permit boundary of the proposed landfill development. **Drawing III-C.2-6** through **Drawing III-C.2-11** provide additional detail for each run-on and run-off subcatchment area draining into and out of the permit boundary of the proposed landfill development for post-development conditions, including the proposed landfill development stormwater management system depicted in **Drawings III-C.2-6** and **III-C.2-7**.

Results

Subcatchment delineations for pre-development and post-development conditions, including the proposed landfill development, are provided in **Appendix III-C.2**. HydroCAD model layout diagrams are included in **Appendix III-C.4** to aid in understanding how modeling is completed.

A description of each point of comparison and explanation of the methodology used in determining each point is provided in **Table III-C.3-2.1**. Subcatchment area acreages for pre-development and post-development conditions are provided in **Table III-C.3-2.2**. Subcatchment area acreages for the proposed landfill development are provided in **Table III-C.3-2.3**.

TABLE C.3-2.1 Point of Comparison Summary Pescadito Environmental Resource Center		
Point of Comparison Summary	**Subcatchment Areas**	**Analysis**
North Area - Run-On Analysis (See Drawing C.2-2 and C.2-8)		
POC-ON-N-1	EX-ON-N-1 / P-ON-N-1	This Point of Comparison evaluates stormwater run-on into the western portion of the north area. Although this area does not contribute stormwater run-on into the proposed landfill development footprint, existing flow patterns are analyzed in this area to ensure that the entire property is considered in this drainage analysis.
POC-ON-N-2a	EX-ON-N-2a / P-ON-N-2a	This Point of Comparison evaluates stormwater run-on into the northern portion of the north area. Although this area does not contribute stormwater run-on into the proposed landfill development footprint, existing flow patterns are analyzed in this area to ensure that the entire property is considered in this drainage analysis.
POC-ON-N-2b	EX-ON-N-2b / P-ON-N-2b	This Point of Comparison evaluates stormwater run-on into the northern portion of the north area. Although this area does not contribute stormwater run-on into the proposed landfill development footprint, existing flow patterns are analyzed in this area to ensure that the entire property is considered in this drainage analysis.
POC-ON-N-3a	EX-ON-N-3a / P-ON-N-3a	This Point of Comparison evaluates stormwater run-on into the northern portion of the north area. Although this area does not contribute stormwater run-on into the proposed landfill development footprint, existing flow patterns are analyzed in this area to ensure that the entire property is considered in this drainage analysis.
POC-ON-N-3b	EX-ON-N-3b / P-ON-N-3b	This Point of Comparison evaluates stormwater run-on into the eastern portion of the north area.
POC-ON-N-4	EX-ON-N-4 / P-ON-N-4	This Point of Comparison evaluates stormwater run-on into the eastern portion of the north area.
North Area - Run-Off Analysis (See Drawing C.2-3 and C.2-9)		
POC-OFF-N-1	EX-OFF-N-1 / P-OFF-N-1	This Point of Comparison evaluates stormwater run-off discharging from the southwestern portion of the north area. Although this area is not directly connected with the stormwater management system from the proposed landfill development, existing flow patterns are analyzed in this area to ensure that the entire property is considered in this drainage analysis..
POC-OFF-N-2	EX-OFF-N-2 / P-OFF-N-2	This Point of Comparison evaluates stormwater run-off discharging from the southwestern portion of the north area. Although this area is not directly connected with the stormwater management system from the proposed landfill development, existing flow patterns are analyzed in this area to ensure that the entire property is considered in this drainage analysis..
POC-OFF-N-3	EX-OFF-N-3 / P-OFF-N-3 + P-OFF-LF-3 + P-OFF-N-3b	This Point of Comparison evaluates stormwater run-off discharging from the central portion of the north area and the stormwater management system from the proposed landfill development and perimeter run-on control ditch.
POC-OFF-N-4a	EX-OFF-N-4a / P-OFF-N-3b	This Point of Comparison evaluates stormwater run-off discharging from the eastern portion of the north area and the perimeter run-on control ditch.
POC-OFF-N-4b	EX-OFF-N-4b / P-OFF-N-4b	This Point of Comparison evaluates stormwater run-off discharging from the eastern portion of the north area and the perimeter stormwater management system from the proposed landfill development.

TABLE C.3-2.1 Point of Comparison Summary Pescadito Environmental Resource Center		
Point of Comparison Summary	**Subcatchment Areas**	**Analysis**
South Area - Run-On Analysis (See Drawing C.2-4 and C.2-10)		
POC-ON-S-1a	EX-ON-S-1a / P-ON-S-1a	This Point of Comparison evaluates stormwater run-on into the western portion of the south area.
POC-ON-S-1b	EX-ON-S-1b / P-ON-S-1b	This Point of Comparison evaluates stormwater run-on into the northern portion of the south area.
POC-ON-S-2	EX-ON-S-2 / P-ON-S-2	This Point of Comparison evaluates stormwater run-on into the northern portion of the south area.
POC-ON-S-3	EX-ON-S-3 / POC-OFF-N-3 + P-ON-S-3SD	This Point of Comparison evaluates stormwater run-on into the northern portion of the south area, including stormwater run-off discharging from the proposed landfill
POC-ON-S-4a	EX-ON-S-4a / POC-OFF-N-4a + P-ON-S-4aSD	This Point of Comparison evaluates stormwater run-on into the northern portion of the south area, including stormwater run-off being diverted around the proposed landfill.
POC-ON-S-4b	EX-ON-S-4b / P-ON-S-4b	This Point of Comparison evaluates stormwater run-on into the northern portion of the south area.
POC-ON-S-5	EX-ON-S-5 / P-ON-S-5	This Point of Comparison evaluates stormwater run-on into the eastern portion of the south area.
South Area - Run-Off Analysis (See Drawing C.2-5 and C.2-11)		
POC-OFF-S-5	EX-OFF-S-5 / P-OFF-S-5	This Point of Comparison evaluates stormwater run-off discharging from eastern portion of the south area.
POC-OFF-S-6	EX-OFF-S-1a / P-OFF-S-1a	This Point of Comparison evaluates stormwater run-off discharging from the large majority of the north area, including discharge from the stormwater management system of the proposed landfill development and all stormwater diverted around the proposed landfill. This Point of Comparison also includes stormwater discharges from the Upper and Burrito Tanks located within the south area.
	EX-OFF-S-1b / P-OFF-S-1b	
	EX-OFF-S-1c / P-OFF-S-1c	
	EX-OFF-S-2 / P-OFF-S-2	
	EX-OFF-S-3 / P-OFF-N-3 + P-OFF-S-3DS	
	EX-OFF-S-4a / P-OFF-N-4a + P-OFF-S-4aDS	
	EX-OFF-S-4b / P-OFF-S-4b	
POC-OFF-S-7	EX-OFF-S-7 / P-OFF-S-7	This Point of Comparison evaluates stormwater run-off discharging from a the western portion of the south area, directly south of the Burrito Tank dam structure.

TABLE C.3-2.2
Subcatchment Area Summary
Pescadito Environmental Resource Center

Subcatchment Name	Total Area (acres)	Subcatchment Name	Total Area (acres)	Subcatchment Name	Total Area (acres)	Subcatchment Name	Total Area (acres)
North Property - Run-On Analysis		**Pre-Development Conditions - Run-Off North Property**		**Pre-Development Conditions - Run-On South Property**		**Pre-Development Conditions - Run-Off South Property**	
EX-ON-N-1	617.70	EX-OFF-N-1	699.96	EX-ON-S-1a	4,625.03	EX-OFF-S-1a	4,625.03
EX-ON-N-2a	187.02	EX-OFF-N-2	515.88	EX-ON-S-1b	699.96	EX-OFF-S-1b	736.98
EX-ON-N-2b	141.33	EX-OFF-N-3	711.90	EX-ON-S-2	518.41	EX-OFF-S-1c	47.24
EX-ON-N-3a	431.23	EX-OFF-N-4a	18.48	EX-ON-S-3	718.93	EX-OFF-S-2	548.83
EX-ON-N-3b	88.65	EX-OFF-N-4b	56.97	EX-ON-S-4a	23.82	EX-OFF-S-3	730.64
EX-ON-N-4	56.97			EX-ON-S-4b	87.35	EX-OFF-S-4a	60.13
				EX-ON-S-5	2,678.07	EX-OFF-S-4b	208.53
						EX-OFF-S-5	2,678.07
						EX-OFF-S-6	134.06
						EX-OFF-S-7	14.76
Total	**1522.90**	**Total**	**2003.19**	**Total**	**9351.56**	**Total**	**9784.27**
Post-Development Conditions - Run-On North Property		**Post-Development Conditions - Run-Off North Property**		**Post-Development Conditions - Run-On South Property**		**Post-Development Conditions - Run-Off South Property**	
EX-ON-N-1	617.70	P-OFF-N-1	699.96	P-ON-S-1a	4,625.03	P-OFF-S-1a	4,625.03
EX-ON-N-2a	187.02	P-OFF-N-2	515.88	P-ON-S-1b	699.96	P-OFF-S-1b	736.98
EX-ON-N-2b	141.33	P-OFF-N-3	527.94	P-ON-S-2	518.41	P-OFF-S-1c	47.24
EX-ON-N-3a	431.23	P-OFF-LF-3[1]	106.29	P-ON-S-3DS[2]	7.03	P-OFF-S-2	548.83
EX-ON-N-3b	88.65	P-OFF-N-3b	96.15	POC-OFF-N-3	708.31	P-OFF-S-3DS[2]	18.42
EX-ON-N-4	56.97	P-OFF-N-4b	56.97	P-ON-S-4aDS[2]	5.33	POC-OFF-N-3	708.31
				POC-OFF-N-4a	22.07	P-OFF-S-4aDS[2]	41.97
				P-ON-S-4b	87.35	POC-OFF-N-4a	22.07
				P-ON-S-5	2,678.07	P-OFF-S-4b	208.53
						P-OFF-S-5	2,678.07
						P-OFF-S-6	134.06
						P-OFF-S-7	14.76
Total	**1522.90**	**Total**	**2003.19**	**Total**	**9351.56**	**Total**	**9784.27**

Notes: 1) Subcatchment P-OFF-LF-3 acreage is the summation of all subcatchment areas used in the "Post-Development Conditions Landfill - North" HydroCAD model. See Table C.3-2.3 - Subcatchment Area Summary - Landfill for subcatchment areas.
2) Subcatchments P-ON-S-3DS, P-ON-S-4aDS, P-OFF-S-3DS, and P-OFF-S-4aDS indicate that these subcatchment acreages account for the drainage area directly downstream of the concentrated discharge locations for the proposed landfill development. The stormwater management system for the proposed landfill development has been modeled separately and connected to the Post-Development Conditions model by a "Link" node that uses a hydrograph at the discharge of the Northeast Detention Basin created in the Landfill model. Link nodes are utilized to connect upstream hydrographs from the stormwater management system used at the proposed landfill developement to downstream subcatchment areas.

TABLE C.3-2.3 Subcatchment Area Summary - Landfill Pescadito Environmental Resource Center							
Subcatchment Name	Total Area (acres)	Subcatchment Name	Total Area (acres)	Subcatchment Name	Total Area (acres)	Subcatchment Name	Total Area (acres)
North Property - Run-On Analysis		Subcatchment Area B		Subcatchment Area C		Subcatchment Area D	
A1	0.59	B1	0.51	C1	1.70	D1	2.45
A2	0.59	B2	1.76	C2	1.05	D2	2.37
A3	1.60	B3	1.40	C3	2.03	D3	1.71
A4	1.58	B4	1.67	C4	2.03	D4	3.72
A5	3.01	B5	3.22	C5	3.43	D5	2.47
A6	3.20	B6	2.26	C6	1.90		
				C7	2.78		
Total	10.55	Total	10.83	Total	14.91	Total	12.71
Subcatchment Area E		Subcatchment Area F		Subcatchment Area G		Subcatchment Area H	
E1	1.93	F1	2.20	G1	1.04	H1	1.85
E2	2.66	F2	2.39	G2	2.23	H2	0.57
E3	2.66	F3	3.93	G3	1.99	H3	1.68
Basin	13.62	F4	1.95	G4	2.00	H4	1.57
		F5	2.09	G5	2.98	H5	2.14
				G6	2.78	H6	3.05
Total	20.86	Total	12.55	Total	13.03	Total	10.85

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

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

8-15-2017

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: CURVE NUMBERS

Problem Statement

Determine the weighted curve number (CN) for each subcatchment area for pre-development and post-development conditions, including the proposed landfill development subcatchment areas of the Pescadito Environmental Resource Center. The CN is used to determine stormwater runoff for subcatchment areas.

Given

- ❑ Table 2-2d *Runoff curve numbers for arid and semiarid rangelands*
- ❑ Technical Release 55 (TR-55), *Urban Hydrology for Small Watersheds,* USDA-NRCS
- ❑ NRCS Soil Survey for Webb County
- ❑ HELP Model *Engineering Documentation for Version 3*
- ❑ The Curve Numbers, CN, used were based on Antecedent Runoff Condition II (ARC II) (formerly Antecedent Moisture Condition or AMC) without a downward adjustment based on the hot, semi-arid climate of the site location.

Assumptions

Weighted curve numbers are used to identify the runoff characteristics of an area. Curve numbers consider both the land cover that will be encountered by surface water (such as grass, road, etc.) as well as the type of soil that underlies the land cover. The underlying soil is important because soil matrix has a large impact on whether water infiltrates the soil or is shed.

The existing property is currently undeveloped. The land is predominantly rangeland with poor stands of vegetation. The land is used for cattle grazing.

HydroCAD utilizes curve number table values that are published by the United States Department of Agriculture – Natural Resources Conservation Service (USDA- NRCS) in technical resource TR-55. The tables provide typical curve numbers for each land cover and soil group pairing.

TR-55 describes the various hydrologic soil groups as follows:

Group A: Soils with low runoff potential; typically more than 90 percent sand or gravel.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: CURVE NUMBERS

Group B: Moderately low runoff potential with water transmission through the soil unimpeded. Group B soils typically have between 10 and 20 percent clay and 50 to 90 percent sand and have loamy sand or sandy loam textures.

