City of Waco Landfill
McLennan and Limestone Counties
TCEQ Permit No. MSW-2400
Parts III and IV, Volume 3 of 4

Administratively Complete

Prepared for

City of Waco

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Waco, Texas 76710

Prepared by:

SCS ENGINEERS

SCS Project No. 16216088.00 | Revision 0 – May 2020 and June 2020

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City of Waco Landfill
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TCEQ Permit No. MSW -2400

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TBPE Reg. # F-3407

MSW Landfill Permit Application, Parts III and IV

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CITY OF WACO LANDFILL
TCEQ PERMIT NO. MSW-2400
McLENNAN AND LIMESTONE COUNTIES, TEXAS

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 5
GEOTECHNICAL/STABILITY ANALYSES

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1 INTRODUCTION

This Attachment 5 – Geotechnical/Stability Analyses has been prepared as a part of the permit application for the City of Waco Landfill (landfill), McLennan and Limestone Counties, Texas, consistent with 30 TAC Chapter 330 requirements. This report addresses the geotechnical aspects of the landfill, including evaluation of the geotechnical properties of the subsurface soils and a discussion with conclusions about the suitability of the soils and strata for the uses proposed within this application.

This attachment also includes stability and other geotechnical-related landfill analyses including the following:

- Excavation Slope Stability;
- Foundation and Waste Slope Stability (Interim Conditions);
- Foundation and Waste Slope Stability (Final Conditions);
- Liner System Veneer Stability (during construction and operation);
- Final Cover System Veneer Stability (after closure);
- Anchor Trench (Liner System) Design; and
- Settlement Analyses.

2 GEOTECHNICAL TESTING

2.1 GENERAL

Geotechnical testing was done on soil samples obtained during the site subsurface exploration conducted from October 2018 to January 2019 (see Attachment 4). During this site exploration, 42 borings were advanced between 28 to 80 feet in depth. Soil samples were collected during auger advancement utilizing thick walled Shelby tubes, two-foot split spoons, or five-foot continuous split barrels. Select soil samples from each stratum were used for geotechnical testing. The geotechnical tests were performed to evaluate physical and engineering properties of the different soil strata in accordance with 30 TAC §330.63(e)(5). Two additional borings were drilled in December 2019 (B-9 and B-43) to depths of 135 feet and 150 ft, respectively. The site exploration is discussed in detail in Attachment 4, Section 5. In Attachment 5, for the evaluation of the tests results, soil samples were grouped as West Disposal Area Samples, East Disposal Area Samples, and Other Samples (i.e., samples from borings outside the respective waste footprints).

Test parameters, the ASTM Test Methods, and the location within this report where test results are presented are shown in Table 5-2-1. The test results are summarized on Tables 5-2-2 to 5-2-6 for reference and individual testing results are shown in Attachment 4, Appendix 4.F.

Table 5-2-1. Laboratory Test Parameters

Test Parameter	Test Results	ASTM Test Method
Standard Proctor	Attachment 4 Appendix 4.F	D 698A
Sieve Analysis (Passing No. 200)	Boring Logs Appendix 4.D	D 1140
Atterberg Limits (Liquid and Plastic Limit, Plasticity Index)	Boring Logs Appendix 4.D	D 4318
Moisture Content & Unit Weight	Boring Logs Appendix 4.D	D 2216
Hydraulic Conductivity (Remolded to 95% Standard Proctor)	Table 5-2-6 Appendix 4.F	USACE EM 1110-2-1906, Appendix VII
Consolidated Undrained Triaxial Test	Table 5-2-5 Appendix 4.F	D 4767
Unconfined Compression Test	Table 5-2-7 Appendix 4.F	D 2166

2.2 SOIL CLASSIFICATION TESTS

Soil classification tests consisting of Atterberg limits, sieve analysis (percent passing the number 200 sieve), unit weight, and moisture content were performed on selected samples recovered from the boreholes. These test results were used to classify the soils according to the USCS and evaluate physical properties of the soils.

2.3 CONSOLIDATED UNDRAINED (CU) TESTS

Consolidated undrained (CU) triaxial tests with pore-pressure measurements were performed on selected undisturbed soil specimens to determine the drained shear strength parameters of soil samples. After the specimens reached 100% consolidation, they were axially loaded to failure under undrained conditions. Pore pressure readings were taken during loading to estimate effective stresses (i.e., drained shear strength parameters). CU test results with pore pressure readings, and resulting estimates of effective shear strength are presented in Attachment 4.

2.4 UNCONFINED COMPRESSION TESTS

Unconfined compression tests were performed on selected undisturbed soil specimens to determine the undrained shear strength parameters. During these tests, an axial load is applied to each specimen with zero confining pressure. Undrained shear strength test results are presented in Attachment 4.

2.5 HYDRAULIC CONDUCTIVITY TESTS

Flexible wall, falling head hydraulic conductivity tests were performed on recompacted soil specimens in the laboratory. Since surficial soils at the site will be used for liner construction, bucket samples taken at four locations from 10 to 12 feet depth were used for these tests. Standard Proctor curves for these samples were obtained. These samples were compacted at 95% Standard Proctor and Optimum Water Content for remolded hydraulic conductivity testing. These results were obtained to confirm the hydraulic conductivity that might be expected from on-site soils when used as landfill liner material.

Field hydraulic conductivity (permeability) slug tests were also performed on selected piezometers as discussed in Attachment 4, Section 6.3. These results were obtained to assist in evaluation of the in-situ permeability of the site lithology.

2.6 TEST CORRELATIONS AND SUMMARIES

2.6.1 General

The Attachment 4 description of site geology defines the site lithology as “shale-marl;” which are bulk rock materials composed of clay. For the purposes of using clearly defined engineering terms in this Attachment, the engineering term “clay” is used to refer to those layers that are referred to as “shale-marl” in Attachment 4. As shown on the logs and geologic cross sections in Attachment

4, Appendix 4B and 4C, the landfill excavation will typically encounter predominantly high plasticity clays (CH).

As described in Attachment 4, site lithology as determined by the drilling exploration program is quite homogenous both horizontally and vertically. Site lithology has been divided into surficial alluvial (Unit I), upper “weathered” calcareous shale-marl (Unit II) and lower “unweathered” calcareous shale-marl (Unit III) horizons based on field observations. Uppermost Unit 1 soil horizon generally ranges from zero to three feet in thickness. This thin uppermost soil layer (Unit I) will mostly be used as topsoil and, due to its thickness and similarity to other layers, will not be used for landfill development to the extent of the lower layers (Units II and III).

2.6.2 Laboratory Test Results

The geotechnical laboratory test results are summarized in the sections below for the West Disposal Area, East Disposal Area, and areas outside the waste footprints. The boring location map and geotechnical laboratory reports are presented in Attachment 4. Laboratory test results including Liquid Limit (LL), Plasticity Index (PI), percent fines, percent sand, percent gravel, water content, dry unit weight, unconfined compressive strength and Unified Soil Classification System (UCSC) classification are presented in Tables 5-2-2 to 5-2-4.

Results of the CU tests are presented in Attachment 4 (Appendix 4.F) and summarized in Table 5-2-5. Results of the hydraulic conductivity tests of the samples remolded at 95% Standard Proctor are presented in Attachment 4 and summarized in Table 5-2-6.

Table 5-2-2. Summary of Geotechnical Material Property Test Results – West Disposal Area

Boring Number	Sample Depth (ft)	Soil Layer	LL	PI(1)	Fines (%)	Sand (%)	Gravel (%)	Water Content (%)	Dry Unit Weight (pcf)	q_u Strength (tsf)	USCS(4)
B-1	15-20	Unit II	75	53	93	5	2	23			CH
	35-38	Unit III	69	45	97	3	0	19			CH
B-3	25-30	Unit II	60	36	93	7	0	18			CH
	40-45	Unit III	63	43	96	4	0	16			CH
B-9	5-7	Unit II	53	35	75	23	2	15			CH
	20-22	Unit II	67	47	91	6	3	20	105	12.32	CH
	35-37	Unit III	62	42	89	8	3	15	116		CH
B-16	10-12	Unit II	78	52	91	9	0	19	105		CH
	25-27	Unit II	60	38	77	18	5	15	116	17.76	CH
	50-52	Unit III	64	43	94	6	0	17	115		CH
B-17	15-17	Unit II	66	41	91	9	0	19	106	8.09	CH
	25-27(2)	Unit II	67	44							CH
	45-47	Unit III	60	41	83	17	0	15	120	23.36	CH
B-23	10-12	Unit II	73	50	98	2	0	20	108		CH
	30-32	Unit II	74	51	85	12	3	18	108		CH
	35-37	Unit II	77	55	89	11	0	20	101		CH
	40-42	Unit III	70	50	96	4	0	15			CH
B-24	5-7	Unit II	51	33	73	24	3	15	112	14.94	CH
	15-17	Unit II	74	52	98	2	0	21	99	7.94	CH
	25-27	Unit II	69	44	89	11	0	19	103		CH
	45-47(2)	Unit III	59	33							CH
B-31	15-17(2)	Unit II	66	39							CH
	30-32	Unit III	74	52	90	7	3	18	103	5.37	CH
	55-57	Unit III	60	37	96	3	1	14			CH
B-44	10-12	Unit II	71	49	91	6	3	20	108		CH
	20-22	Unit II	79	55	84	11	5	21	105		CH
	30-32	Unit II	72	51	97	3	0	25	97	4.44	CH
	50-52	Unit III	60	35							CH

(1) PI = LL – PL
(2) See Table 5-2-5 for CU test results.

Table 5-2-3. Summary of Geotechnical Material Property Test Results – East Disposal Area

Boring Number	Sample Depth (ft)	Soil Layer	LL	PI(1)	Fines (%)	Sand (%)	Gravel (%)	Water Content (%)	Dry Unit Weight (pcf)	q_u Strength (tsf)	USCS(4)
B-15	55-57	Unit III	57	37	91	7	2	11	116	1.61	CH
B-14	15-17	Unit II	58	35	65	30	5	19	104		CH
	35-37	Unit III	58	39	94	5	1	15			CH
B-18	10-12	Unit II	66	45	92	7	1	19	105	4.26	CH
	45-47	Unit III	57	38	90	10	0	13	109	3.59	CH
B-45	25-27	Unit II	66	46	90	8	2	21	107	6.21	CH
	40-42	Unit III	58	38	92	8	0	15			CH
B-21	15-17	Unit II	69	44	97	3	0	19			CH
	35-37	Unit III	57	39	94	6	0	15	108	10.49	CH
	40-42	Unit III	61	40	88	8	4	14			CH
B-19 (2)	10-12	Unit II	83	59	92						CH
	50-52	Unit II	63	44	91	7	2	14	117		CH
	70-72	Unit III	57	38	95	5	0	15			CH
B-46	45-47	Unit III	62	41	94	6	0	13	110		CH
B-20	45-47	Unit II	59	36	95	5	0	13	116	18.68	CH
	55-57	Unit III	58	37	96	3	1	13	118	16.82	CH
B-13	35-37	Unit II	66	43	94	6	0	20			CH
	45-47	Unit III	51	33	95	5	0	15			CH
B-27	25-27	Unit II	68	47	87	10	3	18	108		CH
	45-47	Unit III	61	40	97	3	0	15	118		CH
B-43	10-12	Unit II	60	40	95	5	0	18	111	7.12	CH
	25-27	Unit II	61	42	94	5	1	16	7.12		CH
	45-47	Unit III	63	40	95	5	0	16			CH
B-8	10-12	Unit II	67	50	85						CH
	40-42	Unit II	58	38	92	8	0	16	106	4.02	CH
	50-52	Unit III	58	38	97	2	1	14	116		CH

(1) PI = LL – PL
(2) See Table 5-2-5 for CU test results.

Table 5-2-3. (cont.) Summary of Geotechnical Material Property Test Results – East Disposal Area

Boring Number	Sample Depth (ft)	Soil Layer	LL	PI[1]	Fines (%)	Sand (%)	Gravel (%)	Water Content (%)	Dry Unit Weight (pcf)	q_u Strength (tsf)	USCS[4]
B-35	45-47	Unit III	54	33	75	17	8	13	109		CH
B-30	15-17	Unit II	61	41	90	6	4	18			CH
	30-32	Unit II	62	41	94	6	0	18			CH
B-29	25-27	Unit II	60	39	95	4	1	16	113		CH
	35-37	Unit III	51	34	90	10	0	11	114		CH
B-34	10-12	Unit II	57	38	82	17	1	14			CH
	20-22	Unit II	63	43	95	5	0	16	111		CH
B-22	30-32	Unit II	74	47	84	8	1	20			CH
	45-47	Unit III	64	39	92	7	8	17			CH
B-10	10-12	Unit II	65	41	90	7	3	19			CH
	25-27	Unit II	54	33	94	6	0	15	108		CH
	40-42	Unit III	59	39	92	7	1	14			CH

[1] PI = LL – PL

Table 5-2-4. Summary of Geotechnical Material Property Test Results – Other Borings

Boring Number	Sample Depth (ft)	Soil Layer	LL	PI[1]	Fines (%)	Sand (%)	Gravel (%)	Water Content (%)	Dry Unit Weight (pcf)	q_u Strength (tsf)	USCS[4]
B-11	20-22	Unit II	75	49	89	10	1	21	95		CH
	45-47	Unit III	55	33	86	14	0	13	120		CH
B-36	15-17	Unit II	56	35	91	8	1	18			CH
	30-32	Unit III	64	38	93	7	0	17	115		CH

[1] PI = LL – PL

Table 5-2-5. Summary of Consolidated Undrained (CU) Triaxial Test Results

Area	Boring Number	Sample Depth (ft)	Sampled Layer	CU test Results	
				c′ (psi)	ϕ′ (°)
East Disposal Area	B-19	50-51	Unit II	7.4	24.0
West Disposal Area	B-17	25-26	Unit II	1.6	26.2
West Disposal Area	B-31	15-16	Unit II	5.5	25.9
West Disposal Area	B-24	45-46	Unit III	10.0	34.0
West Disposal Area	B-44	50-51.5	Unit III	1.7	19.2

Table 5-2-6. Summary of Hydraulic Conductivity Tests – Remolded Samples

Area	Boring Number	Sample Depth (ft)	Sampled Layer	Hydraulic Conductivity (Remolded) (cm/s)
West Disposal Area	B-16	10-12	Unit II	1.94×10^{-8}
West Disposal Area	B-23	10-12	Unit II	2.69×10^{-8}
East Disposal Area	B-8	10-12	Unit II	2.23×10^{-8}
East Disposal Area	B-19	10-12	Unit II	2.05×10^{-8}

2.6.3 Material Properties

The geotechnical laboratory test results presented in the previous section are compiled in Table 5-2-7. Test results obtained from areas outside the waste limits are not included in this table since these areas will mostly be undisturbed during landfill construction. The landfill excavation will typically encounter predominantly high plasticity clays (CH) in the West Disposal Area and East Disposal Area, where all samples taken were classified as high plasticity clays (CH).

