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Part III, Appendix III-C.1

Facility Surface Water Drainage Report Narrative

Part III

Attachment III-C

Appendix III-C.1

FACILITY SURFACE WATER DRAINAGE REPORT NARRATIVE

Pescadito Environmental Resource Center

MSW No. 2374

Webb County, Texas

PESCADITO

ENVIRONMENTAL RESOURCE CENTER

Initial Submittal March 2015
Supplement April 2015
Revised September 2015
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Prepared for:

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8-15-2017

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Table of Contents

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1.0 INTRODUCTION

1.1 Purpose

This Facility Surface Water Drainage Report (FSWDR) describes the stormwater management system that will be utilized at the Pescadito Environmental Resource Center (PERC). The proposed stormwater management system has been designed to collect, route, and detain stormwater run-off from the facility in an environmentally sound manner. This report shows that the development of the facility will not adversely alter, to any significant degree, the natural drainage patterns of the existing watershed that will be affected by the proposed development. This goal is achieved by comparing pre-development conditions to post-development conditions for peak discharge rates (flows), velocities, and discharge volumes for the 25-year, 24-hour storm event.

1.2 Regulatory Requirements

This report contains design features that follow best management practices that meet or exceed the regulations applicable to stormwater management outlined in Title 30 of the Texas Administrative Code (30 TAC), Section 330, Municipal Solid Waste. Specifically, Sections 330.63(c), 330.301, 330.303, 330.305, and 330.307 are addressed.

Specific regulations of note include:

- ❑ Section 330.63(c) – Facility Surface Water Drainage Report
  - *"The owner or operator of a municipal solid waste (MSW) facility shall include a statement that the facility design complies with the requirements of 330.303 of this title (relating to Surface Water Drainage for Municipal Solid Waste Facilities). Additionally, applications for landfill and compost units shall include a surface water drainage report to satisfy the requirements of Subchapter G of this chapter (relating to Surface Water Drainage)."*
  - *(2)(D) "for construction in a floodplain, submit, where applicable:*

    (i) approval from the governmental entity with jurisdiction under Texas Water Code, '16.236, as implemented by Chapter 301 of this title (relating to Levee Improvement Districts, District Plans of Reclamation, and Levees and Other Improvements);

    (ii) a floodplain development permit from the city, county, or other agency with jurisdiction over the proposed improvements;

    (iii) a Conditional Letter of Map Amendment from FEMA; and

    (iv) a Corps of Engineers Section 404 Specification of Disposal Sites for

Dredged or Fill Material permit for construction of all necessary improvements."

- ❑ Section 330.303 – Surface Water Drainage for Municipal Solid Waste Facilities
  - *"(a) A facility must be constructed, maintained, and operated to manage run-on and run-off during the peak discharge of a 25-year rainfall event*
  - *(b) Surface water drainage in and around a facility shall be controlled to minimize surface water running onto, into, and off the treatment area"*
- ❑ Section 330.305 – Additional Surface Water Drainage Requirements for Landfills
  - *"(a) Existing or permitted drainage patterns must not be adversely altered.*
  - *(b) The owner or operator shall design, construct, and maintain a run-on control system capable of preventing flow onto the active portion of the landfill during the peak discharge from at least a 25-year rainfall event.*
  - *(c) The owner or operator shall design, construct, and maintain a run-off management system from the active portion of the landfill to collect and control at least the water volume resulting from a 24-hour, 25-year storm.*
  - *(d) The landfill design must provide effective erosional stability to top dome surfaces and external embankment side slopes during all phases of landfill operation, closure, and post-closure care.*
  - *(e) Dikes, embankments, drainage structures, or diversion channels must be sized and graded to handle the design run-off and be graded to minimize the potential for erosion."*
- ❑ Section 330.307 – Flood Protection
  - *"(a) The facility shall be protected from flooding by suitable levees constructed to provide protection from a 100-year frequency flood.*
  - *(b) Flood protection levees must be designed and constructed to prevent the washout of solid waste from the facility."*
- ❑ Section 330.547 – Floodplains
  - *"(a) No solid waste disposal operations shall be permitted in areas that are located in a 100-year floodway as defined by the Federal Emergency Management Administration.*
  - *(b) New municipal solid waste management units, existing municipal solid waste units, and lateral expansions located in 100-year floodplains shall not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment.*
  - *(c) Municipal solid waste storage and processing facilities shall be located outside of the 100-year floodplain unless the owner or operator can demonstrate that the facility is designed and will operate to prevent washout during a 100-year storm event, or obtains a conditional letter of map amendment from the Federal Emergency Management Administration administrator."*