Group C: Moderately high runoff potential. Typically have between 20 and 40 percent clay and less than 50 percent sand, and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures.

Group D: High runoff potential. Typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures.

The NRCS publishes surficial soil surveys for most areas of the United States. Their *Soil Survey of Webb County, Texas* was consulted to identify surficial soils at the facility. For each surficial soil, a name, general description, and Soil Group is provided. This document, in addition to the known landcovers and boundaries of various features, is used to determine the weighted runoff curve number for each subcatchment area.

The Webb County Soil Survey indicates that the soils in the proposed development area include clays, sandy clay loan, and sandy loams that lie on slopes ranging from 0 to 5 percent. Descriptions of soils include the following:

Aguilares sandy clay loam. 0-3 percent slopes (AgB):
The Aguilares sandy clay loam series consists of deep, well drained, moderately permeable, calcareous and moderately alkaline soils on uplands. This Aguilares soil map unit is found on broad, convex plains. The parent material consists of alcareous loamy residuum weathered from sandstone predominantly from the Jackson Formation. Most areas of these soils are mainly used for rangeland and habitat for wildlife. Slopes range from 0 to 3 percent. Hydrologic soil group B.

Brundage fine sandy loam, occasionally flooded (Bd):
The Brundage fine sandy clay loam series consists of deep, moderately well drained, very slowly permeable, saline soils in upland valleys. This Brundage soil map unit is found on valleys along small drainageways and on smooth plains parallel to drainageways. The parent material consists of saline, loamy alluvium. Most areas of these soils are mainly used for rangeland and habitat for wildlife. Slopes range from 0 to 1 percent. Hydrologic soil group D.

Catarina Clay, 0- 2 percent slopes CaB):

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: CURVE NUMBERS

The Catarina Clay series consists of deep, moderately well drained, very slowly permeable, saline soils on upland plains and valleys. This Catarina soil map unit is found on broad and narrow valleys along drainageways and on smooth plains. The parent material consists of calcareous, saline, clayey alluvium. Most areas of these soils are mainly used for rangeland and habitat for wildlife. Slopes range from 0 to 2 percent. Hydrologic soil group D.

Catarina Clay, occasionally flooded (CfA):
The Catarina Clay series consists of deep, moderately well drained, very slowly permeable, saline soils on upland plains and valleys. This Catarina soil map unit is found on narrow valleys along drainageways. The parent material consists of calcareous, saline, clayey alluvium. Most areas of these soils are mainly used for rangeland and habitat for wildlife. Slopes range from 0 to 1 percent. Hydrologic soil group D.

Copita fine sandy loam, 0-3 percent slopes (CpB):
The Copita fine sandy loam series consists of deep, well drained, saline soils in low hills and side slopes. Slopes range from 0 to 3 percent. Hydrologic soil group C.

Maverick-Catarina complex, gently rolling (MCE):
The Maverick-Catarina series consists of deep, well drained, clayey soils located along ridgelines. The parent material consists of saline clay. Slope ranges from 3 to 10 percent. Hydrologic soil group D.

Montell clay, 0-3 percent slopes, saline (MnB):
The Montell clay series consists of deep, moderately well drained, very slowly permeable, saline, clayey soil on upland plains and valleys. This Montell soil map unit is found on broad and narrow valleys along drainageways and on smooth plains. The parent material consists of clayey valley side alluvium. Most areas of these soils are mainly used for rangeland and habitat for wildlife. Slope ranges from 0 to 3 percent. Hydrologic soil group D.

Moglia clay, 1-5 percent slopes (MgC):
The Moglia clay series consists of very deep, well drained, moderately slowly permeable soils that formed in calcareous, saline, loamy residuum weathered from mudstone. This Moglia soil map unit is found on interfluves on coastal plains. The parent material consists of calcareous, saline, loamy residuum weathered from shale. This soil is used primarily for livestock grazing and wildlife habitat. Slope ranges from 1 to 5 percent. Hydrologic soil group C.

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: CURVE NUMBERS

Calculations

Pre-Development Conditions and Unmodified Areas for Post-development Conditions

For pre-development conditions and unmodified subcatchment areas for post-development conditions, the weighted curve number for each subcatchment area is calculated based on surficial soil types and associated land cover. Based on the NRCS Soil Survey for Webb County, the majority of the pre-development and unmodified areas comprises of Soil Group D soils, with the remainder being either Soil Group B or C soils. Based on the natural land cover for the area, values were taken for the land cover type "Desert Shrub – major plants include saltbrush, greasewood, creosotebrush, blackbrush, bursage, palo verde, mesquite, and cactus." Fair hydrologic conditions were assumed for the area since grazing in the area has lessened the quality of ground level vegetation.

AutoCAD Civil3D 2016 was used to delineate both the surficial soil group boundaries to determine their area. A composite (weighted) curve number for each subcatchment area using the following equation:

$$CN_c = \frac{CN_1A_1 + CN_2A_2 \ldots CN_nA_n}{A_1 + A_2 \ \ldots A_n}$$

Where:
- CN_c = Composite CN value
- CN_1-CN_n = Individual CN values
- $A_1 - A_n$ = Area associated with each CN value

Please refer to the attached **Table III-C.3-3**, which summarizes the composite curve number for each subcatchment area of the pre-development conditions and unmodified subcatchment areas for post-development conditions

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: CURVE NUMBERS

Proposed Landfill Development for Post-Development Conditions

Due to the fact that the proposed landfill 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, a value of 90 for the final landform is conservative (exact CN=89), 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.

The CN=90 was then adjusted to represent the engineered nature of the landfill using regression methodology described in HELP Model *Engineering Documentation for Version 3*. Based on this methodology, a regression equation for adjustment of curve number for surface slope is used:

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

Where,

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

A slope length of 200 feet and 4:1 slopes (0.25 ft/ft) is 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 post-development conditions of the proposed landfill development.

Therefore:

$$CN_{II} = 100 - (100 - 90) * \left(\frac{0.4^2}{6.25}\right)^{90^{-0.81}}$$

$CN_{II} = 90.91\ (\approx 91)$ for the proposed landfill development final cover

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: CURVE NUMBERS

Results

Subcatchment areas for the post-development conditions of the proposed landfill development are modeled with a curve number of 91. The detention basin was modeled with a curve number of 98, which is an appropriate curve number for water surfaces. Please refer to the attached **Table III-C.3-3**, which summarizes the composite curve number for each subcatchment area of the pre-development conditions and unmodified subcatchment areas for post-development conditions.

TABLE C.3-3
Curve Number Summary
Pescadito Environmental Resource Center

Subcatchment Name	Soil Group A		Soil Group B		Soil Group C		Soil Group D		Water		Composite Curve Number	
	CN = 55		CN = 72		CN = 81		CN = 86		CN = 98			
	(acres)	%	(acres)	%	(acres)	%	(acres)	%	(acres)	%	Total Acres	CN
Pre-Development Conditions - Run-On North Area												
EX-ON-N-1	0.0	0%	227.6	37%	141.6	23%	243.1	39%	5.4	1%	617.7	80
EX-ON-N-2a	0.0	0%	112.9	60%	0.0	0%	74.1	40%	0.0	0%	187.0	78
EX-ON-N-2b	0.0	0%	99.8	71%	0.0	0%	41.6	29%	0.0	0%	141.3	76
EX-ON-N-3a	0.0	0%	201.9	47%	0.0	0%	229.3	53%	0.0	0%	431.2	79
EX-ON-N-3b	0.0	0%	23.1	26%	0.0	0%	65.6	74%	0.0	0%	88.6	82
EX-ON-N-4	0.0	0%	1.5	3%	0.0	0%	55.5	97%	0.0	0%	57.0	86
Post-Development Conditions - Run-On North Area												
P-ON-N-1	0.0	0%	227.6	37%	141.6	23%	243.1	39%	5.4	1%	617.7	80
P-ON-N-2a	0.0	0%	112.9	60%	0.0	0%	74.1	40%	0.0	0%	187.0	78
P-ON-N-2b	0.0	0%	99.8	71%	0.0	0%	41.6	29%	0.0	0%	141.3	76
P-ON-N-3a	0.0	0%	201.9	47%	0.0	0%	229.3	53%	0.0	0%	431.2	79
P-ON-N-3b	0.0	0%	23.1	26%	0.0	0%	65.6	74%	0.0	0%	88.6	82
P-ON-N-4	0.0	0%	1.5	3%	0.0	0%	55.5	97%	0.0	0%	57.0	86
Pre-Development Conditions - Run-Off North Area												
EX-OFF-N-1	0.0	0%	250.6	36%	145.3	21%	298.7	43%	5.4	1%	700.0	80
EX-OFF-N-2	0.0	0%	153.3	30%	0.0	0%	362.6	70%	0.0	0%	515.9	82
EX-OFF-N-3	0.0	0%	231.5	33%	0.0	0%	480.4	67%	0.0	0%	711.9	81
EX-OFF-N-4a	0.0	0%	0.0	0%	0.0	0%	18.5	100%	0.0	0%	18.5	86
EX-OFF-N-4b	0.0	0%	1.5	3%	0.0	0%	55.5	97%	0.0	0%	57.0	86
Post-Development Conditions - Run-Off North Area												
P-OFF-N-1	0.0	0%	250.6	36%	145.3	21%	298.7	43%	5.4	1%	700.0	80
P-OFF-N-2	0.0	0%	153.3	30%	0.0	0%	362.6	70%	0.0	0%	515.9	82
P-OFF-N-3a	0.0	0%	208.4	39%	0.0	0%	319.6	61%	0.0	0%	527.9	80
P-OFF-LF-3[1]	See Note 1										106.3	92
P-OFF-N-3b	0.0	0%	23.1	24%	0.0	0%	73.1	76%	0.0	0%	96.1	83
P-OFF-N-4b	0.0	0%	1.5	3%	0.0	0%	55.5	97%	0.0	0%	57.0	86
Pre-Development Conditions - Run-On South Area												
EX-ON-S-1a	0.0	0%	0.0	0%	790.8	17%	3800.8	82%	33.4	1%	4625.0	85
EX-ON-S-1b	0.0	0%	250.6	36%	145.3	21%	298.7	43%	5.4	1%	700.0	80
EX-ON-S-2	0.0	0%	153.3	30%	0.0	0%	365.2	70%	0.0	0%	518.4	82
EX-ON-S-3	0.0	0%	231.5	32%	0.0	0%	487.4	68%	0.0	0%	718.9	81
EX-ON-S-4a	0.0	0%	0.0	0%	0.0	0%	23.8	100%	0.0	0%	23.8	86
EX ON S 4b	0.0	0%	1.5	2%	0.0	0%	85.8	98%	0.0	0%	87.3	86
EX-ON-S-5	0.0	0%	953.2	36%	0.0	0%	1724.8	64%	0.0	0%	2678.0	81
Post-Development Conditions - Run-On South Area												
P-ON-S-1a	0.0	0%	0.0	0%	790.8	17%	3800.8	82%	33.4	1%	4625.0	85
P-ON-S-1b	0.0	0%	250.6	36%	145.3	21%	298.7	43%	5.4	1%	700.0	80
P-ON-S-2	0.0	0%	153.3	30%	0.0	0%	365.2	70%	0.0	0%	518.4	82
P-ON-S-3DS[2]	0.0	0%	0.0	0%	0.0	0%	7.0	100%	0.0	0%	7.0	86
POC-OFF-N-3[2]	See Note 2										708.3	--
P-ON-S-4aDS[2]	0.0	0%	0.0	0%	0.0	0%	5.3	100%	0.0	0%	5.3	86
POC-OFF-N-4a[2]	See Note 2										22.1	--
P-ON-S-4b	0.0	0%	1.5	2%	0.0	0%	85.8	98%	0.0	0%	87.3	86
P-ON-S-5	0.0	0%	953.2	36%	0.0	0%	1724.8	64%	0.0	0%	2678.0	81
Pre-Development Conditions - Run-Off South Area												
EX-OFF-S-1a	0.0	0%	0.0	0%	790.8	17%	3800.8	82%	33.4	1%	4625.0	85
EX-OFF-S-1b	0.0	0%	250.6	34%	145.3	20%	335.7	46%	5.4	1%	737.0	80
EX-OFF-S-1c	0.0	0%	0.0	0%	0.0	0%	18.9	40%	28.4	60%	47.2	93
EX-OFF-S-2	0.0	0%	153.3	28%	0.0	0%	388.5	71%	7.1	1%	548.8	82
EX-OFF-S-3	0.0	0%	231.5	32%	0.0	0%	499.2	68%	0.0	0%	730.6	82
EX-OFF-S-4a	0.0	0%	0.0	0%	0.0	0%	54.3	90%	5.9	10%	60.1	87
EX-OFF-S-4b	0.0	0%	1.5	1%	0.0	0%	193.8	93%	13.2	6%	208.5	87
EX-OFF-S-5	0.0	0%	953.3	36%	0.0	0%	1724.8	64%	0.0	0%	2678.1	81
EX-OFF-S-6	0.0	0%	0.0	0%	0.0	0%	134.1	100%	0.0	0%	134.1	86
EX-OFF-S-7	0.0	0%	0.0	0%	0.0	0%	14.8	100%	0.0	0%	14.8	86
Post-Development Conditions - Run-Off South Area												
P-OFF-S-1a	0.0	0%	0.0	0%	790.8	17%	3800.8	82%	33.4	1%	4625.0	85
P-OFF-S-1b	0.0	0%	250.6	34%	145.3	20%	335.7	46%	5.4	1%	737.0	80
P-OFF-S-1c	0.0	0%	0.0	0%	0.0	0%	18.9	40%	28.4	60%	47.2	93
P-OFF-S-2	0.0	0%	153.3	28%	0.0	0%	388.5	71%	7.1	1%	548.8	82
P-ON-S-3DS[2]	0.0	0%	0.0	0%	0.0	0%	18.4	100%	0.0	0%	18.4	86
POC-OFF-N-3[2]	See Note 2										708.3	--
P-ON-S-4aDS[2]	0.0	0%	0.0	0%	0.0	0%	36.1	86%	5.9	14%	42.0	88
POC-OFF-N-4a[2]	See Note 2										22.1	--
P-OFF-S-4b	0.0	0%	1.5	1%	0.0	0%	193.8	93%	13.2	6%	208.5	87
P-OFF-S-5	0.0	0%	953.3	36%	0.0	0%	1724.8	64%	0.0	0%	2678.1	81
P-OFF-S-6	0.0	0%	0.0	0%	0.0	0%	134.1	100%	0.0	0%	134.1	86
P-OFF-S-7	0.0	0%	0.0	0%	0.0	0%	14.8	100%	0.0	0%	14.8	86

Note: 1) Subcatchment Area P-OFF-LF-3 consists of 92.668 Acres of Landfill (CN=91, as described in the Curve Number calculation text) and 13.623 Acres of Water Surface (CN=98).
2) Subcatchments P-ON-S-3DS, P-ON-S-4aDS, P-OFF-S-3DS, and P-OFF-S-4aDS indicate that these subcatchment acreage account for the drainage area directly downstream of the proposed landfill development. Subcatchment areas noted POC-OFF-N-3 and POC-OFF-N-4a are "Link" nodes that combine multiple subcatchments and curve numbers into one, cohesive hydrograph in which the curve number is account for in upstream stormwater models.