Site lithology has been divided into upper “weathered” (Unit II) and lower “unweathered” (Unit III) horizons based on field observations, and the engineering properties of these units confirmed by geotechnical laboratory testing are generally very similar (see Table 5-2-7). In addition to this similarity, engineering properties of soil samples (weathered and/or unweathered) from the West Disposal Area are very similar to the samples from the East Disposal Area. Therefore, for slope stability analyses and settlement analyses, foundation soils are modeled as one uniform layer for the landfill (including the West and East Disposal Areas). The engineering properties of this soil layer are estimated by the weighted average of all test results.

The results of the drained shear strength tests performed on the undisturbed samples are presented in Attachment 4. As seen in Table 5-2-5, similar shear strength properties were obtained for Units 2 and 3. As discussed in Section 4, in addition to these test results, empirical relationships are also used to calculate the shear strength properties.

Table 5-2-6 shows the remolded hydraulic conductivities obtained through laboratory testing. The values for Unit II range between 1.9×10^{-8} and 2.7×10^{-8} cm/sec (four test results). Unit II hydraulic conductivity reported for the West Disposal Area and East Disposal Area were very similar, with little variability. The results as shown in Table 5-2-6 confirms that on-site soils will be suitable for use as liner materials. Although hydraulic conductivity is low enough for liner construction, gravel chimney drains will likely be needed to promote leachate flow through the protective cover. These gravel chimney drains are included in the design (see Attachment 12 – Leachate and Contaminated Water Management Plan).

Table 5-2-7. Typical Properties of On-Site Materials

Laboratory Test	West Disposal Area				East Disposal Area				Foundation Soils (3)
	Weathered Clay Unit II		Unweathered Clay Unit III		Weathered Clay Unit II		Unweathered Clay Unit III		
	Average Value	Number of Tests	Average Value	Number of Tests	Average Value	Number of Tests	Average Value	Number of Tests	
Liquid Limit	68	18	65	10	63	21	58	17	63
Plastic Limit	22	18	22	10	21	21	20	17	21
Plasticity Index	46	18	43	10	42	21	38	17	42
Moisture Content	19	16	16	10	17	19	14	17	16.5
% Passing No. 200 Sieve	88	16	93	8	90	21	92	17	91
Dry Unit Weight (pcf)	105.6	13	113.5	4	110	14	112	10	109.4
Unit Weight (2) (pcf)	125.6	N/A	131.2	N/A	128.7	N/A	127.7	N/A	127.7
CU Test – Cohesion (c) (psi)	3.55	2	5.9	2	7.4	1	N/A	N/A	5.4
CU Test – Friction Angle (ϕ) (°)	26.0	2	26.6	2	24	1	N/A	N/A	25.9
q_u Test – Unconfined Compressive Strength (psf) (4)	10.9	6	14.4	2	8.1	5	9.8	5	10,530
Hydraulic Conductivity (remolded) (cm/s)	2.31×10^{-8}	2	N/A	N/A	2.14×10^{-8}	2	N/A	N/A	2.23×10^{-8}

Notes:
1. West Disposal Area and East Disposal Area averages are arithmetic.
2. Unit Weight is calculated using the dry unit weight, water content (WC), and the following formula: $\gamma = \gamma_d \times (1 + WC)$
3. For foundation soil properties, weighted averages of test results are compiled in this column.
4. Average of 10 lowest q_u values.

3 GEOTECHNICAL CONSTRUCTION MATERIALS

Based on the properties observed during field and laboratory testing, the following evaluation of the applicability of the various strata for geotechnical construction was developed.

3.1 MATERIAL REQUIREMENTS

Construction of the landfill will require clay or clayey soils which can be compacted to have an in-place hydraulic conductivity of 1×10^{-7} cm/sec or less for the soil liner portion of the composite liner and 1×10^{-5} cm/sec or less for the infiltration layer portion of the final cover system. Soil will also be required for protective cover over the liner, operational cover (daily and intermediate), the erosion layer component of the final cover, berm construction, and other miscellaneous general fill. Granular material (i.e., crushed stone) will be used for the leachate collection sumps and filter packing (chimney drains) around leachate collection lines. Typical material requirements are summarized in Table 5-3-1.

3.2 SUITABILITY OF SOILS FOR GEOTECHNICAL CONSTRUCTION

3.2.1 Soil Liner and Infiltration Layer

Material used to construct the soil liner and infiltration layer components of the liner and final cover systems, respectively are required to have a minimum Atterberg liquid limit of 30 and plasticity index of 15 (see Table 5-3-1). While the same material can be used to construct either layer, they have different hydraulic conductivity requirements. The bottom and sides of the landfill excavation will require a 2-foot compacted clay liner as the bottom component of a composite liner system. Adequate clay soils will be available from proposed landfill, basin or perimeter channel excavations, or on-site and select off-site borrow sources to provide material for the constructed liners. Based on Atterberg limits values and hydraulic conductivity testing performed as part of the geotechnical investigation, on-site clays and clayey soils are expected to have remolded hydraulic conductivity of less than 1×10^{-7} cm/sec when compacted to 95 percent of the standard Proctor densities. Soil liner construction and testing procedures are outlined in the SLQCP (Attachment 10).

3.2.2 Protective Cover Material

Protective soil cover will be placed over the leachate collection system (LCS) drainage layer on the bottom and sideslope liners. The protective cover is required to protect the liner and LCS from filling and construction activity. On-site soils are expected to have a hydraulic conductivity of less than 1×10^{-4} cm/sec when loosely compacted due to their clay-like nature and low hydraulic conductivities. Therefore, provisions have been made to extend leachate collection drainage media through the protective cover along the leachate collection lines and over the sump. This extension of the drainage media through the protective cover (referred to as “chimney drains”) will allow transmission of leachate to the LCS, thereby limiting the development of hydraulic head above the protective cover layer.

3.2.3 Final Cover Erosion Layer

The erosion layer should consist of a minimum 24 inches of earthen material, of which the top six inches is capable of sustaining plant growth. The existing site topsoil should be acceptable for this application. Amendment of the erosion layer with fertilizers, organic materials, or pH stabilizers may be required, as determined by evaluation during cover construction and vegetation establishment.

3.2.4 Operational Cover Material

Operational cover includes daily cover and intermediate cover. The materials excavated from the site may be used for operational cover. As listed in Table 5-3-1, operational cover is not restricted by physical properties except for maximum particle size. Any of the materials encountered in the excavation may be used for operational cover provided they are broken up to meet the maximum particle size criterion and were not previously mixed with waste materials.

3.2.5 Soil Fill Materials and Perimeter Embankment Construction

Soil fill will be required for subgrade preparation (refer to Attachment 10 for liner subgrade requirements), embankments, haul roads, and other miscellaneous general fill. Perimeter embankments (cell exterior berms) will be constructed along portions of the landfill perimeter as a component of cell construction. Material availability, compaction characteristics, and long-term maintenance requirements should be considered when evaluating the excavated soils for use as soil fill. All materials encountered in the subsurface investigations were suitable for use as soil fill. Soils typically should be segregated by classifications during excavation where relatively large variations exist, and Proctor moisture-density tests performed for the individual soil types for demonstration of level of compaction of the individual soil types during placement.

Embankments shall have sideslopes no steeper than 3 horizontal to 1 vertical (3H:1V). Unreinforced fill slopes not exceeding 2H:1V also are acceptable, provided diversion berms are provided at the top of the slope to minimize surface water flowing down the 2H:1V slopes. A sufficient amount of soil is available from the landfill excavations to construct the perimeter embankment and other features that require soil fill material.

The embankments will be constructed of on-site soils classified as clay, silty clay, or sandy clay, free of organic and other objectionable materials. The soil fill will be spread in maximum 12-inch thick, loose, horizontal lifts and compacted to a minimum of 95 percent of maximum standard Proctor dry density, within 3 percentage points below to 5 percentage points above the standard Proctor optimum moisture content. Alternative level of compaction and moisture content ranges will require demonstration prior to construction that the proposed alternative provides adequate structural support.

Table 5-3-1. Typical Soil Characteristics for Landfill Construction

Landfill Component	Soil Description	Classification	LL	PI	% - 200	Hydraulic Conductivity cm/sec
Compacted Clay – Liner	clayey sand, sandy clay, or clay	SC, CL, CH	30 min	15 min	30 min	1 x 10^{-7} max
Infiltration Layer – Final Cover	clayey sand, sandy clay, or clay	SC, CL, CH	30 min	15 min	30 min	1 x 10^{-5} max
Protective Cover	sand or sand with silt and clay	SP-SM, SP, SP-SC, SW, SM or SM-SC	(3)	(3)	(3)	1 x 10^{-4} max(1)
Erosion Layer for Final Cover	clayey sand, sandy clay, or clay	SC, CL, SM	Suitable to support plant growth			
Operational Cover (Daily Cover, Intermediate Cover)	sand, clayey sand, sandy clay, or clay	SP, SC, CL, CH	(2)	(2)	(2)	(2)
General Fill: Perimeter Berm, Subgrade Preparation	clayey sand, sandy clay, or clay	SC, CL, CH	To be specified during construction (3)		15 min	No requirement

Notes

1. If material does not meet the hydraulic conductivity criteria, the LCS drainage aggregate will extend through the protective cover at selected locations (i.e., chimney drains) and will be exposed adequately for transmission of leachate to the collection piping.
2. Material is not restricted by physical or engineering properties except for maximum particle size of approximately 4 inches.
3. On-site soils generally have high liquid and plastic limits. As such, if any maximum values are set, these will be set prior to construction to conform to on-site soils.

A minimum of one standard Proctor test (ASTM D 698) will be performed on each representative soil used as fill material. Each lift will receive a minimum of four passes with a heavy tamping roller unless adequate compaction can be demonstrated with fewer passes. If a smooth-drummed or rubber-tired compactor is used, the lifts will be scarified between successive lifts. Moisture-density field testing and full-time monitoring during construction will be provided by qualified geotechnical personnel. The outside face of all embankment construction will be vegetated to minimize erosion and desiccation.

3.2.6 Landfill Cell Excavations

The landfill base grades will be excavated in a manner that will achieve reasonable segregation of liner quality material (clays) from the topsoil and any soils that are not liner-quality materials (if encountered). Materials will be stockpiled separately as necessary, according to construction material properties outlined above, and visual observation during excavation. Excavation and hauling of clay soils is expected to be achieved with scraper equipment or bulldozer and dump truck.

Permanent excavation slopes (i.e., slopes that will be lined) will be rough graded to no steeper than 3H:1V. Slopes to receive liner will be graded to 3H:1V or flatter based on the final construction plans.

4 SLOPE AND FOUNDATION STABILITY

4.1 GENERAL

The following section presents the results of the global slope stability analyses for the landfill. Analyses were also performed to calculate the overall stability of the proposed interim and final slopes of the landfill. Specifically, the following slope stability analyses are performed in this section:

i. excavation stability during cell construction;
ii. stability of waste slopes and foundation soils during filling – interim conditions (circular mode);
iii. stability of liner system during filling – interim conditions (block mode);
iv. stability of waste slopes and foundation soils after closure – final conditions (circular mode);
v. stability of liner system after closure – final conditions (block mode);
vi. veneer stability of liner system during cell construction; and
vii. veneer stability of final cover system – final conditions.

As presented in Attachment 4 (Section 3.1.2), the proposed landfill is not located within a seismic impact zone as defined by 30 TAC 330.557. Therefore, only static stability analyses were performed in this section.

Interim and final conditions stability analyses include both circular and block failure modes, which provide factors of safety against failure of the constructed landfill, landfilled municipal solid waste (MSW), the critical interface of the liner system, and the underlying foundation soils. Stability of the proposed liner and final cover systems in veneer mode are evaluated in Sections 4.5 and 4.6. Anchor trench design is discussed in Section 4.7.

Slope stability analyses were performed using the computer program PCSTABL5M (FHWA, 1995). This program uses two-dimensional limit equilibrium methods to calculate a factor of safety (FS) against shear failure for slope sections analyzed. The PCSTABL5M program uses an automatic search routine to generate multiple shear failure surfaces for both circular failures and block or wedge-type failure modes until the surface with the lowest FS-value (i.e., critical failure surface) is found. The analytical methods used for the circular and sliding block failure modes in the slope stability analysis are the Modified Bishop and Modified Janbu methods, respectively. Circular failure search mode was used to evaluate excavation stability, and stability under interim and final conditions, while sliding block failure mode was used to analyze stability of the critical interfaces in the bottom liner system.

A minimum acceptable FS of 1.5 was assumed for global static slope stability analyses under final conditions. A minimum acceptable FS of 1.3 was assumed for a temporary, static interim waste slope stability analyses. The recommended minimum FS for the conditions analyzed are consistent with the recommendations from the Corps of Engineers "Design and Construction of Levees" manual (EM 1110-2-1913) and EPA's "Technical Guidance Manual for Design of Solid Waste Disposal Facilities."

Cross sections selected for analyses, input parameters and assumptions, and results of the analyses are presented in the following sections. PCSTABL5M output files of the excavation stability, stability under interim and final conditions are presented in Appendix 5A.

Stability of the proposed liner system during construction is evaluated in the veneer mode. The limit equilibrium method of Koerner and Soong (1998) is used to analyze the stability of the liner system on the 3 Horizontal:1 Vertical (3H:1V) sideslopes. Using Koerner and Soong (1998) method, the minimum required interface friction angle that can achieve a target factor of safety is estimated. The result is presented in Appendix 5B.

Stability of the proposed final cover system is also evaluated using the same method used for liner system stability in veneer mode. The result is also presented in Appendix 5B.

4.2 SECTIONS SELECTED FOR ANALYSIS

Slope stability analyses were performed for selected cross-sections of the landfill. The locations of these cross sections were selected based on review of the proposed excavation grades and the final grading plan. A critical slope section is considered to have a maximum waste height, a maximum exterior slope angle, and a shallow perimeter berm. All slope sections except the interim slopes are virtually buttressed by the excavation and the landfill perimeter, including a perimeter berm of various heights.

Please refer to Drawings 5.1 and 5.2 at the end of this attachment (prior to the Appendices) for plan views of the landfill showing where the various sections were cut. Drawings 5.3 through 5.7 show the various sections. Profiles of the sections can also be seen on the model outputs provided in Appendix 5A.

One cross section was selected for excavation stability analysis close to the north corner of the East Disposal Area (Section AA′). This cross section was selected as the most critical because the excavation cut is deepest in this area (including West Disposal Area and East Disposal Area).