1.3 Evaluation Methods

In order to demonstrate compliance with regulatory requirements 30 Texas Admin. Code 330.63(c) and 330.305(a), this report evaluates stormwater from concentrated discharge points from the proposed landfill development as well as stormwater run-on and run-off at various points of comparison along the permit boundary. These evaluations are used to examine and compare the hydrologic conditions occurring in the pre-development and post-development conditions of the property and surrounding drainage areas in order to determine if existing drainage patterns are adversely altered by the proposed landfill development. Two distinct evaluations are used to ensure that existing drainage patterns are not adversely altered by the proposed landfill development; an analysis of the locations with concentrated stormwater discharge from the proposed landfill development and a point of comparison analysis evaluating stormwater draining into and out of the permit boundary. Additionally, a third evaluation was completed to ensure that the proposed stormwater management features employed at the proposed landfill development are adequately sized to handle the 25-year and 100-year, 24-hour storm events.

1.3.1 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.

1.3.2 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
  - o North Area
    - ▪ Stormwater Run-on Model
    - ▪ Stormwater Run-off Model
  - o South Area
    - ▪ Stormwater Run-on Model
    - ▪ Stormwater Run-off Model
- ❑ Post-Development Conditions
  - o North Area
    - ▪ Stormwater Run-on Model
    - ▪ Stormwater Run-off Model
    - ▪ Proposed Landfill Development Model
  - o 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.

1.3.3 Stormwater Management Feature Analysis

To ensure that the proposed stormwater management features are adequately sized to accommodate stormwater volumes associated with the 25-year and 100-year, 24-hour storm events, all elements were computer modeled with numerous conservative assumptions. AutoCAD Civil3D 2016 (AutoCAD) was utilized to delineate key features, and the computer model HydroCAD was used to develop discharge rates and volumes for each stormwater feature described in this report. HydroCAD is a computer aided design program used to model hydrology and hydraulics of stormwater using either TR-20 or TR-55 procedures developed by the Soil Conservation Service (now the Natural Resource Conservation Service). A comprehensive explanation of each stormwater management feature and key model findings is provided in Hydrologic Analysis found in Section 4 of this report.

2.0 PRE-DEVELOPMENT CONDITIONS

2.1 Overview

The proposed landfill (waste management unit) will be located on an approximate 120 acre tract of land falling within the northeastern portion of a 953 acre property owned by Rancho Viejo Waste Management, LLC (RVWM). The facility is located approximately 20 miles east of Laredo in Webb County, Texas. The site is located entirely within the 12,194 acre Yugo Ranch that is owned by Rancho Viejo Cattle Company, Ltd., the same owner as the PERC, and has been used for cattle ranching and oil and gas production for many years.

The 953-acre facility slopes from north to south at approximate grades of 0.5 to 1 percent. Surficial soils generally have very low permeability, and is uniformly covered with native vegetation consisting of brush, forbs and grass. Stormwater run-off historically has not eroded bed-and-bank features into the shallow swales that covey drainage from the site. In recent times, several impoundments have been created on site by shallow excavation and embankment construction across the swales to create livestock watering tanks. Historically, patterns of stormwater run-off have thus been significantly altered by the capture of rainfall by these tanks.

Drawing III-C.2-1 shows the regional pre-development topography of all areas that were reviewed as part of this report. The "drainage areas" (also referred to as "subcatchment areas") that were used for the pre-development conditions are shown on **Drawing III-C.2-5**. The pre-development conditions in this report account for the stormwater run-on and run-off for both north and south areas of the facility.

2.2 Existing Soil Conditions

Surficial soils that influence the rate of run-off within the pre-development and unmodified drainage areas were defined by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) in a custom soils report for Webb County. Surficial soils are the soils located at the surface, although, their characteristics are not necessarily indicative of the subsurface geology. Surficial soils within the pre-development and unmodified areas are comprised mostly of soils in the hydrologic soil group D, with the remainder being either Soil

Group B or C soils. A map of the soil boundaries and a copy of the NRCS soil survey is provided in **Appendix III-C.3-3** (Determination of Curve Number).