United States Department of Agriculture

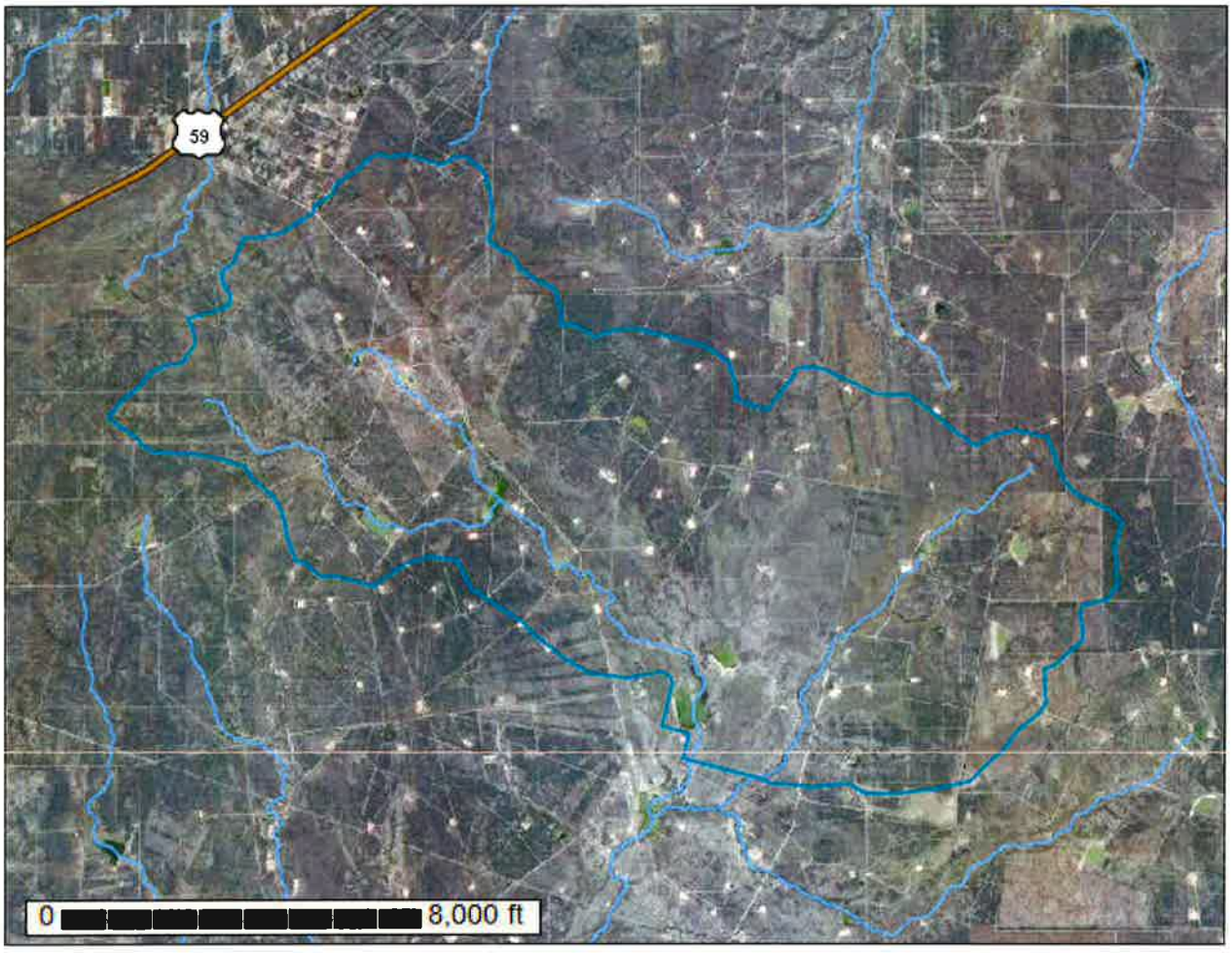
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Webb County, Texas

PERC Soil Survey



August 1, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

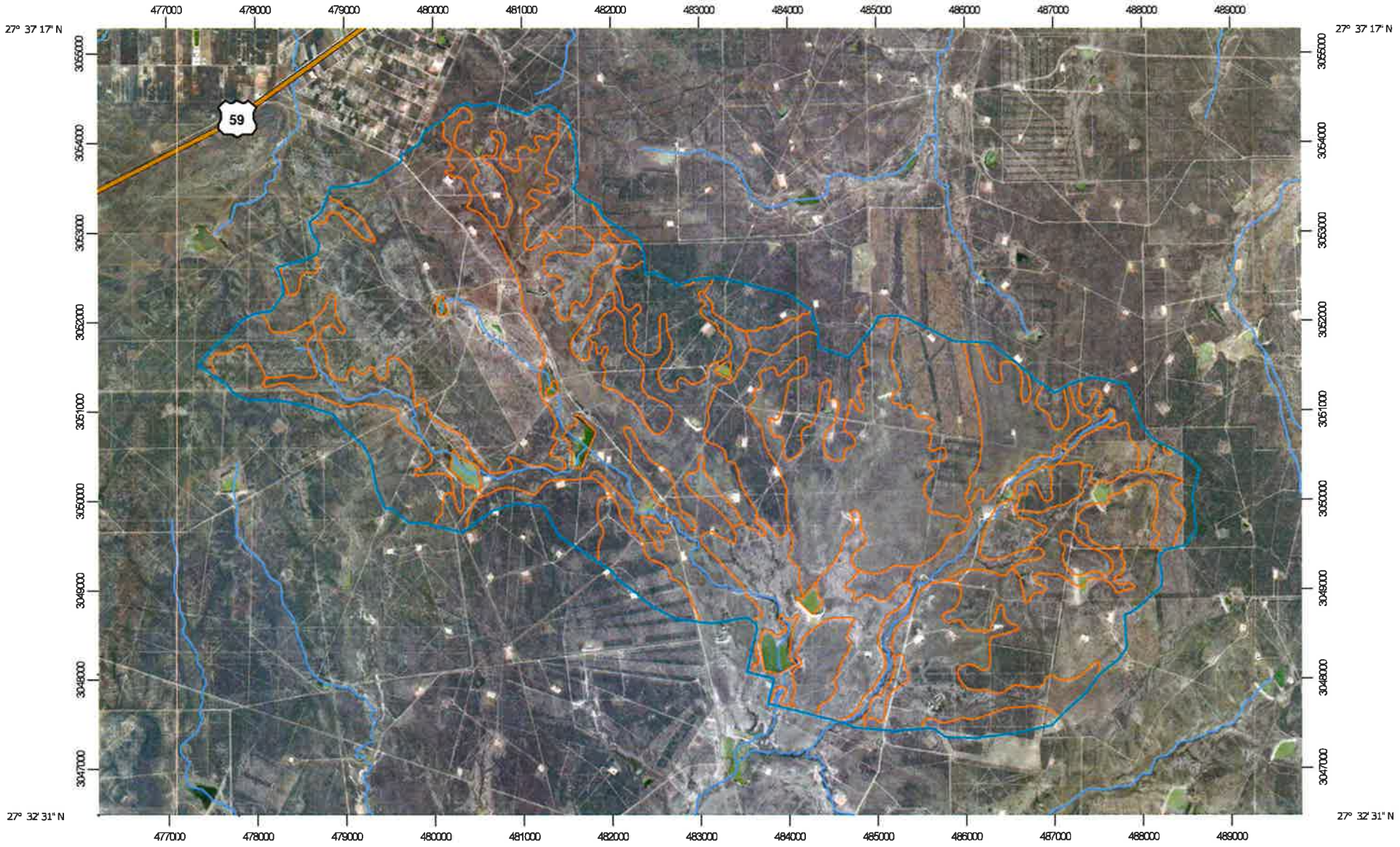
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.


99° 14' 27" W
99° 6' 11" W
27° 37' 17" N
27° 32' 31" N
477000
478000
479000
480000
481000
482000
483000
484000
485000
486000
487000
488000
489000
3055000
3054000
3053000
3052000
3051000
3050000
3049000
3048000
3047000
59
Map Scale: 1:62,200 if printed on A landscape (11" x 8.5") sheet.
Meters
0 500 1000 2000 3000
Feet
0 3000 6000 12000 18000
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:31,700.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Webb County, Texas
Survey Area Data: Version 13, Sep 19, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 12, 2010—Jan 22, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Webb County, Texas (TX479)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AgB	Aguilares sandy clay loam, 0 to 3 percent slopes	1,837.3	18.7%
Bd	Brundage fine sandy loam, 0 to 1 percent slopes, occasionally flooded	716.6	7.3%
CaB	Catarina clay, 0 to 2 percent slopes	2,364.1	24.1%
CfA	Catarina clay, 0 to 1 percent slopes, occasionally flooded	223.1	2.3%
CpB	Copita fine sandy loam, 0 to 3 percent slopes	34.2	0.3%
MCE	Maverick-Catarina complex, gently rolling	2,337.9	23.8%
MgC	Moglia clay loam, 1 to 5 percent slopes	950.6	9.7%
MnB	Montell clay, 0 to 3 percent slopes	1,243.0	12.7%
W	Water	117.1	1.2%
Totals for Area of Interest		**9,823.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They

generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Webb County, Texas

AgB—Aguilares sandy clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2t129
Elevation: 150 to 850 feet
Mean annual precipitation: 18 to 24 inches
Mean annual air temperature: 71 to 73 degrees F
Frost-free period: 265 to 325 days
Farmland classification: Not prime farmland

Map Unit Composition

Aguilares and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Aguilares

Setting

Landform: Low hills
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Calcareous loamy residuum weathered from sandstone

Typical profile

A - 0 to 8 inches: sandy clay loam
Bk1 - 8 to 13 inches: clay loam
Bk2 - 13 to 36 inches: clay loam
Bknz - 36 to 59 inches: sandy clay loam
BCknz - 59 to 80 inches: sandy clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 35 percent
Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Slightly saline to strongly saline (4.0 to 25.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 40.0
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B

Ecological site: Gray Loamy Upland 18-25" PZ (R083BY420TX)
Hydric soil rating: No

Minor Components

Brundage
Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: CLAYPAN PRAIRIE 18-25 PZ (R083BY417TX)
Hydric soil rating: No

Copita
Percent of map unit: 3 percent
Landform: Low hills
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: Gray Sandy Loam 18-25" PZ (R083BY421TX)
Hydric soil rating: No

Moglia
Percent of map unit: 2 percent
Landform: Low hills
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: Saline Clay Loam 18-35" PZ (R083BY433TX)
Hydric soil rating: No

Montell
Percent of map unit: 1 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clay Flat 18-25" PZ (R083BY415TX)
Hydric soil rating: No

Bd—Brundage fine sandy loam, 0 to 1 percent slopes, occasionally flooded

Map Unit Setting
National map unit symbol: 2t124
Elevation: 300 to 900 feet
Mean annual precipitation: 18 to 23 inches
Mean annual air temperature: 70 to 73 degrees F

Frost-free period: 280 to 325 days
Farmland classification: Not prime farmland

Map Unit Composition

Brundage and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brundage

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Saline loamy alluvium

Typical profile

A - 0 to 3 inches: fine sandy loam
Btn - 3 to 9 inches: sandy clay loam
Btknz - 9 to 38 inches: sandy clay loam
BCknz - 38 to 80 inches: sandy clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 32.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 45.0
Available water storage in profile: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: CLAYPAN PRAIRIE 18-25 PZ (R083BY417TX)
Hydric soil rating: No

Minor Components

Monwebb

Percent of map unit: 8 percent
Landform: Drainageways
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: Clay Flat 18-25" PZ (R083BY415TX)
Hydric soil rating: No

Pryor

Percent of map unit: 6 percent
Landform: Low hills
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Saline Clay Loam 18-35" PZ (R083BY433TX)
Hydric soil rating: No

Copita

Percent of map unit: 6 percent
Landform: Low hills
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Gray Sandy Loam 18-25" PZ (R083BY421TX)
Hydric soil rating: No

CaB—Catarina clay, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2t12c
Elevation: 300 to 800 feet
Mean annual precipitation: 18 to 24 inches
Mean annual air temperature: 71 to 74 degrees F
Frost-free period: 280 to 320 days
Farmland classification: Not prime farmland

Map Unit Composition

Catarina and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Catarina

Setting

Landform: Ridges
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Calcareous, saline clayey alluvium

Typical profile

A - 0 to 3 inches: clay
Bnssy - 3 to 14 inches: clay
Bknssyz - 14 to 73 inches: clay
Bknyz - 73 to 80 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 35.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: Saline Clay 18-25" PZ (R083BY432TX)
Hydric soil rating: No

Minor Components

Maverick

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Rolling Hardland 18-25" PZ (R083BY431TX)
Hydric soil rating: No

Viboras

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Saline Clay 18-25" PZ (R083BY432TX)
Hydric soil rating: No

Brundage

Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: CLAYPAN PRAIRIE 18-25 PZ (R083BY417TX)
Hydric soil rating: No