Interim fill condition was analyzed using one cross section (Section BB′) with the tallest potential interim waste slope that would be constructed from an intercell berm to the maximum waste height with a slope inclination of 3H:1V.

Slope stability analyses under final conditions (waste stability, foundation soils stability, and liner stability) were performed for three slopes at final grade (Sections CC′, DD′, and EE′). The analyses were performed on cross-sections assuming that the landfill has reached its maximum height.

4.3 INPUT PARAMETERS AND ASSUMPTIONS

Table 5-2-7 compiles the results of the geotechnical tests performed on the foundation soils. In addition to the CU tests and unconfined compression strength tests, long-term and short-term shear strength parameters for foundation soils are also estimated using (i) the available empirical relationships in the literature and/or (ii) shear strength properties reported in the literature for CH type soils. These estimations are presented in Appendix 5A.

4.3.1 Material Properties for Stability Analysis – Excavation Slope

Table 5-4-1 summarizes the unit weight and shear strength properties of foundation soils used for excavation stability. Please refer to Appendix 5A for more information on these assumptions. Cell excavation is a short-term condition, therefore undrained soil strength properties were used for this analysis.

Table 5-4-1. Summary of Geotechnical Shear Strength Properties – Excavation Slope

Material	γ (pcf)	c (psf)	ϕ (°)
Foundation Soils (undrained)	128	4,000	0

4.3.2 Material Properties for Stability Analysis – Interim and Final Conditions

Table 5-4-2 summarizes the unit weight and shear strength properties used for interim waste slope and final slope conditions. Foundation soil shear strength properties under drained conditions are used for these analyses as summarized in Table 5-4-2. Based on calculations presented in Appendix 5A, a friction angle of 25 degrees is used for foundation soils. To be conservative, cohesion component of soil shear strength is assumed to be zero.

The total unit weight for MSW was assumed to be 60 pcf based on MSW with typical compaction and soil amount reported by Zekkos et al. (2006). Bray et al. (2009) reports that a friction angle of 33 degrees is commonly used in the literature. The same study reports cohesion of 313 psf and 36 degrees for MSW. Based on these values reported in the literature, shear strength parameters reported in Table 5-4-2 are conservatively used for MSW. When assigning these values to the modeled MSW layer, saturated waste within the waste stream is uncommon and is not considered in the analysis.

Most of the landfill footprint is located within the weathered clay layer, in which very high SPT values were recorded as shown in Attachment 4. Clayey soil available on-site will be used for construction of the final cover and liner systems. Unit weight and shear strength properties were based on values reported in the literature.

Table 5-4-2. Summary of Geotechnical Strength Properties – Interim and Final Conditions

Material	γ (pcf)	c (pcf)	ϕ (°)
Foundation Soils (drained) (1)	128	0	25
Municipal Solid Waste	60	200	32
Soil Fill/Soil Liner/Final Cover Soils	120	200	20

(1) Cohesion = 0 (to be conservative). See Appendix 5A for more information.

4.3.3 Additional Slope Stability Analyses Assumptions

The slope stability analyses were performed based on the following assumptions:

- The analyses assume that either a block-type failure surface occurs along the weakest interface of geosynthetic/geosynthetic or soil/geosynthetic components of the liner system or, if a failure occurs within the waste mass or the foundation soil layer, that a circular failure surface occurs.
- Liner systems proposed for the cell side slopes and cell base are different (from bottom to top):
    - Side slopes: 2-foot thick compacted clay liner, textured HDPE geomembrane, double-sided geocomposite, and 2-foot thick protective soil.
    - Cell base: 2-foot thick compacted clay liner, smooth HDPE geomembrane, single-sided geocomposite, and 2-foot thick protective soil.

    The proposed side slope liner system will be extended from the toe of slope to 5 feet onto the cell floor.

    The representative interface friction angles for the interfaces of the proposed liner systems are summarized in Table 5-4-3, which are based on GRI Report #30, "Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces" by G. R. Koerner and D. Narejo (2005). Consistent with the recommendations of Stark and Choi (2004), residual shear strengths are assigned to the sideslopes and peak shear strength are assigned to the base of the liner system to satisfy a FS greater than 1.5.

According to Table 5-4-3, the critical interface friction angle (residual) for the sideslope is the textured HDPE geomembrane and double-sided geocomposite interface with an interface friction angle of 15 degrees. For the landfill base, where the peak interface friction angle is used, the lowest reported interface friction angle is 11 degrees (smooth HDPE geomembrane and saturated compacted clay liner or single-sided (SS) geocomposite interface).

Based on Table 5-4-3, interface friction angles of 11 degrees and 15 degrees were used in the block-type stability analyses for the cell floor and side slope liner systems, respectively.

To be conservative, no adhesion value was used in the analysis; however, adhesion is typically considered to determine the effective shear strength of the critical interface.

Table 5-4-3. Summary of Liner Interface Properties

Interface	Peak Friction Angle ϕ_{peak} (°)	Residual Friction Angle $\phi_{residual}$ (°)
Smooth HDPE GM /Compacted Clay Liner (Saturated)	11	11
Smooth HDPE GM /SS Geocomposite (Geonet)	**11**	9
NW GT/Cohesive Soil	30	21
Textured HDPE GM /Compacted Clay Liner (Saturated)	18	16
Textured HDPE GM /DS Geocomposite	26	**15**
Geocomposite/ Protective Cover	18	18

1. Polyethylene; GM: geomembrane; SS: single-sided; DS: double-sided; NW GT: non-woven geotextile.
2. Interface friction angle for each interface considered is based on 2005 GRI Report #30, "Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces" by G. R. Koerner and D. Narejo (2005).
3. Textured HDPE liner will be used on all sideslopes as well as 5 feet from the toe of the slope.

- The compacted clay liner interface with the HDPE liner was assumed to be in a saturated condition for conservativeness, since the cell excavation extends below the seasonal high groundwater table (see Attachment 10 – Soil and Liner Quality Control Plan for more information).

- According to Federal guidance on the application of Subtitle D regulations, an acceptable factor of safety for long-term global static slope stability analyses is 1.5. For the temporary short-term slope stability condition such as the interim waste slope, a factor of safety of 1.3 is considered acceptable. An acceptable factor of safety for a static veneer stability analysis is 1.5 for the final cover system and 1.3 for the liner system (i.e., interim conditions).

- The ground water table was assumed 1 foot below lowest subgrade elevations for these stability analyses. It is assumed that either the ground water controls will be installed at the time of construction or that sufficient ballast will be in place prior to hydrostatic uplift on the liner in accordance with Attachment 10.

4.4 RESULTS OF ANALYSES – EXCAVATION, INTERIM, AND FINAL CONDITIONS

The results of the global static slope stability analyses for the various scenarios considered are presented in Tables 5-4-4 to 5-4-6. The locations of the critical failure surfaces for each cross-section are presented in Appendix 5A, in which detailed computer graphical printouts and output files for each model run are presented.

The calculated FS for excavation stability analysis and interim conditions are greater than the minimum acceptable value of 1.3.

The calculated FS for the global static slope stability analysis (final conditions) are greater than the minimum acceptable value of 1.5. The most critical section of all those considered, Section CC′ yielded a FS of 1.64 under block-type failure mode, with the failure surface located within the bottom liner system.

Interface friction angles used in the block-type failure mode are considered typical and conservative for the existing interfaces. Should there be a different interface present due to selection of materials not considered before, the global slope stability analyses should be reevaluated during construction in order to validate the requirements of the FS values.

Under circular failure surface mode (final conditions), the calculated factors of safety are greater than 2.5 with a failure surface located within the waste mass. From the results of the analysis, it is anticipated that the block-type failure mode is more critical than the circular failure mode.

The results of the stability analyses indicate that the proposed excavation, interim waste fill slopes and the final waste fill slopes are stable under the conditions analyzed.

Table 5-4-4. Stability Analyses Results – Excavation Stability

Cross Section	Output File Name	Slope Stability Analysis	Calculated Factor of Safety	Target Factor of Safety
AA′	Waco XS A - Undrained	Circular	3.94	1.30

Table 5-4-5. Stability Analyses Results – Interim Conditions

Cross Section	Output File Name	Slope Stability Analysis	Calculated Factor of Safety	Target Factor of Safety
BB′	Waco XS B - Circular	Circular	2.11	1.30
BB′	Waco XS B - Block	Block	1.40	1.30

Table 5-4-6. Stability Analyses Results – Final Conditions

Cross Section	Output File Name	Slope Stability Analysis	Calculated Factor of Safety	Target Factor of Safety
CC′	Waco XS C - Circular	Circular	2.73	1.50
CC′	Waco XS C - Block	Block	1.64	1.50
DD′	Waco XS D - Circular	Circular	2.76	1.50
DD′	Waco XS D - Block	Block	1.69	1.50
EE′	Waco XS E - Circular	Circular	2.88	1.50
EE′	Waco XS E - Block	Block	1.82	1.50

4.5 VENEER SLOPE ANALYSES OF LINER SYSTEM

Veneer stability of the liner system during construction was evaluated using a veneer stability model that evaluates the seepage forces within the liner system using a set of equations and method developed by Koerner and Soong (1998). Both static and seepage forces were considered in the veneer stability analysis, using basic equations as shown on the calculation spreadsheets in Appendix 5B. Interface friction angle that provides the target factor of safety is estimated. Target FS of 1.3 for slope stability was used for this interim condition during construction individual cells.

The veneer slope stability analysis was performed based on the following assumptions:

- Maximum liner system slope was assumed to be at a 3H:1V slope, or 18.44 degrees.
- Length of the slope was assumed to be 150 feet (46 m, i.e., longest excavation slope length at 3H:1V, which is located in the vicinity of north corner of the East Disposal Area, which has deeper excavation depths compared to the West Disposal Area).
- In order to assess seepage forced in the liner system, the permeability of the geocomposite drainage layer was assumed to be equivalent to 4 cm/sec with a thickness of 250-mil.
- The average liner soil internal friction angle was assumed to be 28 degrees and zero cohesion to be conservative. The assumed friction angle is consistent with the literature values reported for compacted clayey soils.
- The seepage force analysis assumed percolation from a 24-hour, 25-year storm event (7.9 inches) to be 8.4 mm per hour.

The results of the veneer slope stability analysis of the liner system are presented in Appendix 5B. As shown in Appendix 5B, the calculated minimum friction angle to achieve the target factor is 22.7 degrees, which is typical of many commercially available products. (see GRI #30 for HDPE GM/unsaturated cohesive soil and HDPE/geocomposite, peak values, and reported adhesions). The method presented is a conservative evaluation of veneer stability, as the analysis disregards tensile strength of the geosynthetic components (e.g., geomembrane and geotextile/geonet composite), cohesion of the liner soils, and adhesion between the liner system components.

4.6 VENEER SLOPE ANALYSES OF FINAL COVER SYSTEM

Veneer stability of the final cover system was evaluated using a veneer stability model that evaluates the seepage forces within the final cover system using a set of equations and method developed by Koerner and Soong (1998). Both static and seepage forces were considered in the veneer stability analysis, using basic equations as shown on the calculation spreadsheets in Appendix 5B. The interface friction angle that provides the target factor of safety was estimated. A target FS of 1.5 was used in this analysis.

The veneer slope stability analysis was performed based on the following assumptions:

- Maximum final cover slope was assumed to be at a 4H:1V slope, or 14.04 degrees.
- Length of the slope was assumed to be 590 feet (180 m, longest 4H:1V slope of the East Disposal Area, which has taller waste heights than the West Disposal Area).
- In order to assess seepage forced in the final cover, the permeability of the geocomposite drainage layer was assumed to be equivalent to 4 cm/sec with a thickness of 250 mil.
- The average cover soil internal friction angle was assumed to be 28 degrees and zero cohesion to be conservative. The assumed friction angle is consistent with the literature values reported for compacted clayey soils.
- The seepage force analysis assumed percolation from a 24-hour, 25-year storm event (7.9 inches) to be 8.4 mm per hour. The maximum drainage length was assumed to be 590 feet since the geocomposite drainage layer is not daylighted at the drainage swale locations.

The results of the veneer slope stability analysis of the final cover system are presented in Appendix 5B. As shown in Appendix 5B, the calculated minimum friction angle to achieve the target factor is 20.3 degree, which is typical of many commercially available products (see GRI #30). The method presented is a conservative evaluation of veneer stability, as the analysis disregards tensile strength of the geosynthetic components (e.g., geomembrane and geotextile/geonet composite), cohesion of the cover soils, and adhesion between the cover system components. As shown in the calculations, saturation of the cover soil is not anticipated since the drainage layer has sufficient capacity to transmit flow so that the final cover remains unsaturated.

4.7 ANCHOR TRENCH DESIGN

The anchor trench for the composite liner system at the top of the side slope is normally constructed to ensure that the geomembrane can pull out of the anchor trench without being stressed to the yield point. Since the textured geomembrane is used on the sideslope for the proposed liner system, the frictional strength along the liner system is normally greater than the side slope angle (18.44 degrees for 3H:1V slopes). Therefore, under normal circumstances and as demonstrated in the veneer stability of the liner system section, the liner system is stable on the side slope, and the geomembrane does not experience significant tensile stress. The anchoring of the geomembrane inside a trench at the top of the sideslope is generally used to protect the exposed edges of the geomembrane during construction. Therefore, run-out length and anchor trench calculation are not performed with textured geomembrane, and the standard anchor trench size shown on the drawing detail (Attachment 6C, Drawing 6C.2) is adequate and consistent with the landfill design standards.

5 SETTLEMENT ANALYSES

5.1 GENERAL

This section addresses post-construction settlement for the bottom liner system and final cover system. Settlement, which may induce stresses on the liner will occur due to consolidation of the foundation soils resulting from the stress induced by the landfill components (e.g., bottom liner, MSW, daily/intermediate cover, and final cover systems). Settlement of the final cover system will occur due to consolidation of foundation soils as well as consolidation (primary) and decomposition (secondary) within the MSW.

5.2 FOUNDATION SETTLEMENT

Foundation soils settlements are calculated using the following 1-D consolidation theory settlement equation used in geotechnical engineering for normally consolidated clays (Holtz and Kovacs, 1981).

$$S = C_c \frac{H}{1 + e_0} log\left(\frac{P}{P_0}\right)$$

where:

S = total settlement;
C_c = compression index;
H = initial thickness of compressible layer;
e_0 = initial void ratio;
P_0 = initial effective overburden stress;
P = final effective overburden pressure.

Following the calculation of settlement along the analyzed cross sections, settlement induced strains of the liner system are calculated using the following equation.

$$\varepsilon = \frac{L_0 - L_f}{L_0} \times 100\ (percent)$$

where:

ε = strain in the liner system (+ indicated compression, - indicated tension);
L_f = final length between calculation points based on post-settlement elevations; and
L_i = initial length between calculation points based on pre-settlement elevations.