2.3 Land Cover

Existing areas to be disturbed by landfill construction are currently undeveloped. The land is predominately rangeland with poor stands of vegetation and is used for cattle grazing. 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. Land covers have been delineated using AutoCAD Civil3D 2016 (AutoCAD), and imported into stormwater modeling software (HydroCAD). See **Appendix III-C.3-3** (Determination of Curve Number) for further details regarding the existing land cover.

2.4 Floodplain

A CLOMR that would remove a large area of the 100-year floodplain within the permit boundary was approved by FEMA on November 21, 2014; however, the CLOMR improvements have not been constructed. For this proposed design, no areas to be disturbed for the development of this proposed landfill are within the 100-year floodplain, as determined through the review of the flood insurance rate map that covers the facility. The flood insurance rate map used was for Webb County, Texas, Map Number 48479C1275C, dated April 2, 2008, published by Federal Emergency Management Agency (FEMA).

3.0 POST-DEVELOPMENT CONDITIONS

3.1 Overview

All stormwater management features have been designed to ensure that the stormwater management system complies with all applicable regulations in 30 TAC, Section 330, Subchapter G. An overview of the post-development conditions is provided on **Drawing III-C.2-6** and **Drawing III-C.2-7**.

The proposed landfill design has 4H:1V sideslopes and a six percent plateau slope. The landfill has a peak elevation of approximately 704 feet Mean Sea Level (ft MSL). The landfill drains to a perimeter channel drainage network that drains into the Northeast Detention Basin, where stormwater ultimately discharges from the facility, as described in the following text.

3.2 Run-On Controls

The proposed landfill has been designed with run-on controls to prevent run-on from entering the landfill disposal area. The landfill has been designed with elevated embankments that range from 4 feet to 14 feet above the existing grade, and 12 feet to 14 feet above the 100-year flood elevation. In addition, run-on diversion channels have been designed at the base of the embankment to route stormwater that will be intercepted by the embankment, allowing water to be safely conveyed around the landfill to discharge locations selected to mimic pre-development conditions. The run-on diversion ditches are sized to convey the 100-year storms. The embankments and diversion channels will have sideslopes of 3H:1V, and be lined with vegetation, therefore, erosion and scour are not anticipated to occur in these areas. The run-on diversion ditches profile and details are shown on **Drawing III-C.2-17**. Design parameters for the run-on diversion ditches are presented in **Appendix III-C.3-8**.

3.3 Terrace Berms

Vegetated terrace berms will be used to collect run-off, and minimize erosion along the sideslopes of the landfill final cover. In the event that vegetation cannot be established, they may be lined with an erosion control material (ECM), such as SmartDitch™, riprap, or other ECM to minimize scour potential. The terrace berms will be constructed approximately perpendicular to the slope of the final landform and will intercept sheet flow coming off of the landfill. Terrace berms are located approximately every 200 horizontal feet. The terrace berms will be constructed in the locations shown on **Drawing III-C.2-7**. Details of the terrace berms are provided on **Drawing III-C.2-12**. The design parameters for the terrace berms and calculations demonstrating that the terrace berms will provide adequate stormwater control and are sufficiently sized are presented in **Appendix III-C.3-6**.

3.4 Downchute Ditches

Downchute ditches will be constructed to convey the stormwater collected by the terrace berms down the slope of the landfill and into the perimeter channels. The downchute ditches will be lined with riprap or other erosion control material (ECM) to minimize scour and prevent erosion. The downchute ditches are designed to adequately handle run-off flow rates from the peak 100-year storm without overtopping, exceeding the requirements of 30 TAC 330.305. The planned locations of the downchute ditches are shown on **Drawing III-C.2-7**. Details of the downchute ditches are provided on **Drawing III-C.2-12**. The design parameters for the downchute ditches and calculations demonstrating that the downchute ditches will provide adequate stormwater control and are sufficiently sized are presented in **Appendix III-C.3-7**.