Monwebb

Percent of map unit: 1 percent
Landform: Drainageways
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: Clay Flat 18-25" PZ (R083BY415TX)
Hydric soil rating: No

CfA—Catarina clay, 0 to 1 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2t12f
Elevation: 280 to 780 feet
Mean annual precipitation: 18 to 23 inches
Mean annual air temperature: 70 to 73 degrees F
Frost-free period: 280 to 320 days
Farmland classification: Not prime farmland

Map Unit Composition

Catarina and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Catarina

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Calcareous, saline clayey alluvium

Typical profile

A - 0 to 3 inches: clay
Bnssy - 3 to 14 inches: clay
Bknssyz - 14 to 73 inches: clay
Bknyz - 73 to 80 inches: clay

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent

Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 35.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups
Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: Saline Clay 18-25" PZ (R083BY432TX)
Hydric soil rating: No

Minor Components

Brundage
Percent of map unit: 3 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: CLAYPAN PRAIRIE 18-25 PZ (R083BY417TX)
Hydric soil rating: No

Maverick
Percent of map unit: 1 percent
Landform: Ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Rolling Hardland 18-25" PZ (R083BY431TX)
Hydric soil rating: No

Viboras
Percent of map unit: 1 percent
Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Saline Clay 18-25" PZ (R083BY432TX)
Hydric soil rating: No

CpB—Copita fine sandy loam, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: 2t11s
Elevation: 350 to 840 feet
Mean annual precipitation: 20 to 23 inches
Mean annual air temperature: 72 to 75 degrees F

Frost-free period: 285 to 330 days
Farmland classification: Not prime farmland

Map Unit Composition

Copita and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Copita

Setting

Landform: Low hills
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Calcareous loamy residuum weathered from sandstone

Typical profile

A - 0 to 11 inches: fine sandy loam
Bk - 11 to 37 inches: sandy clay loam
Cr - 37 to 49 inches: bedrock
R - 49 to 80 inches: bedrock

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock; 40 to 60 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 35 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 12.0
Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Gray Sandy Loam 18-25" PZ (R083BY421TX)
Hydric soil rating: No

Minor Components

Verick

Percent of map unit: 4 percent
Landform: Ridges
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex

Across-slope shape: Convex
Ecological site: SHALLOW RIDGE 18-22" PZ (R083BY575TX)
Hydric soil rating: No

Brundage

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: TIGHT SANDY LOAM 18-25" PZ (R083BY441TX)
Hydric soil rating: No

Mcallen

Percent of map unit: 3 percent
Landform: Paleoterraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Gray Sandy Loam 18-25" PZ (R083BY421TX)
Hydric soil rating: No

MCE—Maverick-Catarina complex, gently rolling

Map Unit Setting

National map unit symbol: djcl
Elevation: 200 to 900 feet
Mean annual precipitation: 18 to 25 inches
Mean annual air temperature: 70 to 73 degrees F
Frost-free period: 270 to 320 days
Farmland classification: Not prime farmland

Map Unit Composition

Maverick and similar soils: 64 percent
Catarina and similar soils: 30 percent
Minor components: 6 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Maverick

Setting

Landform: Ridges, interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Calcareous, saline, clayey residuum weathered from shale

Typical profile

H1 - 0 to 6 inches: clay
H2 - 6 to 15 inches: clay

H3 - 15 to 25 inches: clay
H4 - 25 to 60 inches: clay

Properties and qualities

Slope: 3 to 10 percent
Depth to restrictive feature: About 25 inches to densic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 16.0
Available water storage in profile: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Saline Clay 18-25" PZ (R083BY432TX)
Hydric soil rating: No

Description of Catarina

Setting

Landform: Valley sides, valley floors
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Calcareous, saline clayey alluvium

Typical profile

H1 - 0 to 10 inches: clay
H2 - 10 to 45 inches: clay
H3 - 45 to 60 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Slightly saline to strongly saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 35.0
Available water storage in profile: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Saline Clay 18-25" PZ (R083BY432TX)
Hydric soil rating: No

Minor Components

Unnamed
Percent of map unit: 6 percent
Hydric soil rating: No

MgC—Moglia clay loam, 1 to 5 percent slopes

Map Unit Setting
National map unit symbol: djcm
Elevation: 250 to 800 feet
Mean annual precipitation: 18 to 21 inches
Mean annual air temperature: 72 to 73 degrees F
Frost-free period: 260 to 320 days
Farmland classification: Not prime farmland

Map Unit Composition
Moglia and similar soils: 77 percent
Minor components: 23 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Moglia

Setting
Landform: Interfluves
Landform position (two-dimensional): Shoulder, summit
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Calcareous, saline, loamy residuum weathered from shale

Typical profile
H1 - 0 to 7 inches: clay loam
H2 - 7 to 30 inches: clay
H3 - 30 to 54 inches: clay
H4 - 54 to 60 inches: clay loam
H5 - 60 to 80 inches: clay loam

Properties and qualities
Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Gypsum, maximum in profile: 20 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 40.0
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Saline Clay Loam 18-35" PZ (R083BY433TX)
Hydric soil rating: No

Minor Components

Unnamed

Percent of map unit: 23 percent
Hydric soil rating: No

MnB—Montell clay, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tlfg
Elevation: 200 to 820 feet
Mean annual precipitation: 21 to 25 inches
Mean annual air temperature: 70 to 74 degrees F
Frost-free period: 265 to 310 days
Farmland classification: Not prime farmland

Map Unit Composition

Montell and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Montell

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Microfeatures of landform position: Circular gilgai
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous clayey alluvium

Typical profile

A - 0 to 12 inches: clay
Bnss - 12 to 28 inches: clay
Bknssz - 28 to 38 inches: clay
Bknyz - 38 to 80 inches: clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 20 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 30.0
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: D
Ecological site: Clay Flat 18-25" PZ (R083BY415TX)
Hydric soil rating: No

Minor Components

Brundage

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: CLAYPAN PRAIRIE 18-25 PZ (R083BY417TX)
Hydric soil rating: No

Monwebb

Percent of map unit: 3 percent
Landform: Drainageways
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: Clay Flat 18-25" PZ (R083BY415TX)
Hydric soil rating: No

Moglia

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Saline Clay Loam 18-35" PZ (R083BY433TX)
Hydric soil rating: No

Viboras

Percent of map unit: 2 percent

Landform: Ridges
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Saline Clay 18-25" PZ (R083BY432TX)
Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

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

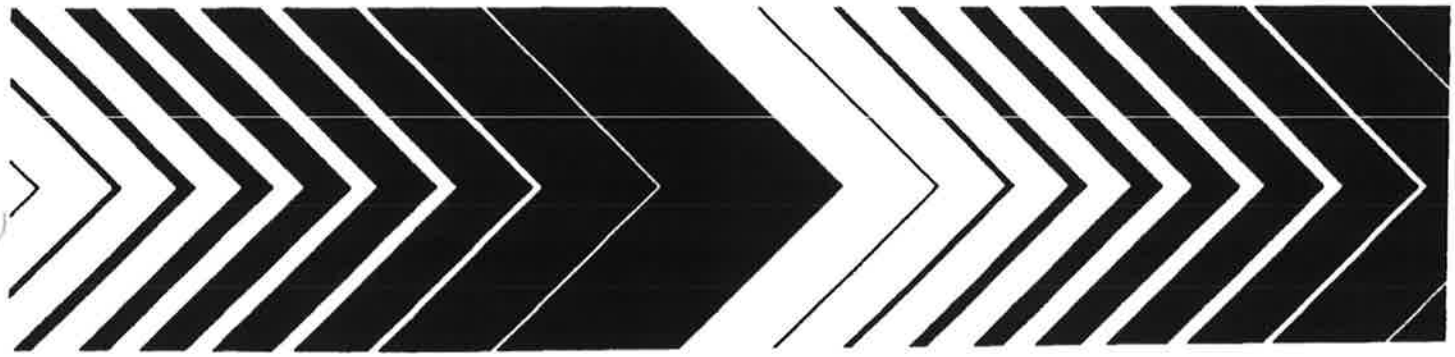
Office of Research and
Development
Washington DC 20460

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

EPA

The Hydrologic Evaluation of Landfill Performance (HELP) Model

Engineering Documentation for Version 3



where

CN_{II_a} = 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

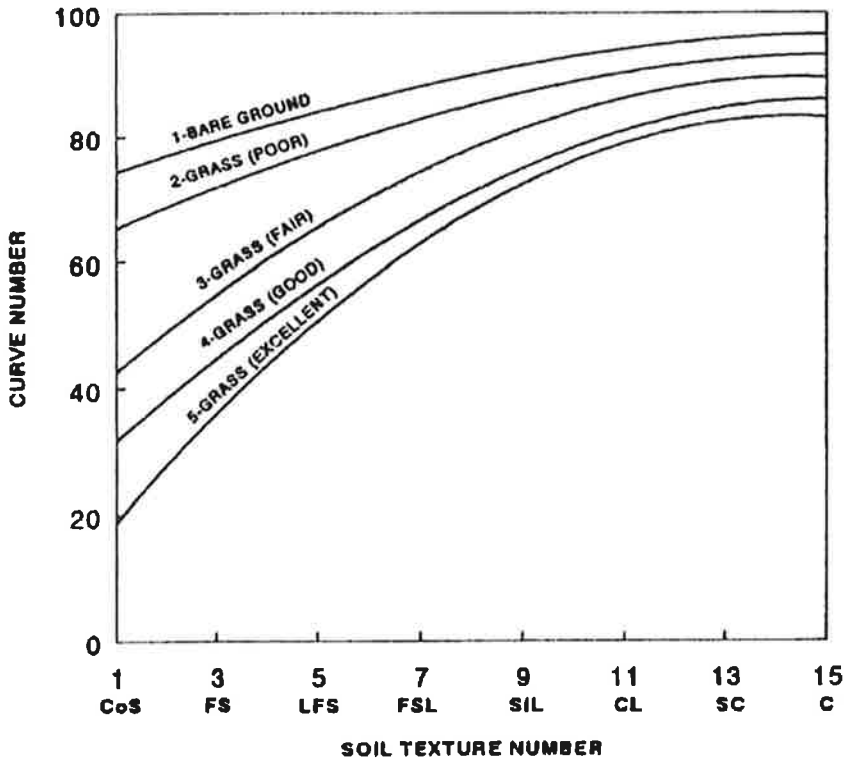


Figure 8. Relation between SCS Curve Number and Default Soil Texture Number for Various Levels of Vegetation

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:

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

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:

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

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

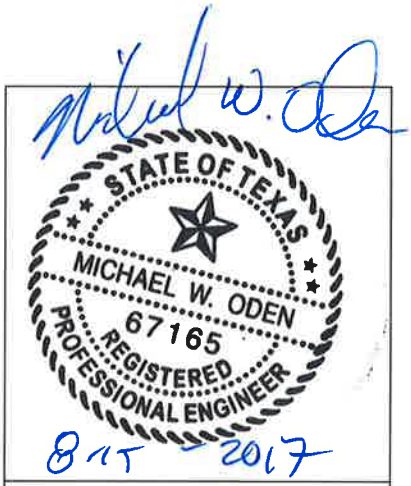
The HELP model determines daily runoff by the following procedure:

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

4. TIME OF CONCENTRATION DETERMINATION (III-C.3-4)



This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LTD**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: TIME OF CONCENTRATION DETERMINATION

Problem Statement

Summarize the input parameters for HydroCAD related to Time of Concentration. 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 methodology that HydroCAD uses to calculate the SCS lag time is based on Technical Release 55 (TR-55) and Technical Release 20 (TR-20), Urban Hydrology for Small Watersheds, published by the Soil Conservation Service (now the Natural Resource 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.

- The time of concentration flow paths for the proposed landfill development HydroCAD model were calculated to be the flow paths from the uppermost points in each subcatchment area to the terrace benches or perimeter ditch segment collecting those respective subcatchment areas.

Assumptions

The following assumptions were made in the calculations:

- The Manning's coefficient "n" for sheet flow for pre-development conditions is assumed to be 0.13, indicative of range land cover.

- The Manning's coefficient "n" for sheet flow in post-development conditions is assumed to be 0.13, indicative of range land cover in undeveloped areas of the facility and 0.15 in areas to be developed for the landfill, 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.

Client:	**Rancho Viejo Waste Management, LTD**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: TIME OF CONCENTRATION DETERMINATION

- ❑ For each subcatchment, 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 based on the TR-55 procedures.

- ❑ Shallow concentrated flow is assumed to become open channel flow when it reaches an ephemeral/intermittent stream or natural ditch segment.

- ❑ For the pre-development conditions and post-development areas of the facility that are not currently proposed to be modified, an average flow velocity factor of 10 ft/sec was assumed for shallow concentrated flow calculations, which is the HydroCAD default of "nearly bare and untilled" conditions, which is the closest available descriptor for the range land cover.

- ❑ For the proposed final landform and perimeter grading areas, an average flow velocity factor 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**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: TIME OF CONCENTRATION 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

Open Channel Flow:

Open channel flow is calculated by HydroCAD using the following equation:

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

Where:

T_t =		Travel time (hours)
L	=	Flow Length, ft
V	=	Average velocity, ft/sec
3,600	=	Conversion factor from seconds to hours

Open channel flow utilizes the Manning's equation to solve for the average velocity. HydroCAD calculates the average velocity using the following equation:

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

Where:

V	=	Average velocity, ft/sec
n	=	Manning's coefficient
R	=	Hydraulic radius, ft
S	=	Channel slope, ft/ft

Client:	Rancho Viejo Waste Management, LTD
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: TIME OF CONCENTRATION DETERMINATION

Results

A summary of the flow lengths and slopes used to calculate the time of concentration for each subcatchment area in both pre-development and post-development conditions is provided in the **Table III-C.3-4.1**. Additionally, **Table III-C.3-4.2** provides flow lengths and slopes used to calculate the time of concentration for each subcatchment in the proposed landfill development HydroCAD model. Time of concentration flowpaths for each subcatchment area is depicted in **Appendix III-C.2**.