The estimated tensile strains were compared to the conservative allowable tensile strains of 5% for the liner system geomembrane and 0.5% for the compacted clay liner.

As described previously in this section, site lithology has been divided into upper "weathered" and lower "unweathered" horizons based on field observations. For foundation settlement calculations, unweathered soil layer is assumed to be incompressible and weathered soil layer remaining following cell excavation is considered the compressible layer. As shown on the landfill cross-sections, the subgrade is very close to the top of the unweathered soil layer. The thickness of remaining weathered soil layer varies from zero to 14 feet within the West Disposal Area and East Disposal Area cell floors. To be conservative, this remaining weathered foundation soil layer is assumed to be normally consolidated. Due to very low thickness of the compressible soil layer, secondary compression is assumed to be negligible.

Potential heave (rebound) due to excavation of overburden above the excavation base grades was built into the foundation settlement spreadsheet when calculating the initial overburden stress of the soil layers.

Settlement of the foundation soils was calculated using the EXCEL spreadsheets as presented in Appendix 5C. Material property assumptions are also summarized in these spreadsheets. Unit weight of MSW is assumed to be 60 pcf for settlement calculations. Compression index (Cc) was estimated with empirical relationships using average moisture contents and liquid limits of the foundation soils, which are summarized in Table 5-2-7.

Two cross sections (Section 1 and 2) were analyzed for the proposed East Disposal Area and West Disposal Area, respectively. Both of these cross sections were located along the leachate corridor of the cells, which has the flattest slope on the cell floor (i.e., 1%). Leachate corridors with thicker underlying compressible foundation soils (i.e., weathered zone) were selected for settlement analyses. The locations of the cross sections on the excavation and final cover grading plans are presented in Figures 1 to 4 of Appendix 5C. The geometries of the cross sections are presented in Figures 5 and 6 of Appendix 5C.

The minimum calculated post-settlement leachate corridor slope is 0.9%, as compared to the original pre-settlement slope of 1%. Therefore, positive drainage of leachate towards the leachate collection sumps will be maintained. Maximum calculated tensile strain in the liner system is less than 0.1%, which is less than the allowable tensile strain for typical liner system geosynthetic components and compacted clay liners. As shown in Appendix 5C, the liner system will be relaxing (i.e., no tension) and therefore not impacted by settlement.

It is therefore concluded that foundation settlement and associated strain will not adversely affect the performance of the bottom liner system.

5.3 FINAL COVER SETTLEMENT

Settlement of the final cover system due to consolidation of MSW is evaluated in this section. The final cover system settles due to primary consolidation of MSW with the construction of the final cover system (i.e., increase in vertical stress), and secondary compression due to waste degradation. Additional settlement of foundation soils due to final cover construction is assumed to be negligible due to small loading from the final cover system.

Final cover system settlements are calculated using the following 1-D consolidation equation presented below. This equation is similar to the one used for estimation of foundation soils settlements with two modifications: (i) Ccε (modified compression index) is used instead of Cc (compression index) (Ccε=Cc/(1+eo)) due to availability of Ccε of MSW in the literature; and (ii) secondary compression of waste is included in the analyses due to the higher potential for secondary settlement of waste compared to the foundation soils. This equation is from Babu et al. (2010, as obtained from Sowers, 1973).

$$S = C_{c\varepsilon} H log\left(\frac{P}{P_0}\right) + C_{\alpha} H log\left(\frac{t_2}{t_1}\right)$$

where:

S	=	total settlement;
$C_{c\varepsilon}$	=	modified compression index;
H	=	initial thickness of compressible layer;
P_0	=	initial effective overburden stress;
P	=	final effective overburden pressure. ($P=P_0 + \Delta P$),
ΔP	=	final cover thickness x unit weight of final cover soils
C_{α}	=	secondary compression index;
t_1	=	time when secondary compression is assumed to begin (assumed to be 1 year)
t_2	=	time for when secondary settlements are calculated for (assumed to be 30 years)

Following the calculation of settlement along the analyzed cross section, settlement induced strains of the final cover system are calculated using the following equation.

$$\varepsilon = \frac{L_0 - L_f}{L_0} \times 100\ (percent)$$

where:

ε	=	strain in the final cover system (+ indicated compression, - indicated tension);
L_f	=	final length between calculation points based on post-settlement elevations; and
L_i	=	initial length between calculation points based on pre-settlement elevations.

The estimated tensile strains were compared to the conservative allowable tensile strains of 5% for the final cover system geomembrane.

Final cover system settlements and accompanying strains were calculated using the EXCEL spreadsheet as presented in Appendix 5C. Material property assumptions are also summarized in these spreadsheets. The unit weight of municipal solid waste is assumed to be 60 pcf for settlement calculations. The modified compression index ($C_{c\varepsilon}$) was selected as 0.205 based on the values reported in Babu et al. (2010), where $C_{c\varepsilon}$ values for MSW ranged from 0.163 to 0.205.

Secondary compression index (C_α) ranged from 0.015 to 0.35. Fassett et al. (1994) reports C_α values ranging from 0.01 to 0.04. Based on these values reported in the literature, a C_α of 0.05 is used in secondary compression calculations.

One cross section from the East Disposal Area was analyzed for final cover settlement analysis. The East Disposal Area has a higher waste thickness compared to the West Disposal Area, and therefore was selected for this analysis. The location of the analyzed cross section on the final cover grading plan is presented in Appendix 5C. The geometry of the cross section is presented in Figure 5-8 of Appendix 5C.

Calculations for the estimated 30-year settlement of the final cover system are presented in Appendix 5C and summarized in Table 5-5-2. Waste settlement was estimated to be about 9 percent of its original thickness after a 30-year period. As presented in the calculations, the strain calculated for each line segment within the final cover have a negative value, meaning the final cover system is under negative tension or relaxing. The negative strains are all less than 2 percent on the sideslope (between the toe and crest), and less than 0.4 percent on the top plateau (between the crest and peak). Both values are well within the tolerances for the components incorporated into the final cover. Based on data published by the Geosynthetic Research Institute (GRI), LLDPE geomembrane materials can tolerate strains in excess of 50 percent, which far exceeds the maximum predicted strain. An HDPE geomembrane can tolerate 5 percent or more stain, which also is below the predicted strain.

Therefore, the post-settlement sideslope will flatten slightly but will maintain and promote positive drainage from the top of the landfill.

In conclusion, the proposed slopes are expected to maintain drainage after landfill settlement has occurred, and settlement-induced strain is expected to be well within the material limits of the final cover system.

6 CONCLUSIONS AND RECOMMENDATIONS

The following general conclusions were presented in this attachment:

- Based upon site subsurface exploration, laboratory testing, and engineering analyses, the site is geotechnically suitable for development as a Type I MSW solid waste disposal facility.

- The slope stability of the proposed landfill excavation slopes, interim sideslopes, and final sideslopes are acceptable as designed.

- The veneer stability of the composite bottom liner and final cover systems is acceptable as designed.

- The waste is expected to settle relatively and uniformly based on the proposed site geometry. The proposed slopes will maintain drainage after landfill settlement has occurred and settlement is expected to be within the strain limits of the composite final cover system.

- Foundation settlement after filling is expected to be negligible and within the strain limits of the composite bottom liner system.

7 REFERENCES

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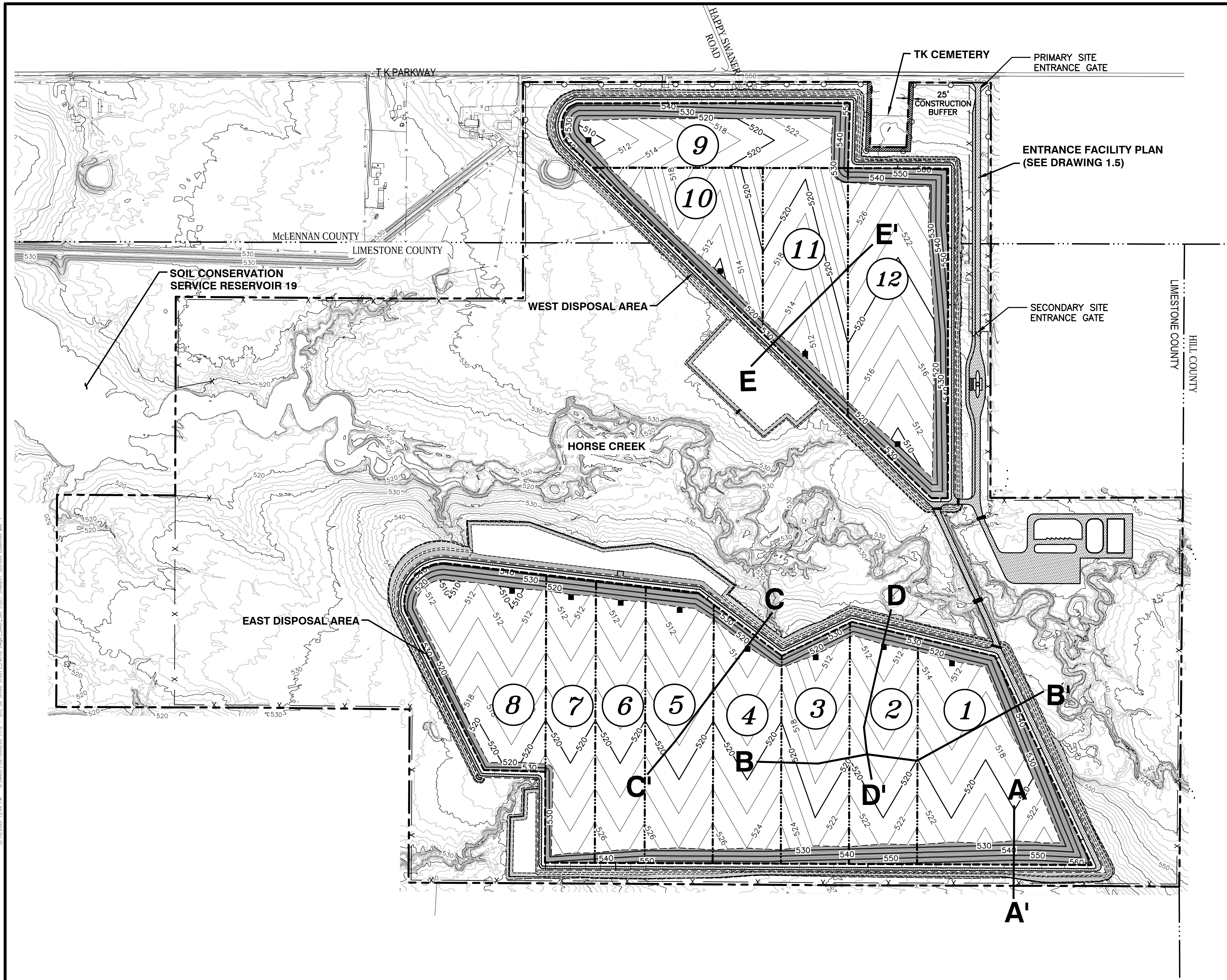
DRAWINGS



0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- SECTOR BOUNDARY
- COUNTY LINE
- 560 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- X PROPOSED/EXISTING PERIMETER FENCE (CHAIN LINK OR BARBED WIRE)
- PROPOSED 8' PRIVACY FENCE
- ACCESS ROAD
- 510 EXCAVATION GRADE TOPOGRAPHIC CONTOURS (SEE NOTE 2)
- X SECTOR DESIGNATION
- **B - B'** STABILITY-SECTION LOCATIONS

NOTES:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPATIAL FLOWN ON JULY 03, 2018.
2. ELEVATIONS SHOWN ON THIS DRAWING WITHIN WASTE LIMITS ARE EXCAVATION GRADES (BOTTOM OF LINER) ELEVATIONS IN FEET MEAN SEA LEVEL (FT MSL).

STATE OF TEXAS
HARTUAN JAMES LAW
135755
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: STABILITY SECTIONS LOCATION MAP 1

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
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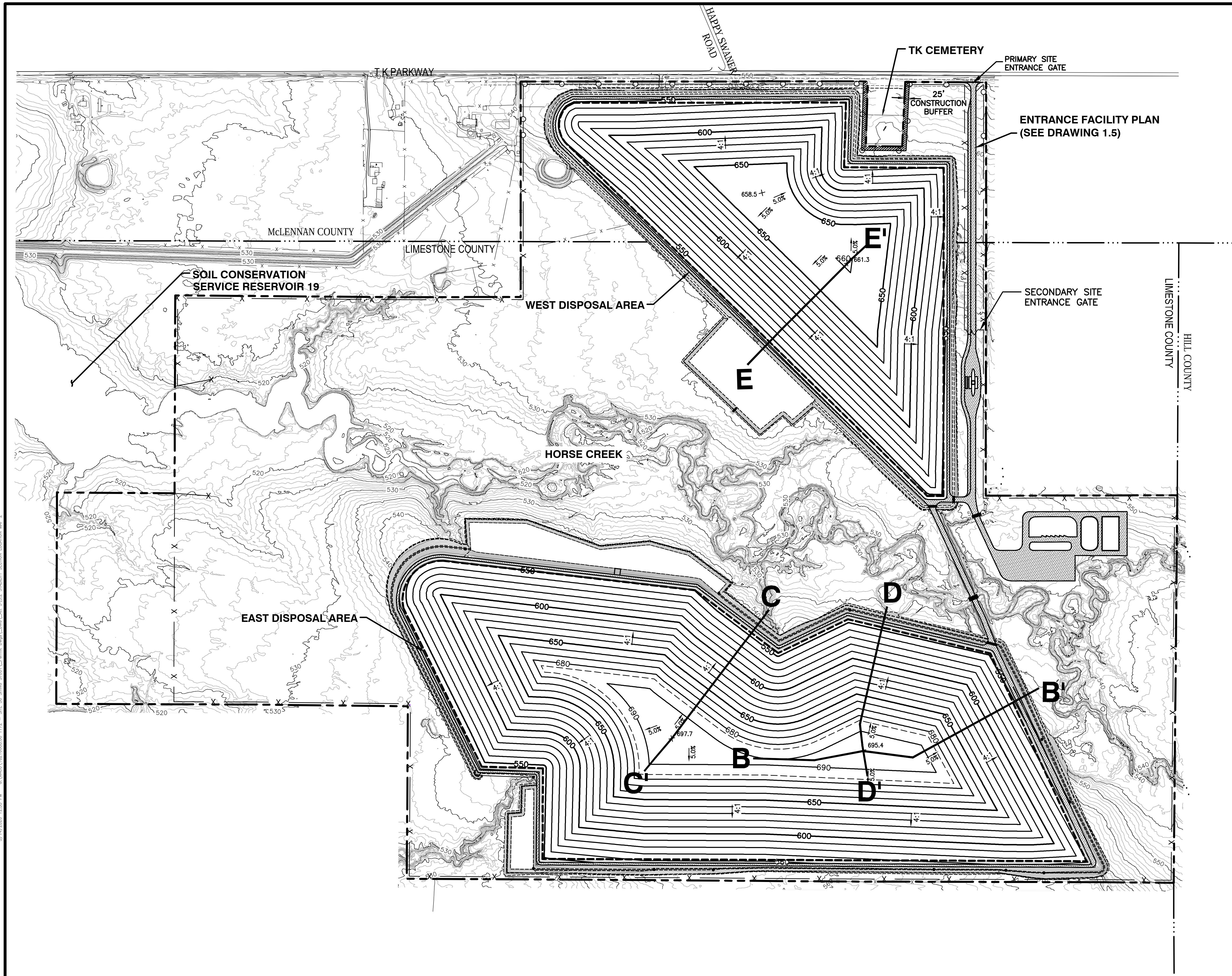
PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 5.1 STABILITY SECTION LOCATION MAP

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.
5.1



0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- COUNTY LINE
- 560 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- 650 FINAL COVER TOPOGRAPHIC CONTOURS (SEE NOTE 2)
- X PROPOSED/EXISTING PERIMETER FENCE (CHAIN LINK OR BARBED WIRE)
- PROPOSED 8' PRIVACY FENCE
- ACCESS ROAD
- **B - B'** STABILITY–SECTION LOCATIONS

NOTES:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPATIAL FLOWN ON JULY 03, 2018.
2. ELEVATIONS SHOWN ON THIS DRAWING WITHIN WASTE LIMITS ARE TOP OF FINAL COVER ELEVATIONS IN FEET MEAN SEA LEVEL (FT MSL).