3.5 Perimeter Channels

As shown on **Drawing III-C.2-6**, drainage channels are positioned around the landfill perimeter. These channels are used to convey non-contact stormwater run-off from the landfill unit, landfill perimeter access road, and ancillary areas to the Northeast Detention Basin. Perimeter channels provide adequate size to handle the peak discharge rates of the 100-year storm without overtopping. The perimeter channels are designed with 4H:1V side slopes, 4-ft depth, and a 15-ft bottom width. Details for the perimeter channels are provided on **Drawing III-C.2-12**. Perimeter channel profiles are shown on **Drawing III-C.2-14**.

Perimeter channels will be vegetated. In the event that vegetation cannot be established within the channels, they may be lined with an erosion control material (ECM), such as SmartDitch™, riprap, or other ECM to minimize scour potential. Any portions of the perimeter channel that show velocities over 5-ft/sec for the 25-year, 24 hour storm event within **Appendix III-C.3-8** will be lined with a Turf Reinforced Mat (TRM). All channels have been designed with excess capacity to convey the peak flow rates and depths of the 100-year 24-hour storm event (and thus, passing the 25-year, 24-hour storm), which exceeds the requirements specified in 30 TAC 330.305. The design parameters for the perimeter channels and calculations demonstrating that the channels will provide adequate stormwater control and are sufficiently sized are presented in **Appendix III-C.3-8**.

3.6 Perimeter Channel Discharge Culverts

Culverts will be installed at the discharge locations of the perimeter channels into the Northeast Detention Basin, as shown on **Drawing III-C.2-7** and **Drawing III-C.2-13**. Culverts have been sized to handle the 100-year, 24-hour storm event from the contributing perimeter channel sections, which is equal to the 100-year discharge rate in the channel at that location. Culverts will be 3-ft in diameter and constructed of corrugated polyethylene or equivalent material. The design parameters for the culverts and demonstration that the culverts will safely convey stormwater associated with the 100-year, 24-hour storm are provided in **Appendix III-C.3-9**.

3.7 Northeast Detention Basin

The Northeast Detention Basin will be developed along the southern border of the landfill (in the northeast section of the facility) to temporarily detain all stormwater that falls on the landfill, perimeter roads, and ancillary facilities. The detention basin receives stormwater through the perimeter channels and culverts. The size of the proposed Northeast Detention Basin has been designed based on a fully developed landfill footprint and will be constructed prior to the time that waste in the first cell is placed above existing ground. The location of the Northeast Detention Basin is shown in **Drawing III-C.2-6** and **Drawing III-C.2-7**. Profiles and details of the basin are provided on **Drawing III-C.2-15** and **Drawing III-C.2-16**.

The basin has been designed with excess capacity to safely detain and release the 25-year and 100-year, 24-hour storm events while maintaining a minimum one foot freeboard below the basin crest elevation, in accordance with best management practices.

3.8 Northeast Detention Basin Discharge

The Northeast Detention Basin will contain an outlet structure to facilitate the controlled release of stormwater. The outlet structure shall comprise of three concrete box culverts. These box culverts will be 5-ft wide, 3-ft tall, and span 150 feet before terminating and discharging stormwater off-site. Refer to **Drawing III-C.2-15** and **Drawing III-C.2-16** for details of the proposed outlet structure design.

Additional stormwater conveyance features may be installed at the discretion of the owner and engineer to convey stormwater directly into the San Jaunito Creek tributary system. Please note that the outlet structure design may be changed at the owner/operator's discretion, provided that the revised design provides adequate reinforcement and protection of the outfall and equivalent release rates to the modeled design.

The outlet structure is designed so that the total release rates from the post-development conditions of the modeled storm events are similar to the corresponding discharge rates for the pre-development conditions, as demonstrated and described in the subsequent modeling text.

4.0 HYDROLOGIC ANALYSES

4.1 Methodology Overview

To ensure that the proposed stormwater management features are adequately sized for the actual stormwater needs, all elements were computer modeled with numerous conservative assumptions. The computer model HydroCAD was used to develop discharge rates and volumes for various storm events for each stormwater feature and subcatchment described in this report. Run-off was evaluated for the 25-year, 24-hour storm event for all upstream and downstream area subcatchments. Furthermore, the proposed landfill footprint and its stormwater control features were analyzed for both 100-year and 25-year, 24-hour storm events. The analyses meet or exceed state and federal requirements for landfills.

The stormwater modeling methodology used the following analysis methods:

Run-off Calculation Method:	SCS TR-20/TR-55
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 run-off equation. For the purpose of this hydrologic model, TR-20 methodology was used. However, some calculation sheets reference input variables from TR-55 guidance documents.