TABLE C.3-4.1
Time of Concentration Summary
Pescadito Environmental Resource Center

Subcatchment Name	Sheet Flow Input Values		Shallow Concentrated Flow Input Values		Open Channel Flow Input Values		Resultant Time of Concentration	
	Length (ft)	Slope (%)	Length (ft)	Slope (%)	Length (ft)	Slope (%)	(Min)	(Hr)
Pre-Development Conditions - Run-On North Area								
EX-ON-N-1	300	0.10%	10,581	0.76%	N/A	N/A	266.7	4.4
EX-ON-N-2a	300	0.10%	5,213	0.77%	N/A	N/A	163.4	2.7
EX-ON-N-2b	300	1.70%	3,705	0.90%	N/A	N/A	85.8	1.4
EX-ON-N-3a	300	0.10%	7,800	0.51%	N/A	N/A	246.4	4.1
EX-ON-N-3b	300	1.80%	3,776	1.00%	N/A	N/A	83.2	1.4
EX-ON-N-4	300	0.70%	2,530	0.48%	N/A	N/A	90.5	1.5
Post-Development Conditions - Run-On North Area								
P-ON-N-1	300	0.10%	10,581	0.76%	N/A	N/A	266.7	4.4
P-ON-N-2a	300	0.10%	5,213	0.77%	N/A	N/A	163.4	2.7
P-ON-N-2b	300	1.70%	3,705	0.90%	N/A	N/A	85.8	1.4
P-ON-N-3a	300	0.10%	7,800	0.51%	N/A	N/A	246.4	4.1
P-ON-N-3b	300	1.80%	3,776	1.00%	N/A	N/A	83.2	1.4
P-ON-N-4	300	0.70%	2,530	0.48%	N/A	N/A	90.5	1.5
Pre-Development Conditions - Run-Off North Area								
EX-OFF-N-1	300	0.10%	12,570	0.68%	N/A	N/A	318.5	5.3
EX-OFF-N-2	300	0.10%	9,281	0.59%	N/A	N/A	265.8	4.4
EX-OFF-N-3	300	0.10%	12,300	0.44%	N/A	N/A	373.4	6.2
EX-OFF-N-4a	300	0.30%	650	0.30%	N/A	N/A	61.3	1.0
EX-OFF-N-4b	300	0.70%	2,530	0.48%	N/A	N/A	90.5	1.5
Post-Development Conditions - Run-Off North Area								
P-OFF-N-1	300	0.10%	12,570	0.68%	N/A	N/A	318.5	5.3
P-OFF-N-2	300	0.10%	9,281	0.59%	N/A	N/A	265.8	4.4
P-OFF-N-3	300	0.10%	12,300	0.44%	N/A	N/A	373.4	6.2
P-OFF-LF-3[1]	**See Note 1**							
P-OFF-N-3b	300	1.80%	3,776	1.00%	N/A	N/A	83.2	1.4
P-OFF-N-4b	300	0.70%	2,530	0.48%	N/A	N/A	90.5	1.5
Pre-Development Conditions - Run-On South Area								
EX-ON-S-1a	300	0.02%	8,398	0.01%	18,256	0.25%	295.2	4.9
EX-ON-S-1b	300	0.10%	12,570	0.68%	N/A	N/A	318.5	5.3
EX-ON-S-2	300	0.10%	9,393	0.59%	N/A	N/A	268.2	4.5
EX-ON-S-3	300	0.10%	12,480	0.44%	N/A	N/A	378.0	6.3
EX-ON-S-4a	300	0.30%	1,005	0.30%	N/A	N/A	72.1	1.2
EX-ON-S-4b	300	0.70%	4,015	0.48%	N/A	N/A	126.2	2.1
EX-ON-S-5	300	3.33%	9,183	0.87%	10,993	0.27%	251.9	4.2
Post-Development Conditions - Run-On South Area								
P-ON-S-1a	300	0.02%	8,398	0.01%	18,256	0.25%	295.2	4.9
P-ON-S-1b	300	0.10%	12,570	0.68%	N/A	N/A	318.5	5.3
P-ON-S-2	300	0.10%	9,393	0.59%	N/A	N/A	268.2	4.5
P-ON-S-3DS[2]	180	0.44%	N/A	N/A	N/A	N/A	23.7	0.4
P-ON-S-4aDS[2]	300	0.30%	55	0.30%	N/A	N/A	43.2	0.7
P-ON-S-4b	300	0.70%	4,015	0.48%	N/A	N/A	126.2	2.1
P-ON-S-5	300	3.33%	9,183	0.87%	10,993	0.27%	251.9	4.2
Pre-Development Conditions - Run-Off South Area								
EX-OFF-S-1a	300	0.02%	8,398	0.01%	18,256	0.25%	295.2	4.9
EX-OFF-S-1b	300	0.10%	15,350	0.68%	N/A	N/A	374.6	6.2
EX-OFF-S-1c	300	0.67%	2,608	0.55%	N/A	N/A	88.7	1.5
EX-OFF-S-2	300	0.10%	11,376	0.59%	N/A	N/A	311.2	5.2
EX-OFF-S-3	300	0.10%	13,252	0.44%	N/A	N/A	397.4	6.6
EX-OFF-S-4a	300	0.30%	3,208	0.30%	N/A	N/A	139.1	2.3
EX-OFF-S-4b	300	0.70%	9,142	0.48%	N/A	N/A	249.5	4.2
EX-OFF-S-5	300	3.33%	9,183	0.87%	10,993	0.3%	251.9	4.2
EX-OFF-S-6	300	0.34%	4,314	0.34%	N/A	N/A	162.8	2.7
EX-OFF-S-7	300	0.36%	1,372	0.36%	N/A	N/A	76.7	1.3
Post-Development Conditions - Run-Off South Area								
P-OFF-S-1a	300	0.02%	8,398	0.01%	18,256	0.25%	295.2	4.9
P-OFF-S-1b	300	0.10%	15,350	0.68%	N/A	N/A	374.6	6.2
P-OFF-S-1c	300	0.67%	2,608	0.55%	N/A	N/A	88.7	1.5
P-OFF-S-2	300	0.10%	11,376	0.59%	N/A	N/A	311.2	5.2
P-OFF-S-3DS[2]	300	0.10%	448	0.44%	N/A	N/A	75.7	1.3
P-OFF-S-4aDS[2]	300	0.30%	1,903	0.30%	N/A	N/A	99.4	1.7
P-OFF-S-4b	300	0.70%	9,142	0.48%	N/A	N/A	249.5	4.2
P-OFF-S-5	300	3.33%	9,183	0.87%	10,993	0.3%	251.9	4.2
P-OFF-S-6	300	0.34%	4,314	0.34%	N/A	N/A	162.8	2.7
P-OFF-S-7	300	0.36%	1,372	0.36%	N/A	N/A	76.7	1.3

Note: 1) Subcatchment Area P-OFF-LF-3 accounts for the entire proposed landfill development area. A comprehensive stormwater model of the proposed landfill development has been completed. Please see Table C.3-4.2 for time of concentration parameters for the landfill subcatchment areas.
2) Subcatchments P-ON-S-3DS, P-ON-S-4aDS, P-OFF-S-3DS, and P-OFF-S-4aDS indicate that these subcatchment areas account for the drainage area directl downstream of the proposed landfill development.

TABLE C.3-4.2 Time of Concentration Summary - Landfill 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)
Subcatchment Area A					
A1	227	16%	N/A	N/A	6.8
A2	227	16%	N/A	N/A	6.8
A3	215	25%	N/A	N/A	5.4
A4	215	25%	N/A	N/A	5.4
A5	185	25%	N/A	N/A	4.8
A6	185	25%	N/A	N/A	4.8
Subcatchment Area B					
B1	215	17%	N/A	N/A	6.3
B2	244	16%	N/A	N/A	7.2
B3	215	25%	N/A	N/A	5.4
B4	195	25%	N/A	N/A	5.0
B5	185	25%	N/A	N/A	4.8
B6	200	25%	N/A	N/A	5.1
Subcatchment Area C					
C1	220	17%	N/A	N/A	6.4
C2	181	25%	N/A	N/A	4.7
C3	200	25%	N/A	N/A	5.1
C4	161	25%	N/A	N/A	4.3
C5	215	25%	N/A	N/A	6.1
C6	147	25%	N/A	N/A	4.0
C7	173	25%	N/A	N/A	4.6
Subcatchment Area D					
D1	263	18%	N/A	N/A	7.3
D2	289	19%	N/A	N/A	7.7
D3	136	25%	N/A	N/A	3.8
D4	200	25%	N/A	N/A	5.1
D5	135	25%	N/A	N/A	3.7
Subcatchment Area E					
E1	262	20%	N/A	N/A	6.9
E2	192	25%	N/A	N/A	5.0
E3	179	25%	N/A	N/A	4.7
Basin	N/A	N/A	N/A	N/A	7.2
Subcatchment Area F					
F1	260	18%	N/A	N/A	7.2
F2	295	16%	N/A	N/A	8.3
F3	216	25%	N/A	N/A	5.4
F4	160	25%	N/A	N/A	4.3
F5	103	25%	N/A	N/A	3.0
Subcatchment Area G					
G1	191	22%	N/A	N/A	5.2
G2	226	18%	N/A	N/A	6.4
G3	187	25%	N/A	N/A	4.8
G4	193	25%	N/A	N/A	5.0
G5	221	25%	N/A	N/A	5.5
G6	190	25%	N/A	N/A	4.9
Subcatchment Area H					
H1	232	17%	N/A	N/A	6.7
H2	220	17%	N/A	N/A	6.4
H3	204	25%	N/A	N/A	5.2
H4	214	25%	N/A	N/A	5.4
H5	186	25%	N/A	N/A	4.8
H6	180	25%	N/A	N/A	4.7

Average Land Slope

The average land slope (or average watershed slope) is a critical factor in the use of the Curve Number method, as described on page 53. A theoretical determination would require placing a grid over the subcatchment and averaging the slopes for all squares. Other techniques are available that have more modest data requirements, such as the following equation from NEH p15-5:

$$Y = 100 \frac{C\ I}{A} \qquad \text{Eq. 5}$$

Y=Average land slope [percent]
C=Total Contour length [ft] or [m]
I=Contour Interval [ft] or [m]
A=Land Area [ft²] or [m²]

C is obtained by adding the length of all contour lines within the subcatchment. The accuracy of this technique depends on having a sufficient number of contour lines within the subcatchment. Reducing the contour interval will generally increase the accuracy of the result.

Sheet Flow Procedure

The Sheet Flow procedure is designed for flow over plane surfaces, as usually occurs at the headwaters of a catchment area. (See NEH p.15-6) The following equation is used for sheet flow:

$$T_t = \frac{0.007(nL)^{.8}}{P_2^{.5}\ s^{.4}} \qquad \text{Eq. 6}$$

T_t=Travel time [hours]
n=Manning's coefficient for sheet flow (See page 167)
L=Flow length [ft]
P_2=2-year, 24-hour rainfall [inches] (See map on page 159)
s=Land slope (along flow path) [ft/ft]

Determining the actual length of sheet flow is critical to this method. Although the technique was originally intended for lengths up to 300 feet, most agencies now recommend a maximum of 100 feet. In any case, the length should not extend past the point where there is evidence of concentrated flow on the ground. The length is also critical in that Sheet Flow is often a dominant factor in a subcatchment's total Tc.

Note: At the point where sheet flow no longer occurs, additional segments of shallow concentrated flow and/or channel flow are typically used to evaluate the remainder of the flow path. The total time for all flow segments is used in the final runoff calculations.

Shallow Concentrated Flow

Shallow concentrated flow (aka Upland Method) is designed for conditions that occur in the headwaters of a watershed, including overland flow, grassed waterways, paved areas, and through small upland gullies. Shallow concentrated flow does not have a well-defined channel, and generally has flow depths of 0.1 to 0.5 feet. Although commonly published as a chart of velocity vs. slope for various surfaces (see NEH Ch.15), shallow concentrated flow is based on the following equations:

$$T_t = \frac{L}{3600\ V} \quad where \quad V = K_v \sqrt{s} \qquad \text{Eq. 7}$$

T_t=Travel time [hours]
L=Flow length [ft] or [m]
V=Average velocity [ft/sec] or [m/sec]
K_V=Velocity factor [ft/sec] or [m/sec] (See page 168)
s=Land slope (along flow path) [ft/ft] or [m/m]

See page 168 for a list of common K_V values provided with HydroCAD.

Channel Flow

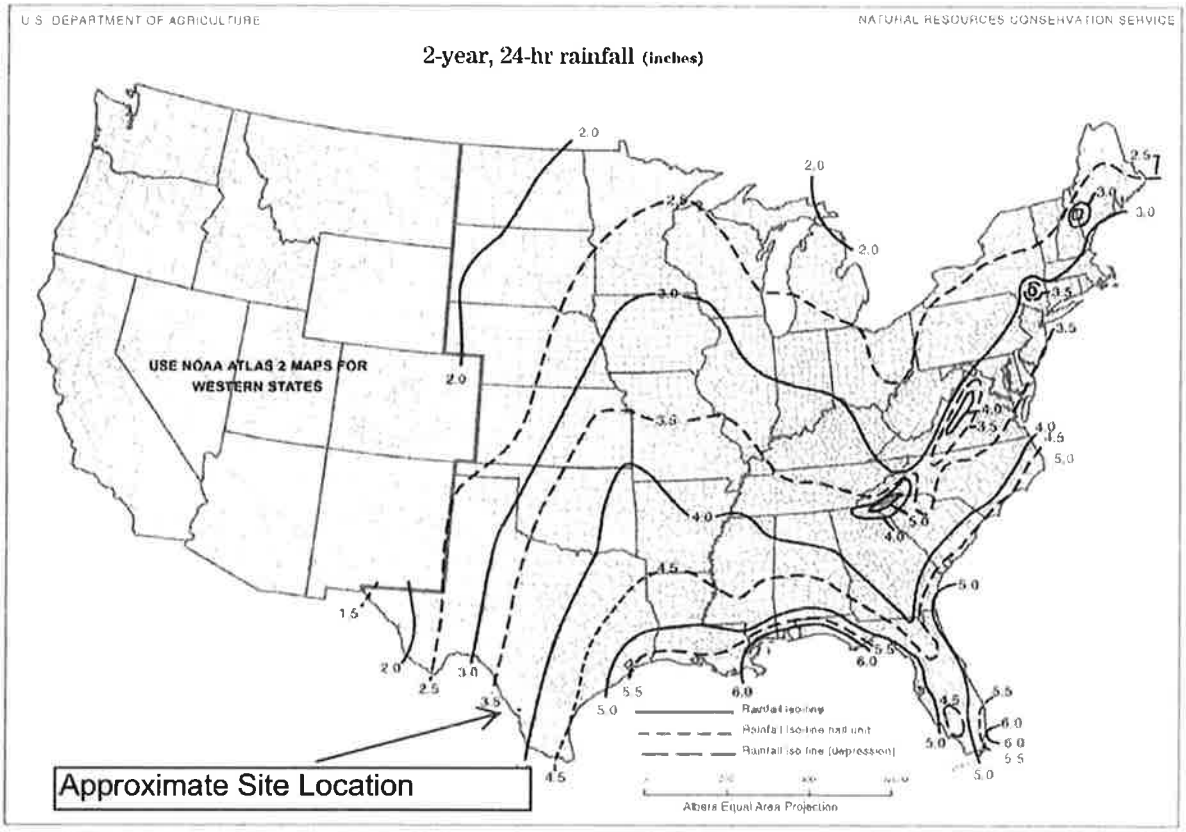
The Channel Flow procedure (see TR-55 p.3-3) is commonly employed where surveyed cross-sections are available, or anywhere the velocity can be reasonably determined by Manning's equation.