STATE OF TEXAS
HARTUAN JAMES LAW
135755
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: STABILITY SECTIONS LOCATION MAP 2

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

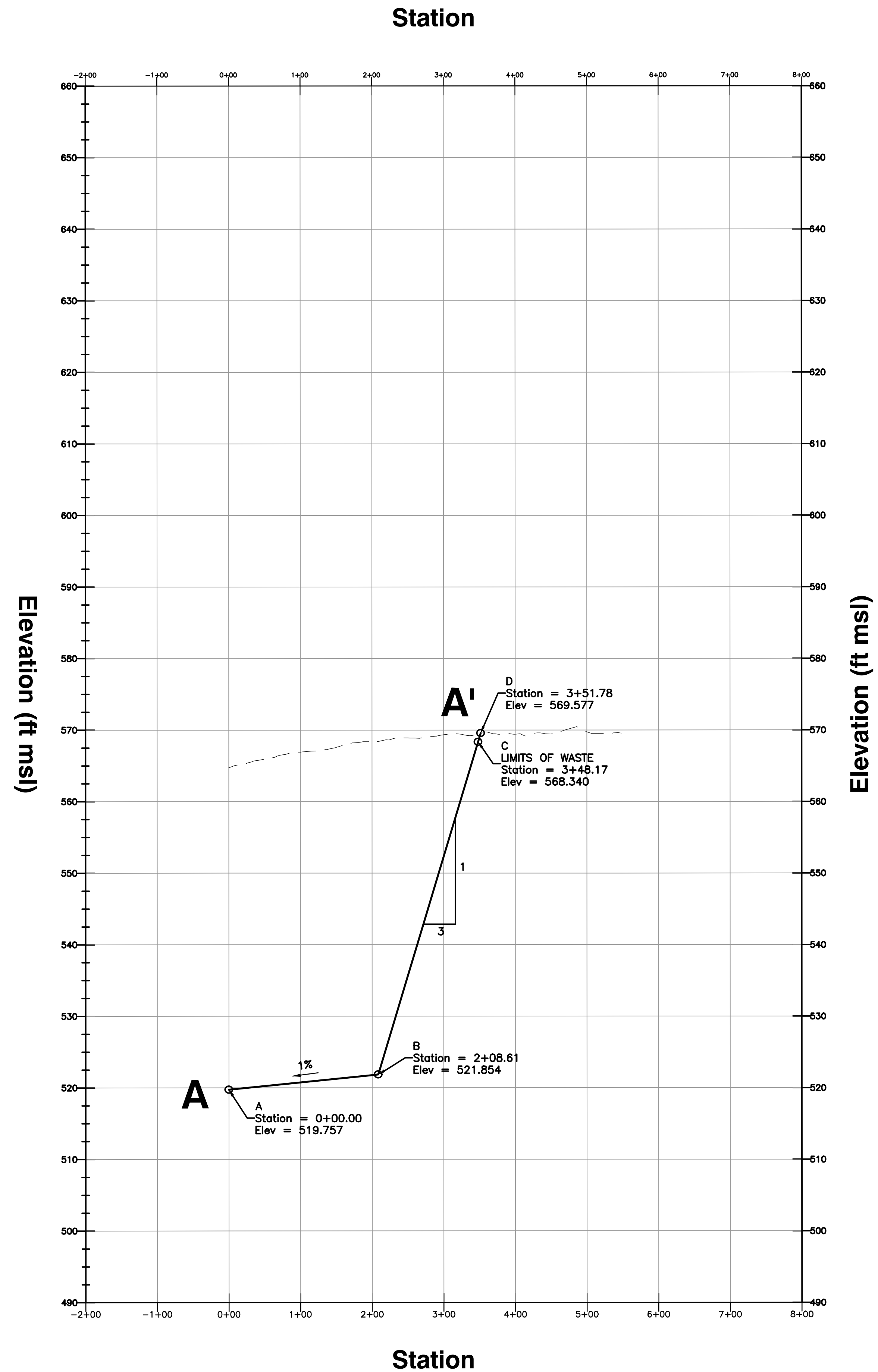
PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

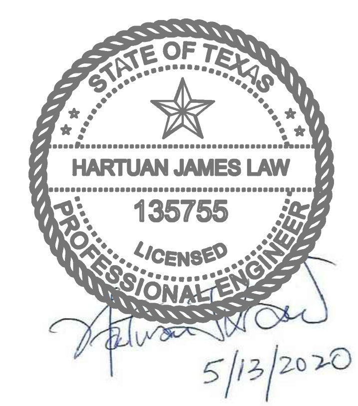
CADD FILE: 5.2 STABILITY SECTION LOCATION MAP 2

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. **5.2**





FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EAST DISPOSAL AREA
STABILITY CROSS SECTION A-A'

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

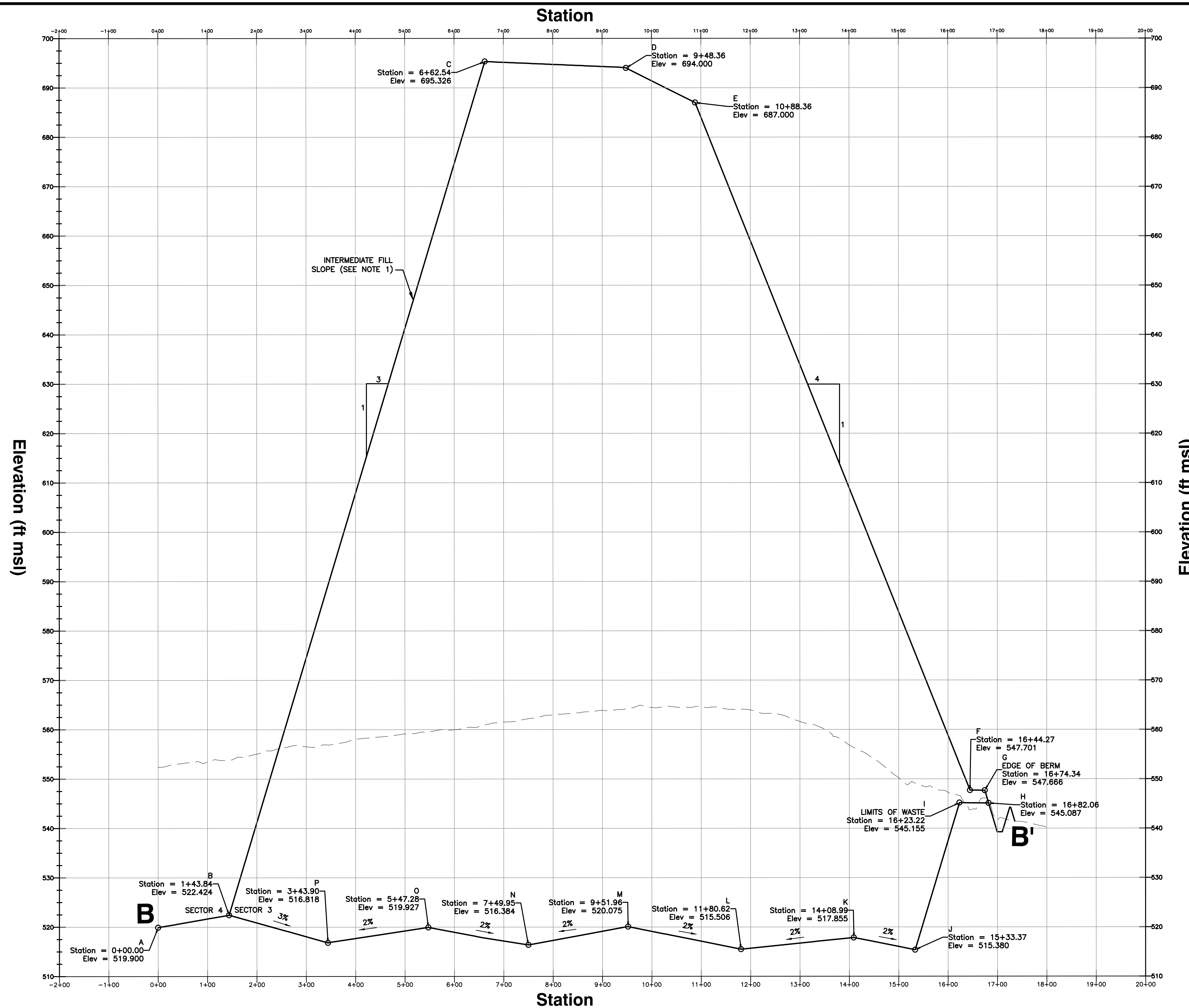
PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 5.3 - 5.8 STABILITY SECTIONS

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.
5.3



NOTE:

1. 3H:1V IS ASSUMED MAXIMUM SLOPE OF THE INTERMEDIATE FILL SLOPES.

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5/13/2020

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REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EAST DISPOSAL AREA
STABILITY CROSS SECTION B-B'

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

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PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

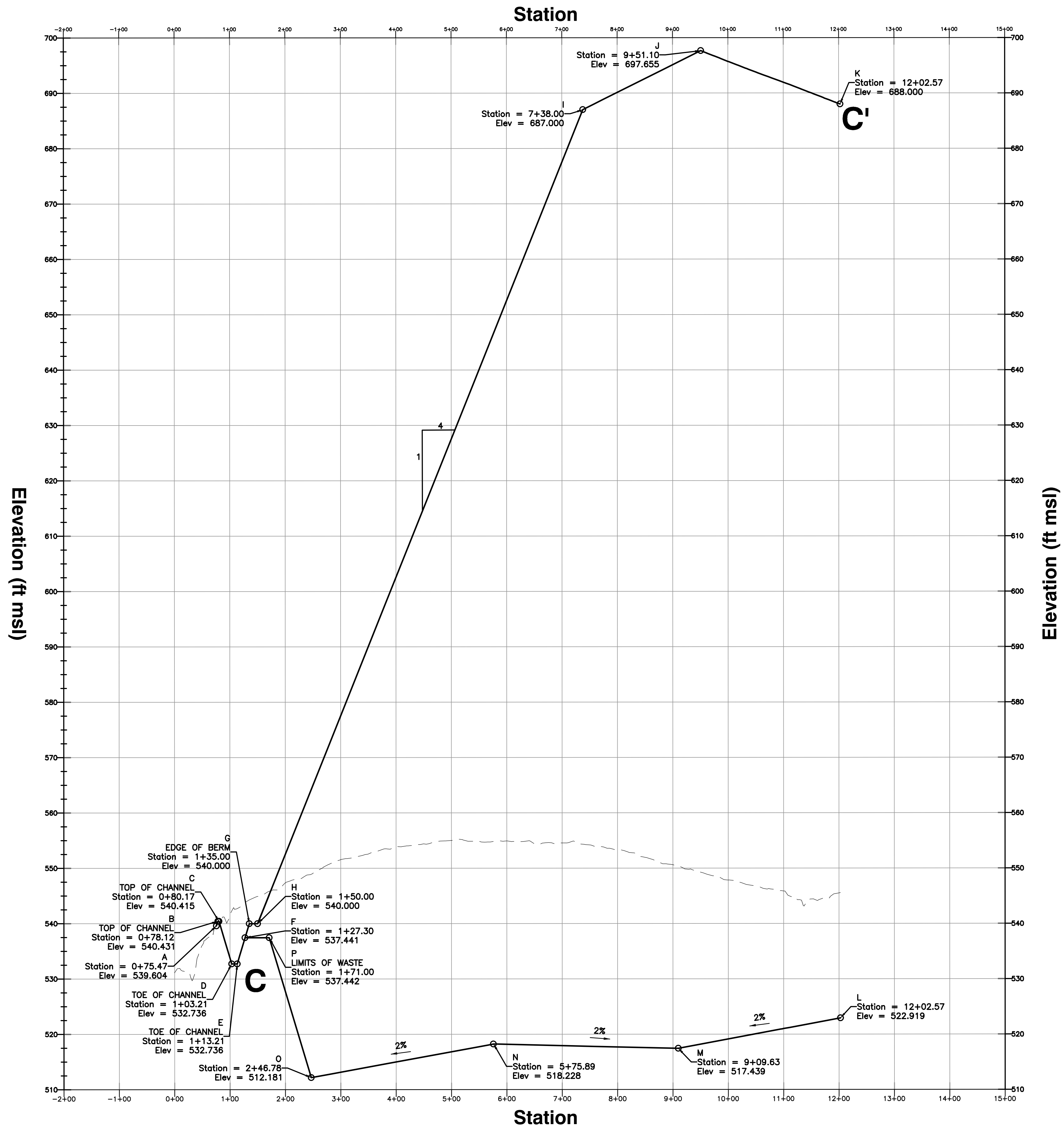
CADD FILE: 5.3 - 5.8 STABILITY SECTIONS

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.