Stormwater modeling has been completed with the software program HydroCAD. HydroCAD is a computer aided design program used to model hydrology and hydraulics of stormwater using either TR-20 or TR-55 procedures developed by the Soil Conservation Service (now the Natural Resource Conservation Service). HydroCAD was selected for the modeling software due to the large number of stormwater control devices that will be utilized at the PERC. Unlike models such as HEC-HMS, HydroCAD can link multiple models together to allow the user to model a large number of nodes. Model linking has been utilized in this analysis.

4.2 Model Inputs

Detailed model inputs of all key landfill stormwater management features are provided in the calculations and summaries provided in **Appendix III-C.3** and are briefly discussed in the following text sections. Detailed information provided in **Appendix III-C.3** includes:

1. Rainfall Totals and Distributions
2. Subcatchment Delineation
3. Run-off Curve Number Determination
4. Time of Concentration Determination
5. Subcatchment Discharge Rates
6. Terrace Berm Sizing
7. Downchute Ditch Sizing
8. Perimeter Channel and Run-On Diversion Ditch Sizing
9. Culvert Sizing
10. Detention Basin Sizing
11. Stormwater Drainage Compliance Evaluation

A brief summary is also provided in the following text.

4.2.1 Hydrologic Elements Nomenclature

The following nomenclature was used in the pre-development and post-development hydrologic evaluations:

EX - Pre-development conditions (Existing) drainage area
P - Post-development conditions (Proposed) drainage area
POC - Point of Comparison at the permit boundary
ON - Stormwater run-on into the permit boundary
OFF - Stormwater run-off out of the permit boundary
N - North area of the property
S - South area of the property
RD - Run-on diversion ditch segment

C - Culvert

DS - Downstream element

The following nomenclature was used in the proposed landfill development hydrologic evaluation:

A through H - Subcatchment drainage areas

TB - Terrace Berm

D - Downchute

PC - Perimeter channel

C - Culvert

NDB - Northeast Detention Basin

4.2.2 Rainfall Totals

The precipitation for the 100-year storm was obtained from Technical Paper No. 40, "Rainfall Frequency Atlas of the United States" (TP-40). A summary of all rainfall depths associated with the 25-year and 100-year modeled storms is provided in **Appendix III-C.3-1**. The Soil Conservation Service Storm Type III rainfall distribution was used to develop the peak rainfall for the 100-year and 25-year frequency rainfall events to ensure that all stormwater management features are appropriately sized with respect to 30 TAC Section 330.301 through 307 requirements.

4.2.3 Subcatchment Delineation

Subcatchment areas (also known as watersheds) were delineated using AutoCAD based on topographic breaks and proposed stormwater feature delineations. After delineation, the acreages of each subcatchment were directly imported into HydroCAD. The topographic map used to delineate subcatchment areas consisted of 2-foot contours from aerial photography flown for the project site and immediate surrounding area combined with a 10-foot contour map provided by the United States Geologic Survey (USGS). Please see **Appendix III-C.2** for figures that demonstrate the subcatchment boundaries and additional information.

4.2.4 Run-off Curve Number Determination

In order to determine the run-off curve numbers for the pre-development and post-development conditions, land cover, surficial soil types, and conservative landfill design assumptions were considered. Local surficial soil boundaries and designations, as identified by NRCS, were used in

HydroCAD to determine run-off coefficient variables. Each land cover was assigned a run-off coefficient for each Hydrologic Soil Group based on TR-20 standard values that reflect these cover types. Based off of land cover and hydrologic soil group, HydroCAD determines the weighted curve number for each subcatchment area. 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.

The land covers were delineated for the proposed landfill footprint area for both pre-development and post-development conditions. For pre-development conditions, the land covers were determined based on a review of aerial photography and the topographic survey. 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. Please see **Appendix III-C.3-3** for additional information.

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).

The curve number of 90 was then adjusted to represent the engineered nature of the landfill using the 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 was used to calculate the adjusted curve number value of 91. Please see **Appendix III-C.3-3** for additional information.