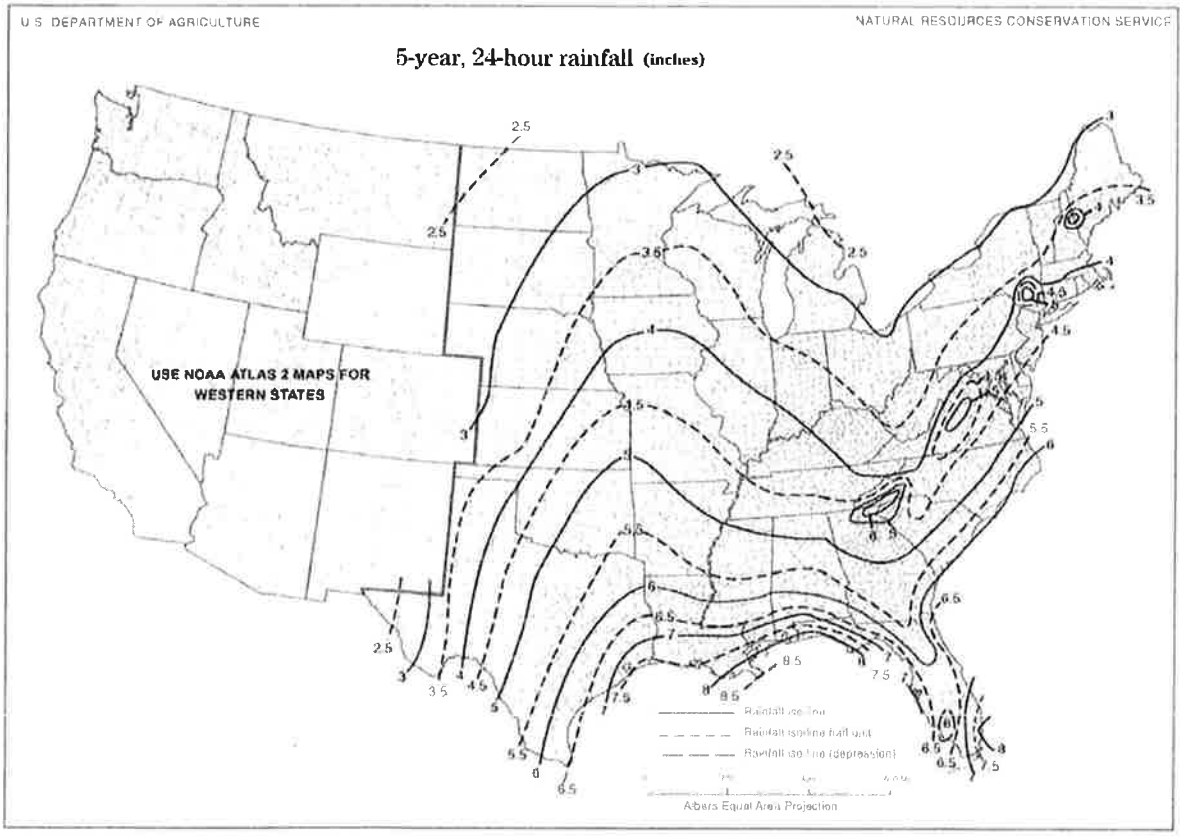
$$T_t = \frac{L}{3600\,V} \quad where \quad V = \frac{1.486 r^{2/3} s^{1/2}}{n} \quad and \quad r = \frac{a}{P_w} \qquad \text{Eq. 8}$$

T_t=Travel time [hours]
L=Flow length [ft] or [m]
V=Average velocity [ft/sec] or [m/sec]
n=Manning's coefficient (See table on page 162)
s=Channel slope [ft/ft] or [m/m]
r=Hydraulic radius [ft] or [m]
a=Cross-sectional flow area [ft²] or [m²]
P_w=Wetted perimeter [ft] or [m]
1.486=English factor (use 1 for metric evaluation)

In addition to allowing direct entry of cross-sectional area and wetted perimeter, HydroCAD provides automatic flow analysis of many standard channel and pipe shapes as described on page 169.

Appendix B4: Rainfall Depth Maps





This appendix reprinted from S.C.S. TR-55, revised 1986.

Appendix G: Velocity Factors

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)

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: SUBCATCHMENT AREA DISCHARGES RATES

Problem Statement

Determine the stormwater runoff rates for the pre-development and post-development conditions for the Pescadito Environmental Resource Center. Stormwater discharge rates are used for the Points of Comparison calculation within **Appendix III-C.3-11**. Additionally, stormwater discharge rates from the proposed landfill development subcatchment areas are used to determine the adequacy of terrace berms, downchute ditches, perimeter ditches, and other stormwater control features, provided in **Appendix III-C.3-6** through **III-C.3-10**.

Given

The stormwater discharge rates for each subcatchment were calculated using HydroCAD. Various parameters, such as rainfall, drainage acreage, and flow lengths within subcatchments 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

The Soil Conservation Service (SCS), now renamed the Natural Resources Conservation Service (NRCS) developed methods TR-20 and TR-55 as standardized stormwater modeling. Both provide similar results; the main differentiation in methodology is based on the use of chart-based solutions vs. computer modeling. TR-20 is the computer based modeling approach that is more complex and generally considered slightly more accurate than TR-55. TR-55, frequently called the "tabular method" was developed after TR-20 to help simplify the modeling process. As such it was developed to utilize chart based solutions to use the SCS runoff equation. For the purpose of this hydrologic model, TR-20 methodology was used.

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: SUBCATCHMENT AREA DISCHARGES RATES

Model Calculations and Results

The stormwater models were analyzed for the 25-year and 100-year, 24-hour storm events. A summary of the discharge rates for the 25-year, 24-hour storm event for pre-development and post-development conditions are provided in **Table III-C.3-5.1**. The stormwater model for the proposed landfill development subcatchment areas were analyzed for the 25-year and 100-year, 24-hour storm event. A summary of discharge rates for the proposed landfill development subcatchment areas is provided in **Table III-C.3-5.2**. In addition, reports summarizing the results of the HydroCAD model runs are provided in **Appendix III-C.4**.

TABLE C.3-5.1 Subcatchment Area Discharge Summary Pescadito Environmental Resource Center	
Subcatchment Name	Discharge Rate (cfs) 25-year, 24-hour storm event
Pre-Development Conditions - Run-On North Property	
EX-ON-N-1	539.2
EX-ON-N-2a	221.3
EX-ON-N-2b	248.7
EX-ON-N-3a	387.6
EX-ON-N-3b	180.7
EX-ON-N-4	118.4
Post-Development Conditions - Run-On North Property	
P-ON-N-1	539.2
P-ON-N-2a	221.3
P-ON-N-2b	248.7
P-ON-N-3a	387.6
P-ON-N-3b	180.7
P-ON-N-4	118.4
Pre-Development Conditions - Run-Off North Property	
EX-OFF-N-1	531.4
EX-OFF-N-2	470.7
EX-OFF-N-3	497.9
EX-OFF-N-4a	48.7
EX-OFF-N-4b	118.4
Post-Development Conditions - Run-Off North Property	
P-OFF-N-1	531.4
P-OFF-N-2	470.7
P-OFF-N-3	361.5
P-OFF-LF-3[1]	170.8
P-OFF-N-3b	199.7
P-OFF-N-4b	118.4
Pre-Development Conditions - Run-On South Property	
EX-ON-S-1a	4,136.3
EX-ON-S-1b	531.4
EX-ON-S-2	468.7
EX-ON-S-3	497.0
EX-ON-S-4a	57.0
EX-ON-S-4b	145.0
EX-ON-S-5	2,493.4
Post-Development Conditions - Run-On South Property	
P-ON-S-1a	4,136.3
P-ON-S-1b	531.4
P-ON-S-2	468.7
P-ON-S-3DS[2]	29.8
P-ON-S-4aDS[2]	26.0
P-ON-S-4b	145.0
P-ON-S-5	2,493.4
Pre-Development Conditions - Run-Off South Property	
EX-OFF-S-1a	4,136.3
EX-OFF-S-1b	503.6
EX-OFF-S-1c	108.6
EX-OFF-S-2	447.4
EX-OFF-S-3	497.0
EX-OFF-S-4a	94.8
EX-OFF-S-4b	218.5
EX-OFF-S-5	2,493.4
EX-OFF-S-6	186.2
EX-OFF-S-7	34.1
Post-Development Conditions - Run-Off South Property	
P-OFF-S-1a	4,136.3
P-OFF-S-1b	503.6
P-OFF-S-1c	108.6
P-OFF-S-2	447.4
P-OFF-S-3DS[2]	42.8
P-OFF-S-4aDS[2]	115.7
P-OFF-S-4b	218.5
P-OFF-S-5	2,493.4
P-OFF-S-6	186.2
P-OFF-S-7	34.1

Note: 1) Subcatchment Area P-OFF-LF-3 accounts for the entire proposed landfill development area. A comprehensive stormwater model of the proposed landfill development has been completed. Please see Table C.3-4.2 for time of concentration parameters for the landfill subcatchment areas.
2) Subcatchments P-ON-S-3DS, P-ON-S-4aDS, P-OFF-S-3DS, and P-OFF-S-4aDS indicate that these subcatchment areas account for the drainage area directly downstream of the proposed landfill development.

TABLE C.3-5.2 Subcatchment Area Discharge Summary - Landfill Pescadito Environmental Resource Center		
Subcatchment Name	Discharge Rate (cfs)	
	25-year, 24-hour storm event	100-year, 24-hour storm event
Subcatchment Area A		
A1	4.1	5.4
A2	4.1	5.3
A3	11.6	15.2
A4	11.5	15.1
A5	22.4	29.4
A6	23.8	31.2
Subcatchment Area B		
B1	3.6	4.8
B2	12.1	15.8
B3	10.2	13.4
B4	12.4	16.2
B5	23.9	31.4
B6	16.6	21.8
Subcatchment Area C		
C1	11.9	15.7
C2	7.9	10.3
C3	14.9	19.6
C4	15.4	20.1
C5	24.4	32.0
C6	14.5	19.0
C7	20.8	27.3
Subcatchment Area D		
D1	16.7	21.9
D2	16.0	21.0
D3	13.2	17.2
D4	27.3	35.9
D5	19.1	25.0
Subcatchment Area E		
E1	13.3	17.5
E2	19.6	25.7
E3	19.8	26.0
Basin	124.0	160.0
Subcatchment Area F		
F1	15.1	19.8
F2	15.8	20.7
F3	28.6	37.5
F4	14.8	19.4
F5	16.6	21.7
Subcatchment Area G		
G1	7.7	10.0
G2	15.7	20.6
G3	14.8	19.4
G4	14.8	19.4
G5	21.6	28.4
G6	20.6	27.0
Subcatchment Area H		
H1	12.9	16.9
H2	4.0	5.3
H3	12.3	16.1
H4	11.4	15.0
H5	15.9	20.9
H6	22.7	29.8

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

6. TERRACE BERM SIZING (III-C.3-6)

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: TERRACE BERM SIZING

Problem Statement

Demonstrate that the proposed terrace berms are sized to handle the peak flow volumes anticipated for the 25-year and 100-year, 24-hour storm event frequencies.

Given

- ❑ The locations of the terrace berms are shown on **Drawing III-C.2-7** in **Appendix III-C.2**.
- ❑ The model configuration of the terrace berms are shown in the HydroCAD output files in **Appendix III-C.4**.
- ❑ The details of the terrace berms are shown on **Drawing III-C.2-12** in **Appendix III-C.2**.

Design Assumptions

- ❑ Terrace berms will be constructed with a 1.5% channel slope to facilitate drainage of all stormwater to the downchute ditches.
- ❑ Terrace berm sideslopes will have a depth of 2 ft. with 4H:1V sideslopes that follow the final landform sideslope and 3H:1V sideslopes on the inside slope of the terrace berm. The terrace berm will grade back down to the final landform sideslope at a 2H:1V.
- ❑ Terrace berm sections are conservatively sized to detain the peak discharge rate associated with the entire subcatchment area that they serve.
- ❑ A Manning's coefficient of 0.030 was modeled in HydroCAD to represent grass-lined terrace berms. This value is used to calculate the critical velocity for the terrace berms.
- ❑ Flow velocities less than 5 ft/sec are assumed are assumed to be non-erosive. It is assumed that all channels with a flow velocity less than 5 ft/sec do not require erosion control lining material. Erosion control lining material (rip-rap, turf-reinforced mats, synthetic ditch liners, etc) will be installed if erosion is noted during regular maintenance inspections or if deemed appropriate.