5.4



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5/13/2020

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EAST DISPOSAL AREA
STABILITY CROSS SECTION C-C'

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

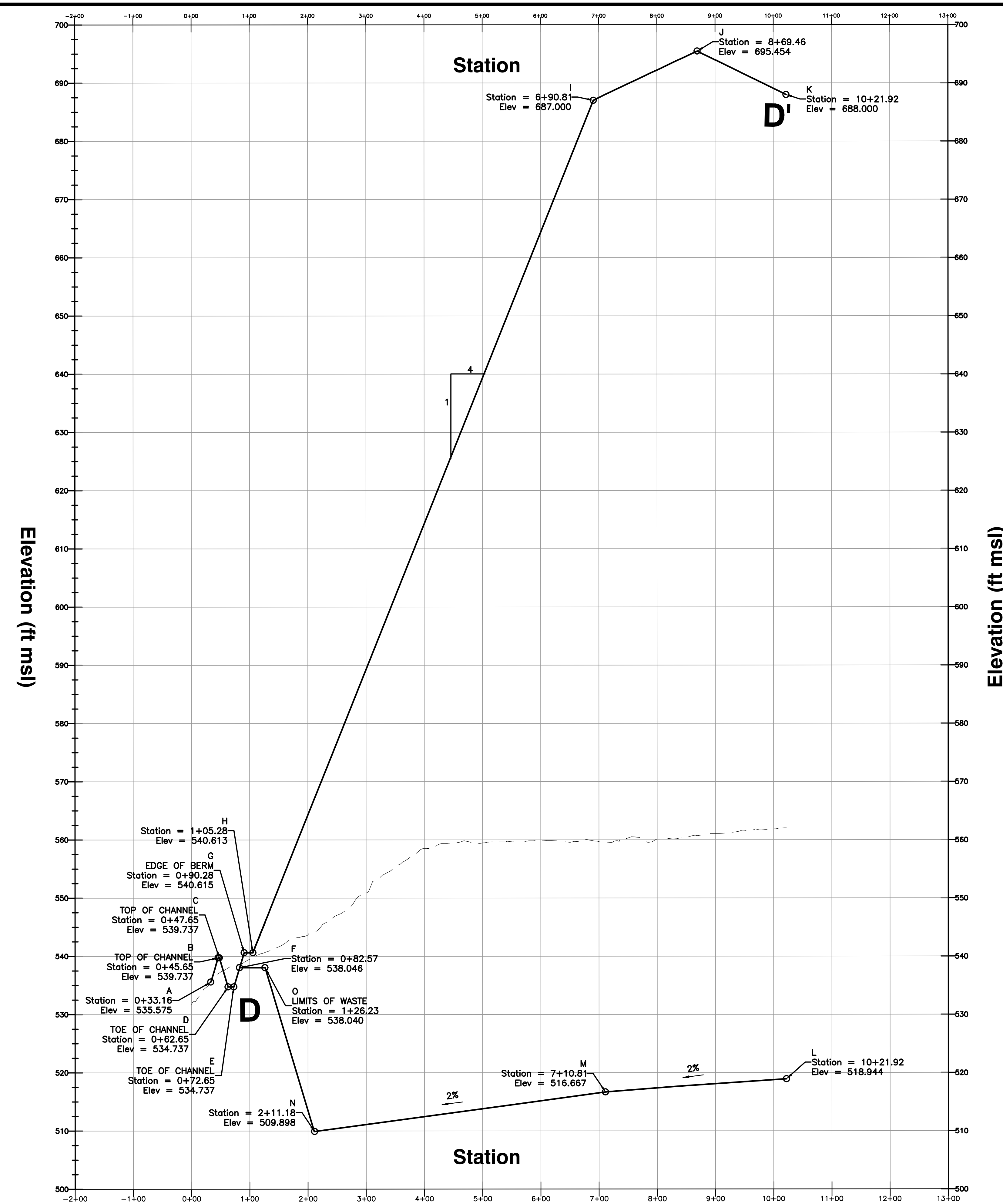
PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

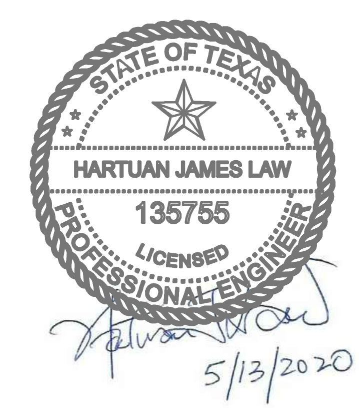
CADD FILE: 5.3 - 5.8 STABILITY SECTIONS

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 5.5





FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EAST DISPOSAL AREA
STABILITY CROSS SECTION D-D'

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

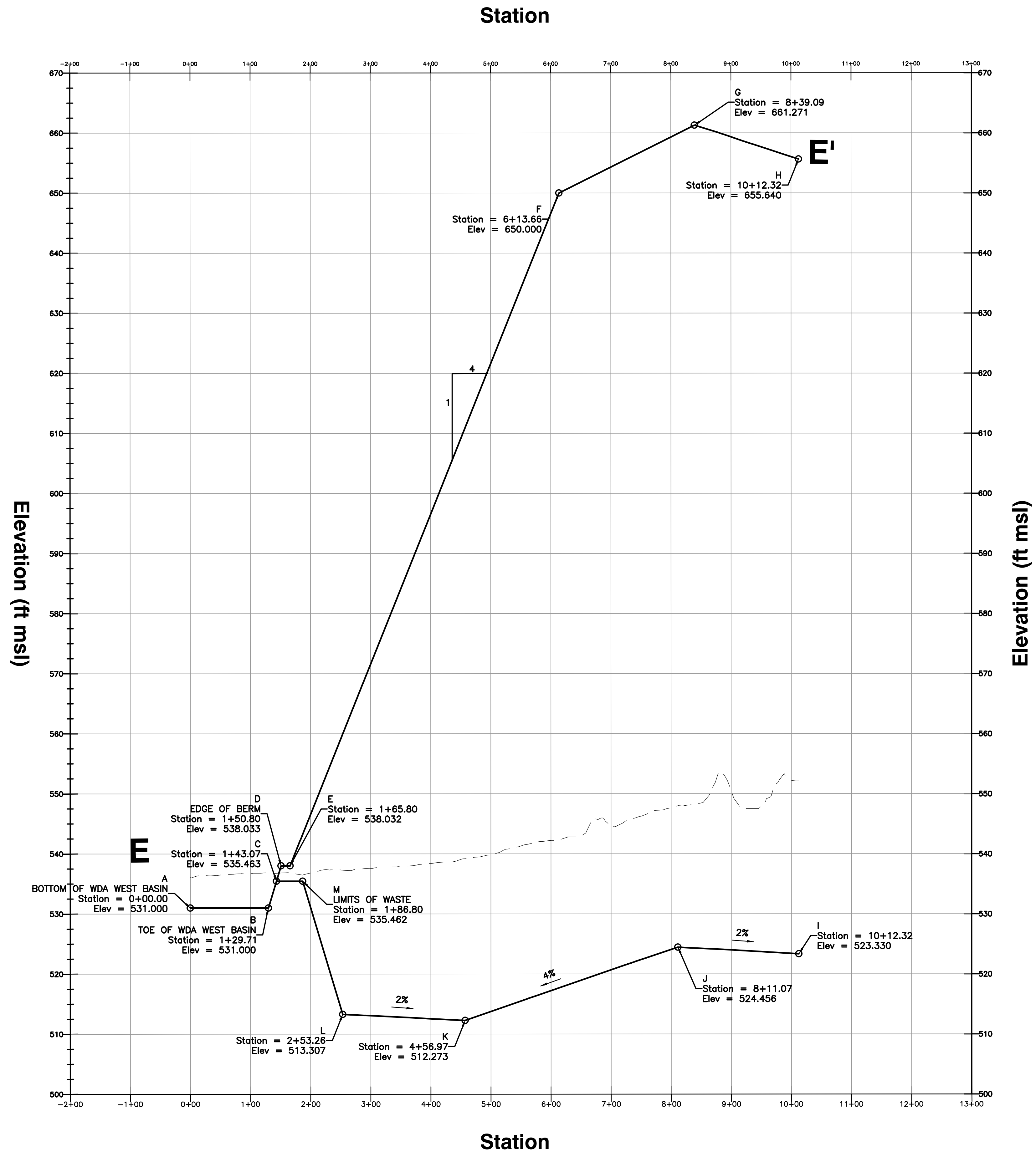
PROJ. NO. 16216088.00
DSN. BY: BC/RRK
DWN. BY: NR
CHK. BY: BJD
Q/A RVW BY: RRK
APP. BY: RRK

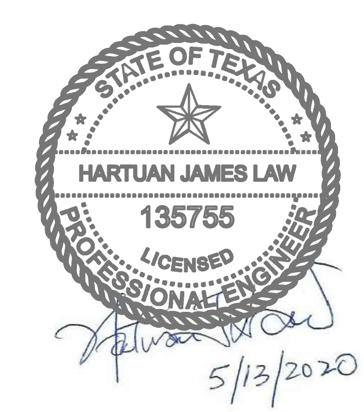
CADD FILE: 5.3 - 5.8 STABILITY SECTIONS

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.
5.6





FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
WEST DISPOSAL AREA
STABILITY CROSS SECTION E-E'

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 5.3 - 5.8 STABILITY SECTIONS

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.
5.7

APPENDIX 5A

SLOPE STABILITY ANALYSES

- Shear Strength Parameters Assumptions
- PCSTABL5M Slope Stability Model Graphical Printouts
- PCSTABL5M Slope Stability Model Computer Outputs

SCS Engineers
TBPE Reg. # F-3407

Inclusive of Pages 5-A-1 to 5-A-126

SHEAR STRENGTH PARAMETERS ASSUMPTIONS

FOUNDATION SOILS

Table 1. Summary of CU Test Results

Area	Sample Identification	Sample Depth (ft)	CU Test Results	
			c (psf)	ϕ (°)
East Disposal Area	B-19	50-51	1,065.6	24.0
West Disposal Area	B-17	25-26	230.4	26.2
West Disposal Area	B-31	15-15.9	792.0	25.9
West Disposal Area	B-24	45-46	1,440.0	34.0
West Disposal Area	B-44	50-51.5	72.0	19.2
		Minimum	77.5	19.2
		Average	720.0	25.9

Table 2. Estimated Drained Friction Angle

Area	Sample Identification	Sample Depth (ft)	PI [1]	ϕ (°)
East Disposal Area	B-19	50-51	40	27.0
West Disposal Area	B-17	25-26	45	26.2
West Disposal Area	B-31	15-15.9		
West Disposal Area	B-24	45-46		
West Disposal Area	B-44	50-51.5		
Foundation Soils	N/A	N/A	42	26.7

[1] Average Plasticity index (PI) of East Disposal Area samples, West Disposal Area samples, and overall foundation soils.

Available SPTs from East Disposal Area > 30 (stiff to very stiff clays). Indicative of the clay being over consolidated. To be conservative, stability analyses were performed assuming the clay is normally consolidated. (Over consolidated clays tend to have higher shear strengths than normally consolidated clays.)
For drained analysis (long-term), effective friction angle was estimated based on the plasticity index (PI) using the following relationship (EPRI, 1990):

$\sin\phi' = 0.8 - 0.094 \ln(PI)$; for foundation soils: Average PI = 42 and ϕ'=26 .7 degrees

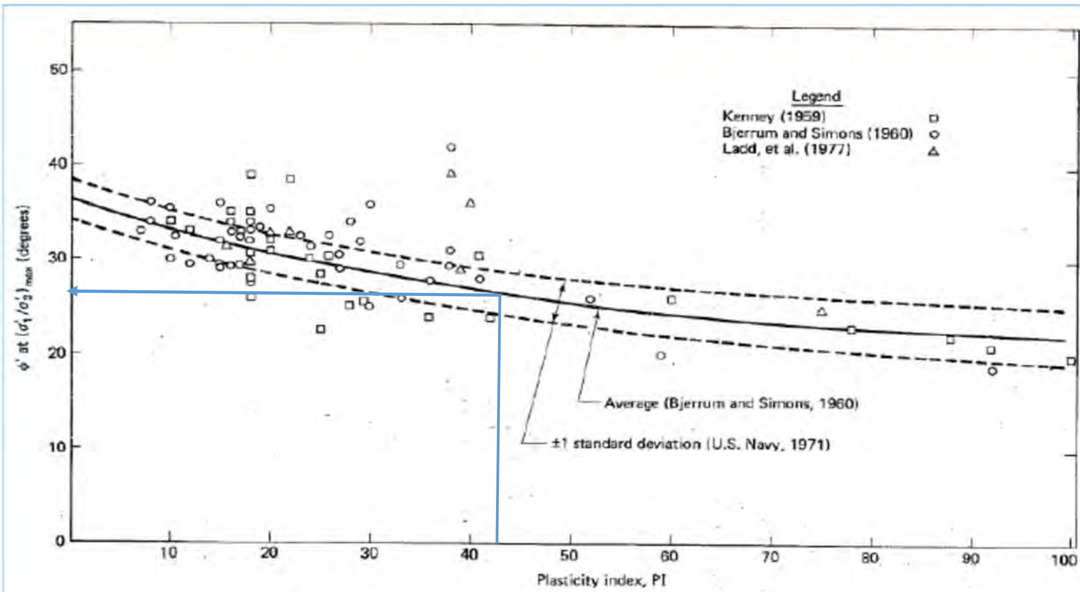


Fig. 11.27 Empirical correlation between ϕ' and PI from triaxial compression tests on normally consolidated undisturbed clays (after U.S. Navy, 1971, and Ladd, et al., 1977).

Based on Tables 1 and 2, the following shear strength parameters are estimated for foundation soils (drained conditions):

ϕ'=25°

To be conservative, cohesion will assumed to be zero for interim and long-term stability analyses.

Foundation Soils - Shear Strength Parameters
Undrained - Short-term Stability

$$\boxed{c = \frac{q_u}{2}}$$

where:
c = cohesion, undrained shear strength (s_u) (psf)

Table 1. Summary of Unconfined Compression Strength (q_u) Test Results

Area	Sample	Depth	q_u (tsf)	q_u (psf)	c (psf)
West Disposal Area	B-24	5-7	14.94	29,880	14,940
	B-24	15-17	7.94	15,880	**7,940**
	B-17	15-17	8.09	16,180	**8,090**
	B-9	20-22	12.32	24,640	12,320
	B-16	25-27	17.76	35,520	17,760
	B-31	30-32	5.37	10,740	**5,370**
	B-44	30-32	4.44	8,880	**4,440**
	B-17	45-47	23.36	46,720	23,360
East Disposal Area	B-18	10-12	4.26	8,520	**4,260**
	B-43	10-12	7.12	14,240	**7,120**
	B-45	25-27	6.21	12,420	**6,210**
	B-21	30-32	10.49	20,980	10,490
	B-8	40-42	4.02	8,040	**4,020**
	B-18	45-47	3.59	7,180	**3,590**
	B-20	45-47	18.68	37,360	18,680
	B-15	55-57	1.61	3,220	**1,610**
	B-20	55-57	16.82	33,640	16,820
	B-19	70-72	16.29	32,580	16,290
Average of 10 Lowest Cohesion Values					5,265

1. 1 tsf=2,000 psf

Average of 10 Lowest Cohesion Values: 5,265 psf
Conservatively, c=4,000 psf will be used for foundation soils for excavation stability analyses.