4.2.5 Time of Concentration

The time of concentration, defined as the longest amount of time a waterdrop would take to travel from the headwater of a subcatchment area to its downstream edge (ie. prior to being managed by a downstream element) was delineated in AutoCAD and entered for each subcatchment in HydroCAD. A discussion of how the flow paths are used to calculate time of concentration is further discussed in **Appendix III-C.3-4**.

4.2.6 Subcatchment Area Discharge Rates

The stormwater discharge rates for each subcatchment were calculated in HydroCAD. Various parameters, such as rainfall, drainage acreage, and flow lengths within subcatchments are entered into the program. **Appendix III-C.3-5** provides a summary of these input values and the model results.

4.2.7 Terrace Berm Sizing

Terrace berms will be constructed with a 1.5% channel slope to facilitate drainage of all stormwater to the downchute ditches. The 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 slope. Terrace berm sections have been 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 and peak depth for the terrace berms.

4.2.8 Downchute Sizing

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 and use a Manning's coefficient of 0.035. This is representative of a typical riprap open channel, and is used for both critical velocity and depth determination.

4.2.9 Perimeter Channel and Run-On Diversion Ditch Sizing

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 channels.

Landfill perimeter channels have a depth of 4 ft. with 4H:1V sideslopes and a bottom width of 15 ft. with slopes ranging 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. The run-on diversion ditches slope at 0.29%. Based on these design parameters, erosion and scour are not anticipated to occur at the perimeter channels or diversion ditches.

4.2.10 Culvert Sizing

The culvert systems between the landfill perimeter channels and Northeast Detention Basin utilize 3-ft. diameter corrugated polyethylene pipes with a Manning's n value of 0.013, and sloped at 0.7%. The culvert systems used to convey stormwater run-on and run-off from the site include the Northeast Detention Basin outlet structure as well as the diversion ditch culvert system. The Northeast Detention Basin outlet structure comprises of three concrete box culverts that are 5-ft. wide and 3-ft. tall, having a Manning's n value of 0.012 and sloping at 0.7%. The diversion ditch culvert system includes two 10-ft. wide by 3-ft. tall concrete box culverts and one 6-ft. wide by 3-ft. tall box culvert. The diversion ditch culvert system has a Manning's n value of 0.012 and slopes at 0.3%.

The locations of the different culvert systems are shown on **Drawing III-C.2-7**. Details of the culvert systems are provided in **Drawing III-C.2-13**, **Drawing III-C.2-15** and **Drawing III-C.2-17**.

4.2.11 Northeast Detention Basin Sizing and Discharge Rates

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 5-ft. wide by 3-ft. tall box culverts at invert elevation 549ft ft. 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 **Appendix III-C.3-10**. 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 **Appendix III-C.3-10**. Design values were calculated using AutoCAD Civil 3D 2016. **Drawing III-C.2-15** and **Drawing III-C.2-16** show the location of the Northeast Detention Basin.

4.3 Key Model Findings

All stormwater controls were found to be appropriately sized to convey the 100-year and 25-year, 24-hour storm events (surpassing local, state, and federal requirements). Key findings include the following:

1. The terrace berms have been designed to function without overtopping during all modeled storms, including the 100-year, 24-hour storm, which exceeds the requirements specified in 30 TAC 330.305. Additionally, all of the terrace berms exhibit flow velocities less than 5 ft/sec, therefore, they are not anticipated to experience erosion or scour.
2. Downchutes can safely convey the 100-year, 24-hour storm. Downchutes will be armoured with riprap or other equivalent erosion control material.
3. All stormwater perimeter channels are appropriately sized to convey the 100-year, 24-hour storm event without overtopping under anticipated conditions (and thus, passing the 25-year, 24-hour storm), which exceeds the requirements specified in 30 TAC 330.305. The perimeter channels will be vegetated, lined with SmartDitchTM, riprap, or lined with other erosion control material to minimize the potential for erosion or scour. Areas where peak velocities within the perimeter channel are over 5-ft/sec for the 25-year, 24-hour storm will be lined with Turf Reinforced Mats (TRM).
4. All culverts are appropriately sized to convey stormwater within the perimeter channels for the 100-year, 24-hour storm event. The culverts will not back up or lead to overtopping conditions within the stormwater channels.
5. The Northeast Detention Basin is sufficiently sized to detain the 100-year, 24-hour storm event.
6. The stormwater release rate from the basin watershed is similar for both pre-development and post-development conditions for all modeled storms.
7. Peak discharge velocities leaving the proposed landfill development 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 due to scour, in accordance with 30 Texas Admin. Code 330.305(a).
8. The drainage patterns for the post-development condition use discharge locations that are selected to reflect pre-development drainage conditions. Therefore, the proposed landfill

development does not adversely alter existing drainage patterns, in accordance with 30 Texas Admin. Code 330.305(a).