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: TERRACE BERM SIZING

Calculations

Table III-C.3-6 summarizes the peak discharge rates, and peak water depths in the terrace berms 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 III-C.3-6**, the critical findings are noted:

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

2. All terrace berms are able to pass the peak storm with flow velocities less than 5 ft/sec, indicating that erosion or scour is not anticipated. If erosion or scour is observing during landfill construction or maintenance inspections, erosion control materials will be installed, if deemed appropriate. Please refer to **Table III-C.3-6** for further information.

TABLE C.3-6
Terrace Berm Design Summary - Landfill
Pescadito Environmental Resource Center

Terrace Berm Name	Design Parameters				Model Results						
	Left Sideslope	Right Sideslope	Slope	Depth	25-Year Storm Peak Velocity	25-Year Storm Peak Depth	100-Year Storm Peak Velocity	100-Year Storm Peak Depth	Design Depth > Peak Depth?	Flow Rate < 5 fps?	Erosion Control Anticipated to be Required?[1]
	(H:V)	(H:V)	(ft/ft)	(ft)	(ft/sec)	(ft)	(ft/sec)	(ft)	YES/NO	YES/NO	YES/NO
Subcatchment Area A											
TBA1	3H:1V	4H:1V	0.015	2	2.78	0.64	2.97	0.71	YES	YES	NO
TBA2	3H:1V	4H:1V	0.015	2	2.77	0.64	2.97	0.71	YES	YES	NO
TBA3	3H:1V	4H:1V	0.015	2	3.58	0.94	3.83	1.04	YES	YES	NO
TBA4	3H:1V	4H:1V	0.015	2	3.57	0.94	3.82	1.04	YES	YES	NO
Subcatchment Area B											
TBB1	3H:1V	4H:1V	0.015	2	2.69	0.61	2.88	0.68	YES	YES	NO
TBB2	3H:1V	4H:1V	0.015	2	3.63	0.96	3.88	1.07	YES	YES	NO
TBB3	3H:1V	4H:1V	0.015	2	3.46	0.90	3.71	1.00	YES	YES	NO
TBB4	3H:1V	4H:1V	0.015	2	3.64	0.97	3.90	1.07	YES	YES	NO
Subcatchment Area C											
TBC1	3H:1V	4H:1V	0.015	2	3.61	0.95	3.87	1.06	YES	YES	NO
TBC2	3H:1V	4H:1V	0.015	2	3.22	0.80	3.45	0.89	YES	YES	NO
TBC3	3H:1V	4H:1V	0.015	2	3.80	1.03	4.07	1.14	YES	YES	NO
TBC4	3H:1V	4H:1V	0.015	2	3.80	1.03	4.08	1.15	YES	YES	NO
TBC6	3H:1V	4H:1V	0.015	2	3.75	1.01	4.02	1.12	YES	YES	NO
Subcatchment Area D											
TBD1	3H:1V	4H:1V	0.015	2	3.91	1.08	4.19	1.20	YES	YES	NO
TBD2	3H:1V	4H:1V	0.015	2	3.88	1.06	4.15	1.18	YES	YES	NO
TBD3	3H:1V	4H:1V	0.015	2	3.67	0.98	3.93	1.09	YES	YES	NO
Subcatchment Area E											
TBE1	3H:1V	4H:1V	0.015	2	3.68	0.98	3.95	1.09	YES	YES	NO
Subcatchment Area F											
TBF1	3H:1V	4H:1V	0.015	2	3.82	1.04	4.09	1.15	YES	YES	NO
TBF2	3H:1V	4H:1V	0.015	2	3.86	1.06	4.14	1.17	YES	YES	NO
TBF3	3H:1V	4H:1V	0.015	2	3.78	1.02	4.05	1.13	YES	YES	NO
Subcatchment Area G											
TBG1	3H:1V	4H:1V	0.015	2	3.22	0.80	3.45	0.89	YES	YES	NO
TBG2	3H:1V	4H:1V	0.015	2	3.86	1.06	4.14	1.17	YES	YES	NO
TBG3	3H:1V	4H:1V	0.015	2	3.79	1.03	4.06	1.14	YES	YES	NO
TBG4	3H:1V	4H:1V	0.015	2	3.80	1.03	4.07	1.14	YES	YES	NO
Subcatchment Area H											
TBH1	3H:1V	4H:1V	0.015	2	3.69	0.99	3.95	1.09	YES	YES	NO
TBH2	3H:1V	4H:1V	0.015	2	2.76	0.64	2.95	0.71	YES	YES	NO
TBH3	3H:1V	4H:1V	0.015	2	3.63	0.97	3.89	1.07	YES	YES	NO
TBH4	3H:1V	4H:1V	0.015	2	3.56	0.94	3.82	1.04	YES	YES	NO

Note: 1.) Flow velocities less than 5 ft/sec are assumed to be non-erosive. It is assumed that all channels with a flow velocity less than 5 ft/sec do not require erosion control lining material. Erosion control lining material (rip-rap, turf-reinforced mats, synthetic ditch liners, etc) will be installed if erosion is noted during regular maintenance inspections or if deemed appropriate.

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

7. DOWNCHUTE DITCH SIZING (III-C.3-7)

8-15-2017

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: DOWNCHUTE DITCH SIZING

Problem Statement

Determine whether the proposed downchute ditches are sized to handle the peak flow velocities and depths anticipated for the 25-year and 100-year, 24-hour storms.

Given

- ❑ The locations of the downchute ditches are shown in the **Drawing III-C.2-7** of **Appendix III-C.2**.
- ❑ The details of the downchute ditches are provided in **Drawing III-C.2-12** of **Appendix III-C.2**.

Design Assumptions

- ❑ Downchute ditches have a maximum slope of 25%, a bottom width of 15 feet, and a depth of 2 feet.
- ❑ Downchute ditches 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 ditch for the 25-year, 24-hour storm and the 100-year, 24-hour storm were determined using HydroCAD. The results are presented in **Table III-C.3-7**.

The peak velocity of all downchute ditches is greater than 5 ft/sec for the 25-year and 100-year, 24-hour storms 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 model results from the 25-year and 100-year, 24-hour storm event, the downchute ditches are sized appropriately to prevent overtopping during all modeled storm events. Therefore, the downchute ditches are appropriately designed.

TABLE C.3-7
Downchute Ditch Design Summary - Landfill
Pescadito Environmental Resource Center

Downchute Ditch Name	Design Parameters					Model Results				
	Left Sideslope	Right Sideslope	Slope	Bottom Width	Depth	25-Year Storm Peak Velocity	25-Year Storm Peak Depth	100-Year Storm Peak Velocity	100-Year Storm Peak Depth	Design Depth > Peak Depth?
	(H:V)	(H:V)	(ft/ft)	(ft)	(ft)	(ft/sec)	(ft)	(ft/sec)	(ft)	YES/NO
Subcatchment Area A										
DA1	3H:1V	3H:1V	0.25	15	2	4.79	0.11	5.32	0.13	YES
DA2	3H:1V	3H:1V	0.25	15	2	7.93	0.24	8.80	0.28	YES
Subcatchment Area B										
DB1	3H:1V	3H:1V	0.25	15	2	6.13	0.16	6.81	0.19	YES
DB2	3H:1V	3H:1V	0.25	15	2	8.54	0.27	9.47	0.32	YES
Subcatchment Area C										
DC1	3H:1V	3H:1V	0.25	15	2	4.61	0.10	5.13	0.12	YES
DC2	3H:1V	3H:1V	0.25	15	2	6.63	0.18	7.37	0.21	YES
DC3	3H:1V	3H:1V	0.25	15	2	8.20	0.25	9.10	0.30	YES
DC4	3H:1V	3H:1V	0.25	15	2	9.38	0.31	10.40	0.37	YES
DC5	3H:1V	3H:1V	0.25	15	2	10.29	0.36	11.39	0.43	YES
Subcatchment Area D										
DD1	3H:1V	3H:1V	0.25	15	2	6.24	0.16	6.93	0.19	YES
DD2	3H:1V	3H:1V	0.25	15	2	8.06	0.25	8.95	0.29	YES
DD3	3H:1V	3H:1V	0.25	15	2	9.01	0.29	9.99	0.35	YES
Subcatchment Area E										
DE1	3H:1V	3H:1V	0.25	15	2	5.67	0.14	6.32	0.17	YES
Subcatchment Area F										
DF1	3H:1V	3H:1V	0.25	15	2	6.11	0.16	6.80	0.19	YES
DF2	3H:1V	3H:1V	0.25	15	2	7.88	0.24	8.74	0.28	YES
DF3	3H:1V	3H:1V	0.25	15	2	9.01	0.29	9.98	0.35	YES
Subcatchment Area G										
DG1	3H:1V	3H:1V	0.25	15	2	7.09	0.20	7.88	0.24	YES
DG2	3H:1V	3H:1V	0.25	15	2	9.61	0.33	10.65	0.38	YES
Subcatchment Area H										
DH1	3H:1V	3H:1V	0.25	15	2	6.32	0.17	7.01	0.20	YES
DH2	3H:1V	3H:1V	0.25	15	2	8.76	0.28	9.70	0.33	YES

Note: 1) The peak velocity of all downchute ditches is greater than 5 ft/sec for the 25-year and 100-year, 24-hour storms 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.

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

8. PERIMETER CHANNEL AND RUN-ON DIVERSION DITCH SIZING (III-C.3-8)

8-15-2017

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: PERIMETER CHANNEL AND RUN-ON DIVERSION DITCH SIZING

Problem Statement

Determine whether the proposed stormwater channels and run-on diversion ditches are sized to handle the peak flow velocities and depths associated with the 25-year and 100-year, 24-hour storm events.

Design Assumptions

- ❑ The channels will be designed to convey run-off from the 25-year and 100-year, 24-hour storm events without overtopping.
- ❑ The locations of the proposed stormwater channels and perimeter drainage ditches are shown in **Drawing III-C.2-7**.
- ❑ The proposed landfill perimeter channels and diversion 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 channels. This value is used to calculate the critical velocity and depth within the perimeter channels.
- ❑ Landfill perimeter channels have a depth of 4 ft. with 4H:1V sideslopes and a bottom width of 15 ft.
- ❑ Landfill perimeter channel slopes range from 0.38% to 0.72%
- ❑ Run-on diversion ditches have a depth of 4 ft. with 3H:1V sideslopes and a bottom width of 20-30 ft.
- ❑ Run-on diversion ditch slopes at 0.29%

Calculations

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: PERIMETER CHANNEL AND RUN-ON DIVERSION DITCH SIZING

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 III-C.3-8 lists the length and slope of each perimeter channel and the run-on diversion ditches in the HydroCAD model. **Table III-C.3-8** also lists the peak depth and peak velocity in each perimeter channel and the run-on diversion ditches 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 III-C.3-8**, the critical findings are noted:

1. The peak velocities of all perimeter channels and run-on diversion ditches do not exceed 5 ft/sec during the 25-year, 24-hour storm event with the exception of perimeter channel PCF2. This channel section will be lined with erosion control material. Peak velocities of specific vegetated stormwater perimeter channels (PCD2, PCF1, PCF2, and PCG2) do exceed 5 ft/sec during the 100-year, 24-hour storm event. As a result, erosion control lining material (rip-rap, turf-reinforced mats, synthetic ditch liners, etc) will be installed if erosion is noted during regular maintenance inspections or if deemed appropriate.

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, all stormwater perimeter channels and perimeter drainage ditches will not overtop.

TABLE C.3-8
Perimeter Channel and Run-on Diversion Ditch Design Summary - Landfill
Pescadito Environmental Resource Center

Perimeter Channel Name	Design Parameters					Model Results						
	Left Sideslope	Right Sideslope	Slope	Bottom Width	Depth	25-Year Storm Peak Velocity	25-Year Storm Peak Depth	100-Year Storm Peak Velocity	100-Year Storm Peak Depth	Design Depth > Peak Depth?	Flow Rate < 5 fps?	Erosion Control Anticipated to be Required?[1]
	(H:V)	(H:V)	(ft/ft)	(ft)	(ft)	(ft/sec)	(ft)	(ft/sec)	(ft)	YES/NO	YES/NO	YES/NO
Subcatchment Area A												
PCA1	4H:1V	4H:1V	0.0050	15	4	2.12	0.53	2.34	0.63	YES	YES	NO
PCA2	4H:1V	4H:1V	0.0050	15	4	3.19	1.08	3.49	1.26	YES	YES	NO
Subcatchment Area B												
PCB1	4H:1V	4H:1V	0.0050	15	4	3.41	1.21	3.73	1.42	YES	YES	NO
PCB2	4H:1V	4H:1V	0.0050	15	4	3.91	1.55	4.26	1.81	YES	YES	NO
Subcatchment Area C												
PCC1	4H:1V	4H:1V	0.0050	15	4	4.05	1.65	4.42	1.93	YES	YES	NO
PCC2	4H:1V	4H:1V	0.0050	15	4	4.51	2.00	4.91	2.33	YES	YES	NO
Subcatchment Area D												
PCD1	4H:1V	4H:1V	0.0050	15	4	4.56	2.04	4.96	2.37	YES	YES	NO
PCD2	4H:1V	4H:1V	0.0050	15	4	4.83	2.27	5.25	2.64	YES	NO	NO
Subcatchment Area E												
PCE1	4H:1V	4H:1V	0.0038	15	4	1.85	0.54	2.05	0.63	YES	YES	NO
PCE2	4H:1V	4H:1V	0.0038	15	4	1.59	0.42	1.76	0.49	YES	YES	NO
Subcatchment Area F												
PCF1	4H:1V	4H:1V	0.0072	15	4	4.74	1.57	5.16	1.83	YES	NO	NO
PCF2	4H:1V	4H:1V	0.0072	15	4	5.19	1.85	5.64	2.16	YES	YES	YES
Subcatchment Area G												
PCG1	4H:1V	4H:1V	0.0072	15	4	3.95	1.13	4.31	1.33	YES	YES	NO
PCG2	4H:1V	4H:1V	0.0072	15	4	4.68	1.54	5.10	1.80	YES	NO	NO
Subcatchment Area H												
PCH1	4H:1V	4H:1V	0.0072	15	4	2.42	0.49	2.67	0.58	YES	YES	NO
PCH2	4H:1V	4H:1V	0.0072	15	4	3.71	1.02	4.05	1.19	YES	YES	NO
Stormwater Run-on												
RD1[2]	3H:1V	3H:1V	0.0029	30	4	3.38	1.65	3.76	1.98	YES	YES	NO
RD2[2]	3H:1V	3H:1V	0.0029	30	4	3.38	1.76	3.73	2.09	YES	YES	NO

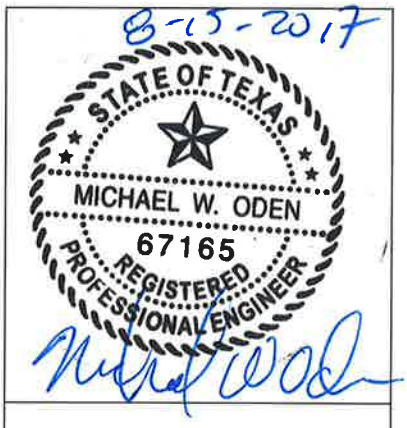
Note: 1) Flow velocities less than 5 ft/sec are assumed are assumed to be non-erosive. It is assumed that all channels with a flow velocity less than 5 ft/sec do not require erosion control lining material. Erosion control lining material (rip-rap, turf-reinforced mats, synthetic ditch liners, etc) will be installed if erosion is noted during regular maintenance inspections or if deemed appropriate.
2) Stormwater run-on diversion ditches are included in the "Post-Development Conditions Runoff-North" HydroCAD model.