Available SPTs from East Disposal Area > 30 (stiff to very stiff clays).
Assumed cohesion value is consistent with literature values reported for hard clays:

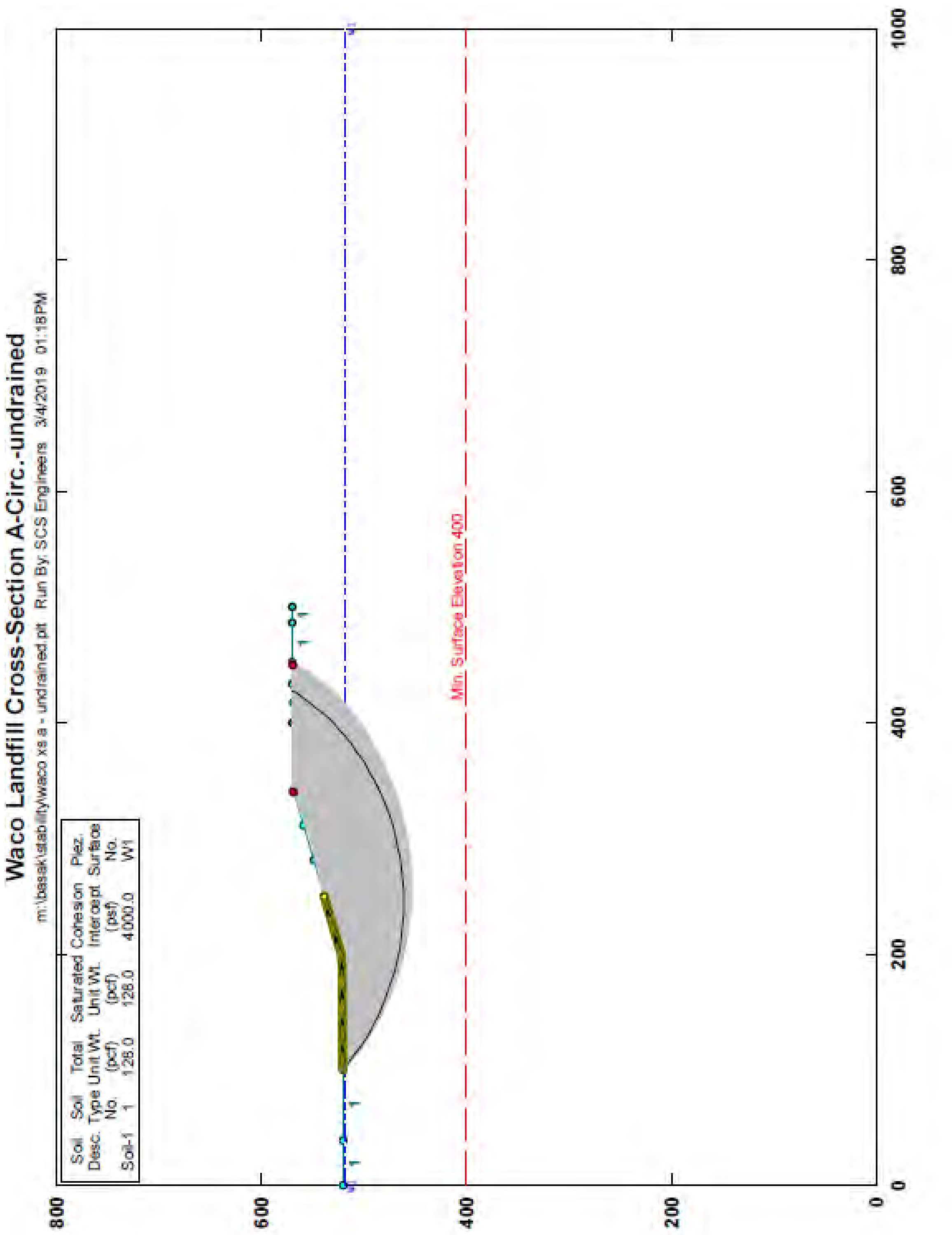
hard clays: q_u > 4 tsf (c > 4,000 psf) (Das, 2002)

PCSTABL5M SLOPE STABILITY MODEL

GRAPHICAL PRINTOUTS

SECTION AA′

Circular Failure Mode (Excavation, Undrained)


Waco Landfill Cross-Section A-Circ.-undrained
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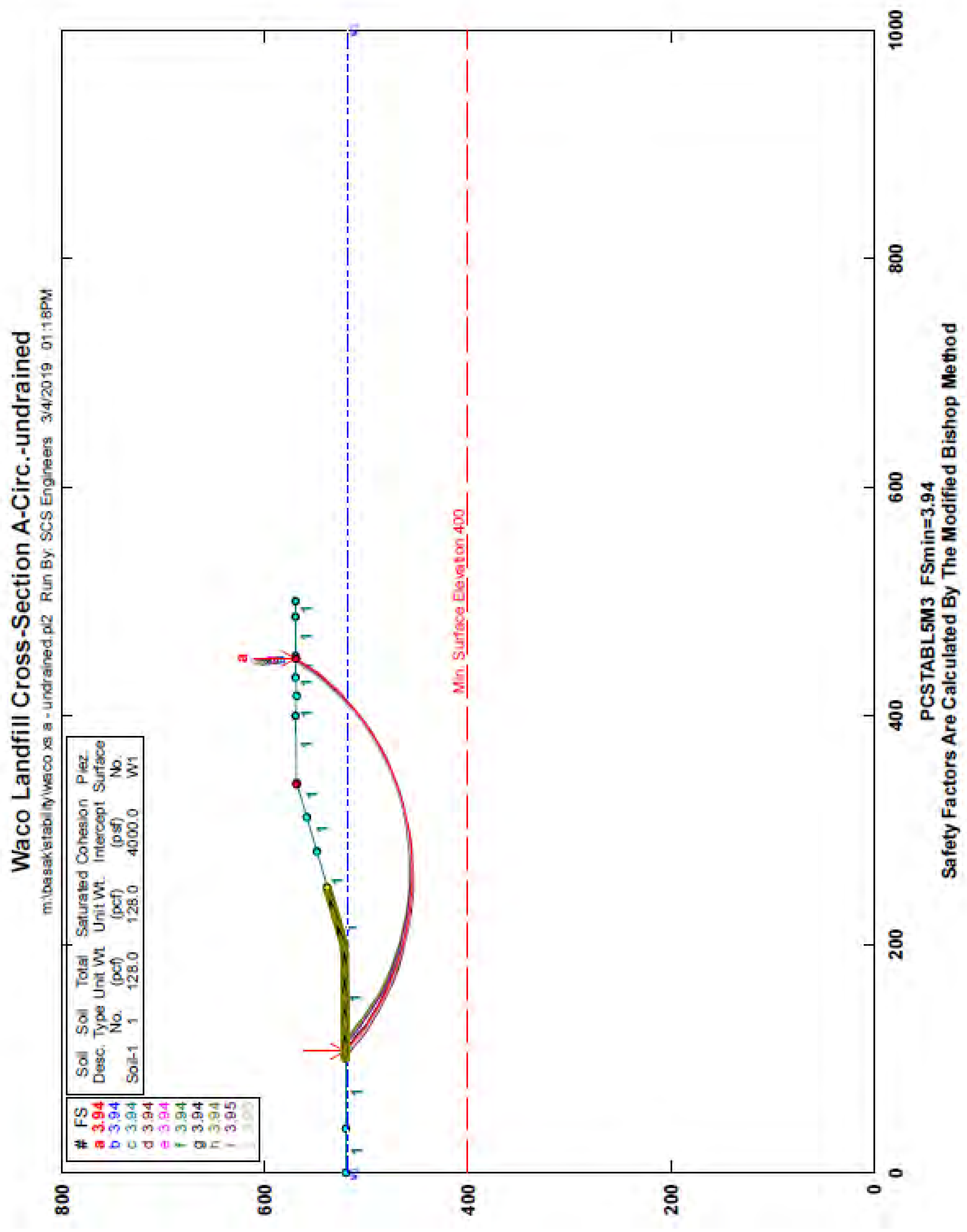
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Piez. Surface No.
Soil-1 | 1 | 128.0 | 128.0 | 4000.0 | W1
Min. Surface Elevation 400
0
200
400
600
800
1000


Waco Landfill Cross-Section A-Circ.-undrained
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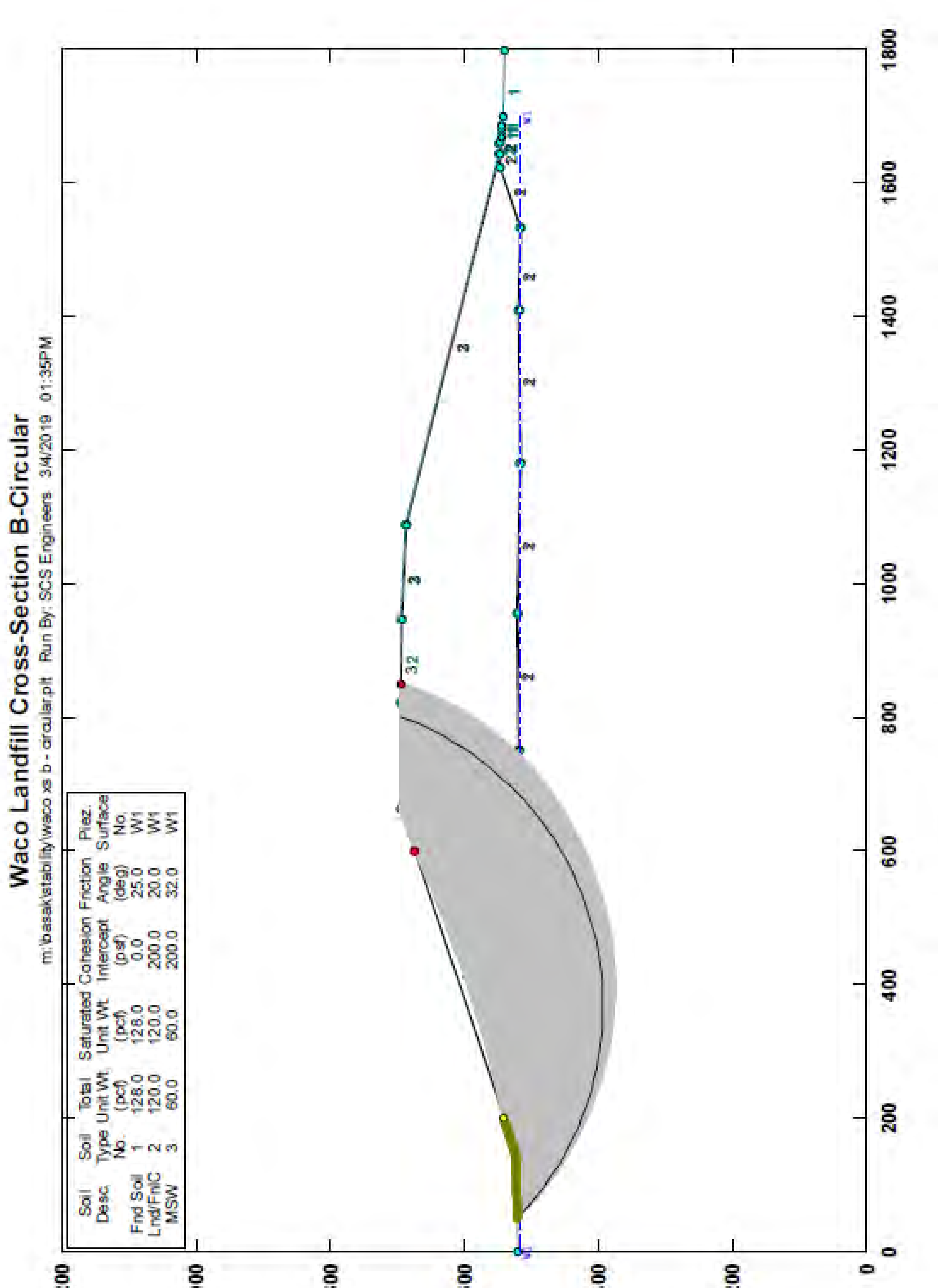
FS
a 3.94
b 3.94
c 3.94
d 3.94
e 3.94
f 3.94
g 3.94
h 3.94
i 3.95
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Piez. Surface No.
Soil-1 | 1 | 128.0 | 128.0 | 4000.0 | W1
a
Min. Surface Elevation 400
0
200
400
600
800
1000
PCSTABL5M3 FSmin=3.94
Safety Factors Are Calculated By The Modified Bishop Method