9. For the 25-year, 24-hour storm event, 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).
10. Run-on diversion channels are appropriately sized to convey the 100-year, 24-hour storm event without overtopping under anticipated conditions (and thus, passing the 25-year, 24-hour storm), which exceeds the requirements specified in 30 TAC 330.305. The diversion channels will be vegetated, lined with SmartDitchTM, riprap, or lined with other erosion control material, therefore, erosion and scour are not anticipated to occur. Areas where peak velocities within the perimeter channel are over 5-ft/sec for the 25-year, 24-hour storm will be lined with Turf Reinforced Mats (TRM).

Based on the results summarized above and described in detail within the calculations, all stormwater management features for the post-development design of the landfill have been modeled and have been shown to be adequately sized to manage the 100-year and 25-year storm events, satisfying 30 TAC 330.305. Additionally, sections of the perimeter channel exhibiting peak stormwater velocities greater than 5 ft/sec for the 25-year, 24-hour storm event will be lined with TRM. Downchutes will be reinforced with rip-rap or an alternative erosion control material. Therefore, erosion or scour of any stormwater management features is not anticipated. Moreover, based on the results of the landfill development in-conjunction with upstream and downstream subcatchments, the existing area drainage patterns are not adversely altered from the proposed landfill development.

4.3.1 Run-On Protection

Run-on from off-site areas will be prevented from flowing onto the active portion of the landfill by virtue of the fact that the outer alignment of the perimeter road, which will surround the waste unit, has been designed to be at least one foot higher than the surrounding existing topography. This creates an island affect where surficial water will flow around the landfill facility. Additionally, the waste boundary is located one-foot in elevation higher than the crest of the perimeter channels, which are designed to convey the 100-year storm. Thus, the toe of slope for the waste boundary is located at least two feet in elevation higher than the surrounding topography in all areas of the landfill.

4.3.2 Flood Protection

As previously noted, a CLOMR that would remove a large area of the 100-year floodplain within the permit boundary was approved by FEMA on November 21, 2014; however, the CLOMR improvements have not been constructed. For this proposed design, no portion of the landfill footprint, proposed landfill development, ancillary facilities, or associated appurtenances are located within the 100-year floodplain, as shown on **Drawing III-C.2-6.** Therefore, requirements of 30 TAC Section 330.63(c)(2)(D), 330.547(a) and (b) are met. The waste disposal unit or any operations area will not be located within the 100-year floodplain. The landfill facility development will not restrict the flow of the 100-year flood, will not reduce the temporary water storage capacity of the floodplain, and will not result in the washout of solid waste.

4.3.3 Contaminated Water Management

Contaminated water is defined in in TAC Section 330.3(36) as leachate, gas condensate, or water that has come into contact with waste. Stormwater will be managed carefully in all areas of the landfill to limit the quantity that may come in contact with waste. Earthen berms will be used to separate rainfall that has not become contaminated from exposed waste. An intact layer of soil, or other approved cover will be placed over the waste to prevent rainfall from contacting the waste. Ditches, swales, culverts, and other structures as appropriate will be constructed to prevent stormwater run-on onto the active fill areas. The handling, storage, treatment, and disposal of contaminated surface or groundwater will be managed according to TAC Section 330.207. See **Appendix III-D.6** for a detailed leachate and contaminated water plan.

5.0 CONCLUSION

The stormwater management system has been designed and is proposed to be operated in a manner that protects the public health, safety and welfare. The discharge rates and volumes will be controlled to facilitate sedimentation and prevent flooding, and will not adversely alter the drainage patterns of off-site areas located upstream or downstream of the facility. Stormwater will be controlled to prevent contact with waste, and stormwater which contacts waste will be contained and treated as leachate. Erosion control techniques and best management practices will be used to minimize the generation of sediment in the run-off from disturbed areas. These techniques will not only minimize sediment erosion but will improve the water quality of the stormwater run-off.