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

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



This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: CULVERT SIZING

Problem Statement

Determine whether the proposed stormwater culverts used in the proposed landfill development stormwater management system and run-on diversion feature are sized to handle the peak flow velocities and depths associated with the 25-year and 100-year, 24-hour storm events.

Design Assumptions

- ❑ The culverts will be designed to convey run-off from the 25-year and 100-year, 24-hour storm event without restricting upland flow.
- ❑ The locations of the culverts between the perimeter channels and the Northeast Detention Basin are shown on **Drawing III-C.2-7**. Details of the culvert systems used to convey stormwater run-on and run-off are provided in **Drawings III-C.2-13** and **III-C.2-17**.
- ❑ The design parameters of each culvert are included in **Table III-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.

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: CULVERT SIZING

Table III-C.3-9 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.

Conclusions

A summary of the key design features, including the modeled peak discharge velocities and depths within the culverts, are shown in **Table III-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 25-year and 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 Summary - Landfill
Pescadito Environmental Resource Center

Culvert Name	Design Parameters					Model Results				
	Diameter or Dimensions	Slope	Number of Culverts at Location	Culvert Material	Manning's Coefficient	25-Year Storm Peak Velocity	25-Year Storm Peak Depth	100-Year Storm Peak Velocity	100-Year Storm Peak Depth	Design Depth > Peak Depth?
	(in) or (width x height)	(ft/ft)	(number)	(description)	(unitless)	(ft/sec)	(in)	(ft/sec)	(in)	YES/NO
Culverts 1	36	0.0069	9	Corrugated Polyethylene	0.013	8.07	19.20	8.62	23.16	YES
Culverts 2	36	0.0069	8	Corrugated Polyethylene	0.013	7.99	19.08	8.55	22.56	YES
Culverts 3a	120 x 36	0.0030	2	Concrete	0.012	4.91	24.48	5.42	30.36	YES
Culvert 3b	72 x 36	0.0030	1	Concrete	0.012	4.88	24.48	5.39	30.36	YES

Note: 1) Riprap or other erosion control measure will be placed at culvert outlets to minimize the potential for erosion and scour.
2) Stormwater Run-on perimeter drainage ditch segments are included in the "Post-Development Conditions Runoff-North" HydroCAD model.

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

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

8-15-2017

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: DETENTION BASIN SIZING

Problem Statement

Determine whether the Northeast Detention Basin that detains stormwater for the proposed landfill development 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 discharge at POC-OFF-N-3 that is less than or equal to the overall discharge rate at the same point of comparison in the stormwater run-off model for pre-development conditions.

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

Given

- ❑ Manning's Coefficient HydroCAD default value of 0.012 for concrete culverts.

- ❑ The Northeast Detention Basin will have one discharge point located approximately at the southwest corner of the basin. The southwest discharge point will consist of three (3) 60"Wx36"H box culverts at invert elevation 549ft Mean Sea Level (MSL). 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.

- ❑ A summary of calculated volumes for the Northeast Detention Basin is provided in **Table III-C.3-10.1**. Volumes were calculated using AutoCAD for available stormwater storage volume within the basin.

- ❑ The size, outlet structures, and model results for the proposed stormwater detention basin are provided in **Table III-C.3-10.2**. Design values were calculated using AutoCAD Civil 3D 2016.

- ❑ **Drawings III-C.2-15** and **III-C.2-16** show the location of the Northeast Detention Basin.

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: DETENTION BASIN SIZING

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. AutoCAD Civil 3D 2016 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 proposed landfill development, the proposed detention basin is adequately sized to handle stormwater associated with the 100-year, 24-hour storm event while maintaining a one-foot freeboard and discharging at a lower rate than pre-development conditions at POC-OFF-N-3. **Table III-C.3-10.2** summarizes the results of the HydroCAD calculations.

TABLE C.3-10.1 Detention Basin Elevation - Storage Summary Pescadito Environmental Resource Center			
Elevation (ft MSL)	Surface Area (ft^2)	Incremental Storage (ft^3)	Cumulative Storage (ft^3)
South Detention Basin			
549.00	451,169	0	0
550.00	466,412	458,791	458,791
552.00	497,421	963,833	1,422,624
554.00	529,133	1,026,554	2,449,178
556.00	561,548	1,090,681	3,539,859

TABLE C.3-10.2 Detention Basin Design Summary - Landfill Pescadito Environmental Resource Center			
Detention Basin General Design	Capture Area	acres	106.3
	Basin Sideslopes	H:V	5:1
	Normal Water Level	ft MSL	549
	Crest Elevation	ft MSL	556
Outlet Structure	Culvert Height	in	36
	Culvert Width	in	60
	Number of Outlet Culverts	Quantity	3
	Outlet Structure Elevation	ft MSL	549
Modeling Results	Maximum Discharge Rate 25-year, 24-hour Storm	cfs	170.78
	Maximum Discharge Rate 100-year, 24-hour Storm	cfs	240.88
	Peak Water Elevation 25-year, 24-hour Storm	ft MSL	551.33
	Peak Water Elevation 100-year, 24-hour Storm	ft MSL	551.92

ATTACHMENT III-C

APPENDIX III-C.3

FACILITY SURFACE WATER DRAINAGE ANALYSIS

11. STORMWATER DRAINAGE COMPLIANCE EVALUATION (III-C.3-11)

This document is released for the purpose of permitting only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Texas Registered Engineering Firm F-5650.

APTIM

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**SJL** **Date: 8/09/17**
Checked By:	**MWO** **Date: 8/10/17**

TITLE: STORMWATER DRAINAGE COMPLIANCE EVALUATION

Problem Statement

Determine whether the proposed landfill development maintains compliance with 30 Texas Admin. Code 330.63(c) and 330.305(a), '*Existing drainage patterns must not be adversely altered.*' The proposed landfill development is compliant with the regulations if the following are achieved:

1) Stormwater run-off from concentrated discharge points of the proposed landfill development release stormwater at a velocity that does not adversely alter ground cover conditions downstream (discharge velocities less than 5 ft/sec) for the 25-year, 24-hour storm event.

2) Post-development stormwater discharge rates at all Points of Comparison must be less than or equal to pre-development stormwater discharge rates for the 25-year, 24-hour storm to ensure that existing drainage patterns are not adversely altered by the proposed landfill development.

Methodology

Concentrated Discharge Point Analysis

The proposed landfill development is designed to capture, convey, and discharge stormwater in a controlled manner using engineered landscapes and stormwater control features. As part of the proposed landfill development, concentrated stormwater flows collected by the stormwater management system discharge from the proposed landfill development at three distinct locations designed to replicate the existing drainage patterns observed in this area during pre-development conditions. The concentrated discharge locations are as follows:

1) Outlet structure discharging stormwater from the Northeast Detention Basin.

2) Run-on diversion ditch discharging to the west from Culvert 3a.

3) Run-on diversion ditch discharging to the south from Culvert 3b.

At the three discharge points, stormwater discharge velocities are evaluated to ensure that stormwater flows from these locations with concentrated stormwater discharge from the proposed landfill development do not adversely alter ground cover conditions downstream (discharge velocities less than 5 ft/sec) for the 25-year, 24-hour storm event.

Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**SJL**	**Date:**	**8/09/17**
Checked By:	**MWO**	**Date:**	**8/10/17**

TITLE: STORMWATER DRAINAGE COMPLIANCE EVALUATION

Point of Comparison Analysis

In order to determine compliance with 30 Texas Admin. Code 330.63(c) and 330.305(a), points of comparison where stormwater passes through the permit boundary are evaluated to determine peak flow rates and run-off volumes associated with the following instances:

- ❑ Pre-Development Conditions
  - North Area
    - Stormwater Run-on Model
    - Stormwater Run-off Model
  - South Area
    - Stormwater Run-on Model
    - Stormwater Run-off Model
- ❑ Post-Development Conditions
  - North Area
    - Stormwater Run-on Model
    - Stormwater Run-off Model
    - Proposed Landfill Development Model
  - South Area
    - Stormwater Run-on Model
    - Stormwater Run-off Model

Compliance with 30 Texas Admin. Code 330.63(c) and 330.305(a) is achieved if peak flow rates during the 25-year, 24-hour storm event for post-development conditions are less than or equal to the peak flow rates from the pre-development model. Additionally, run-off volumes are evaluated to ensure that an increase in total run-off volume at a point of comparison does not result in an increase in peak flow rate. The evaluation at each point of comparison ensures that existing drainage patterns in the pre-development condition of the property are not adversely altered as a result of the proposed landfill development but rather maintained or managed in a more controlled manner.

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	SJL Date: 8/09/17
Checked By:	MWO Date: 8/10/17

TITLE: STORMWATER DRAINAGE COMPLIANCE EVALUATION

Results

Concentrated Discharge Point Analysis

The peak discharge velocities for each concentrated discharge point are presented for the 25-year, 24-hour storm in **Table III-C.3-11.1**. As shown in **Table III-C.3-11.1**, peak discharge velocities are less than 5 ft/sec for the 25-year, 24-hour storm event, resulting in a stormwater discharge from the proposed landfill development that does not adversely alter ground cover conditions downstream. Therefore, the proposed landfill development does not adversely alter existing drainage patterns, in accordance with 30 Texas Admin. Code 330.63(c) and 330.305(a).

Point of Comparison Analysis

The peak flow rates and run-off volumes for the pre-development and post-development conditions analyzing stormwater flow from all subcatchment areas are presented for the 25-year, 24-hour storm event in **Table III-C.3-11.2**. As shown in **Table III-C.3-11.2**, peak flow rates for the post-development conditions are lower than those from pre-development conditions, despite potential increases in run-off volumes at specific points of comparison. Therefore, the proposed landfill development does not adversely altered existing drainage patterns, in accordance with 30 Texas Admin. Code 330.63(c) and 330.305(a).

TABLE C.3-11.1 Concentrated Discharge Point Analysis Summary Pescadito Environmental Resource Center		
Concentrated Discharge Point	25-year Storm Event Peak Velocity (fps)	Peak Velocity ≤ 5 fps? (YES/NO)
Northeast Detention Basin Outlet Structure	4.87	YES
Culvert 3a from Run-on Diversion Ditch	4.91	YES
Culvert 3b from Run-on Diversion Ditch	4.88	YES

Note: 1) Peak velocity values for the Northeast Detention Basin Outlet Structure were taken from the HydroCAD model entitled "Post-Development Conditions Landfill - North".
2) Peak velocity values for Culvert 3a and Culvert 3b from Run-on Diversion Ditch were taken from the HydroCAD model entitled "Post-Development Conditions Runoff - North".

TABLE C.3-11.2 Point of Comparison Analysis Summary Pescadito Environmental Resource Center					
Point of Comparison Name	Pre-Development		Post-Development		Model Results
	25-year Storm Event Peak Discharge Rate (cfs)	25-year Storm Event Runoff Volume (acre-ft)	25-year Storm Event Peak Discharge Rate (cfs)	25-year Storm Event Runoff Volume (acre-ft)	Post-Development discharge rate ≤ Pre-Development discharge rate? (YES/NO)
North Property - Run-On Analysis					
POC-ON-N-1	539.20	270.282	539.20	270.282	YES
POC-ON-N-2a	221.28	78.274	221.28	78.274	YES
POC-ON-N-2b	248.70	56.478	248.70	56.478	YES
POC-ON-N-3a	387.57	184.587	387.57	184.587	YES
POC-ON-N-3b	180.69	40.489	180.69	40.489	YES
POC-ON-N-4	118.37	28.222	118.37	28.222	YES
North Property - Run-Off Analysis					
POC-OFF-N-1	531.41	306.189	531.41	306.189	YES
POC-OFF-N-2	470.74	235.611	470.74	235.611	YES
POC-OFF-N-3	497.90	317.970	419.88	324.305	YES
POC-OFF-N-4a	48.74	9.154	44.80	10.290	YES
POC-OFF-N-4b	118.37	28.222	118.37	28.222	YES
South Property - Run-On Analysis					
POC-ON-S-1a	4136.29	2245.833	4136.29	2245.833	YES
POC-ON-S-1b	531.41	306.189	531.41	306.189	YES
POC-ON-S-2	468.66	236.766	468.66	236.766	YES
POC-ON-S-3	497.78	321.074	421.17	327.787	YES
POC-ON-S-4a	56.99	11.799	47.92	12.934	YES
POC-ON-S-4b	145.00	43.266	145.00	43.266	YES
POC-ON-S-5	2493.35	1197.470	2493.35	1197.470	YES
South Property - Run-Off Analysis					
POC-OFF-S-5	2493.35	1197.470	2493.35	1197.470	YES
POC-OFF-S-6	5825.34	3380.434	5782.93	3382.239	YES
POC-OFF-S-7	34.07	7.312	34.07	7.312	YES