SECTION BB′

Circular Failure Surface (Interim Conditions)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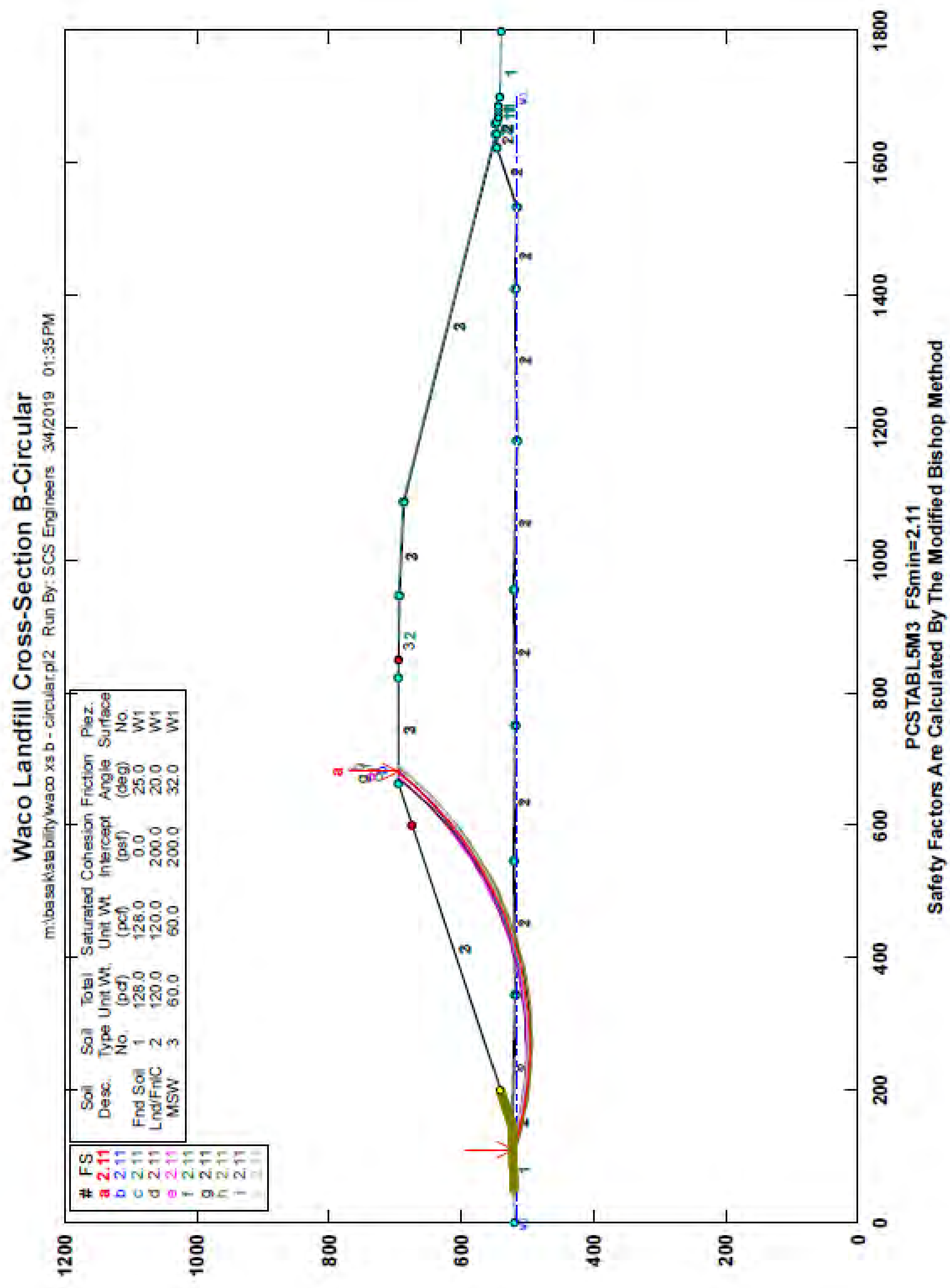
Soil Desc.
Soil Type No.
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
1600
1800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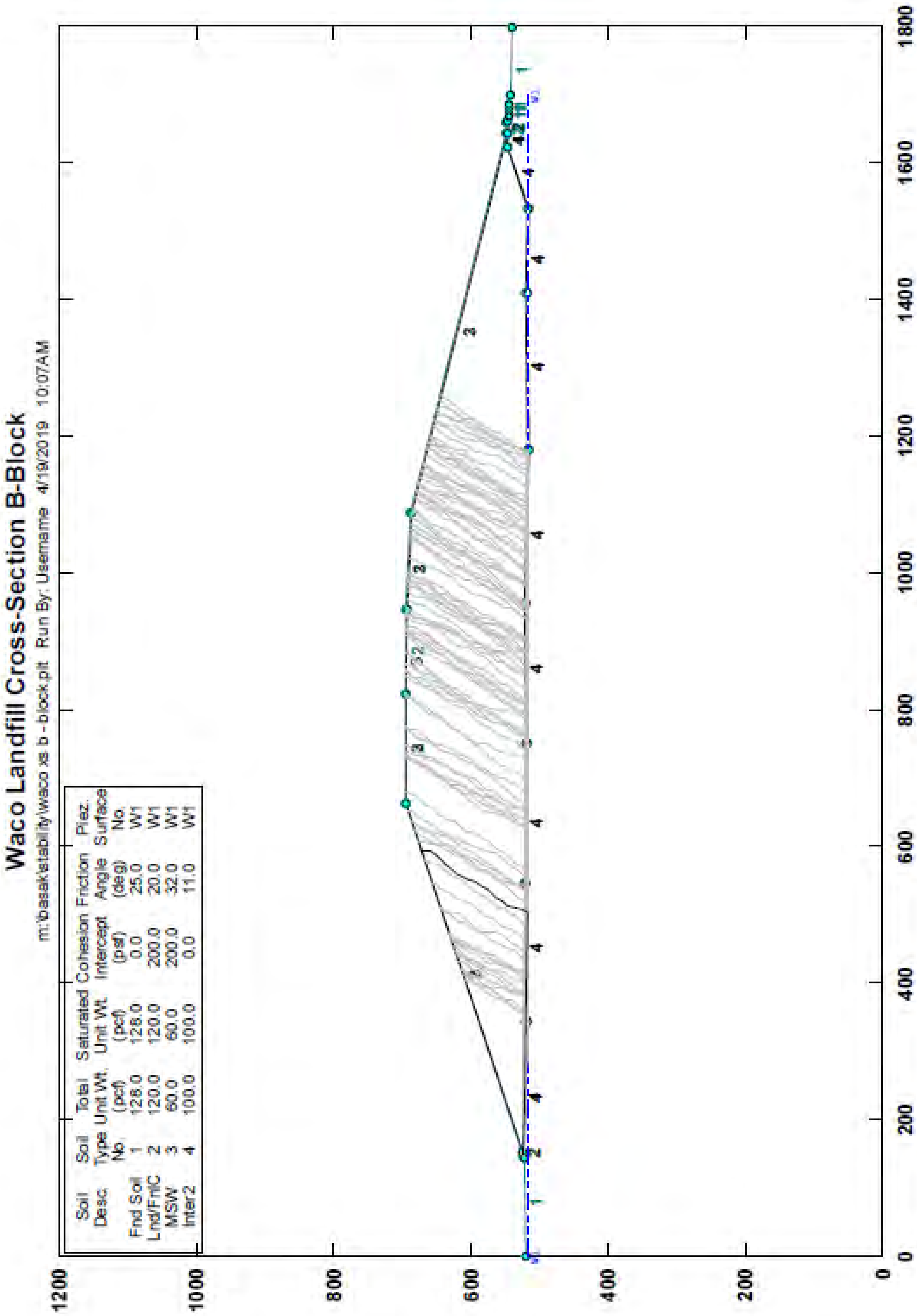
FS
a 2.11
b 2.11
c 2.11
d 2.11
e 2.11
f 2.11
g 2.11
h 2.11
i 2.11
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil | 1 | 128.0 | 128.0 | 0.0 | 25.0 | W1
Lnd/FnlC | 2 | 120.0 | 120.0 | 200.0 | 20.0 | W1
MSW | 3 | 60.0 | 60.0 | 200.0 | 32.0 | W1
PCSTABL5M3 FSmin=2.11
Safety Factors Are Calculated By The Modified Bishop Method

SECTION BB′

Block Failure Surface (Interim Conditions)


Waco Landfill Cross-Section B-Block
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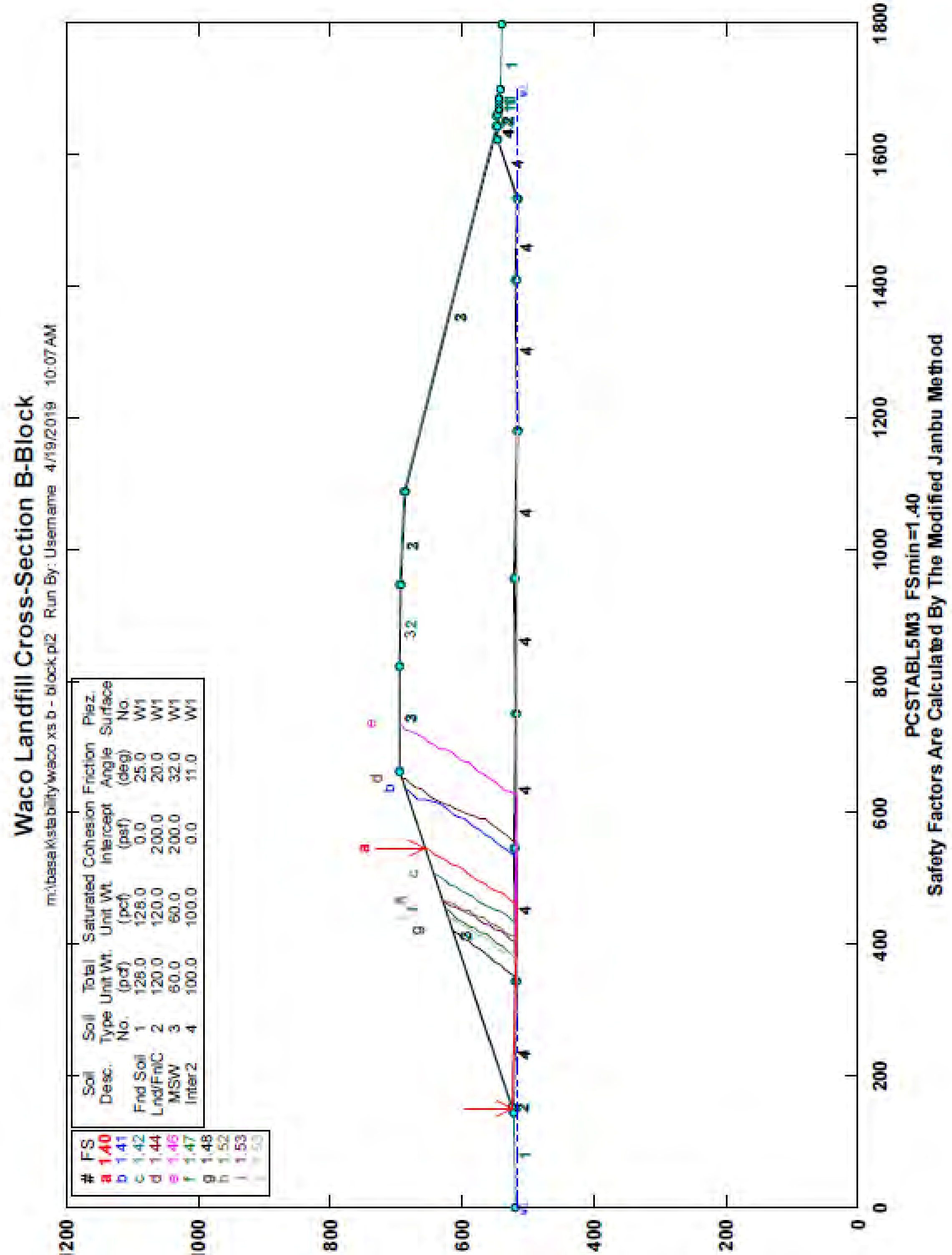
Soil Desc. | Soil Type No | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil | 1 | 128.0 | 128.0 | 0.0 | 25.0 | W1
Lnd/FnlC | 2 | 120.0 | 120.0 | 200.0 | 20.0 | W1
MSW | 3 | 60.0 | 60.0 | 200.0 | 32.0 | W1
Inter2 | 4 | 100.0 | 100.0 | 0.0 | 11.0 | W1
0
200
400
600
800
1000
1200
1400
1600
1800


Waco Landfill Cross-Section B-Block
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FS
a 1.40
b 1.41
c 1.42
d 1.44
e 1.46
f 1.47
g 1.48
h 1.52
i 1.53
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
Inter2 4 100.0 100.0 0.0 11.0 W1
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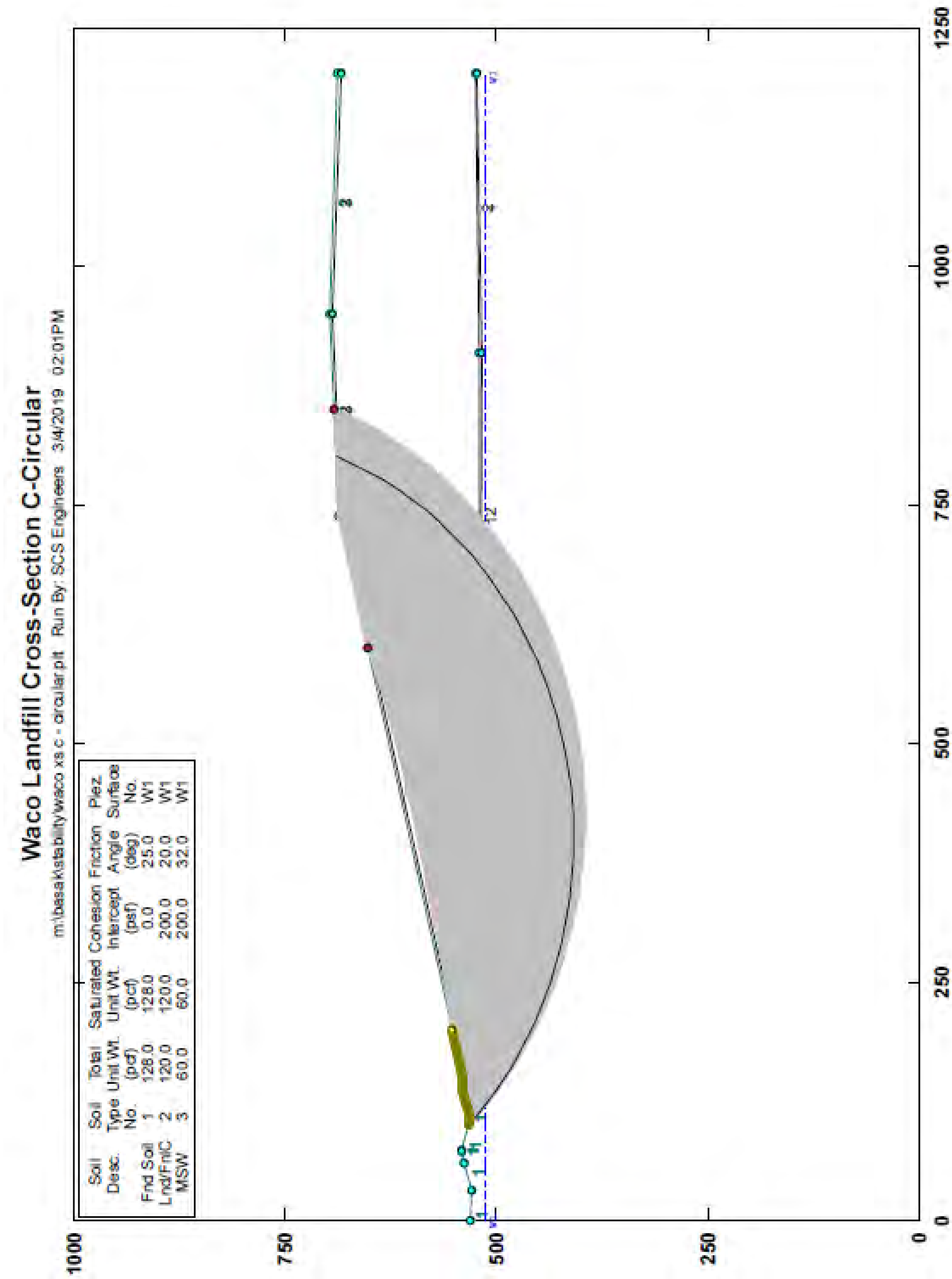
Safety Factors Are Calculated By The Modified Janbu Method

SECTION CC′

Circular Failure Surface (Final Conditions)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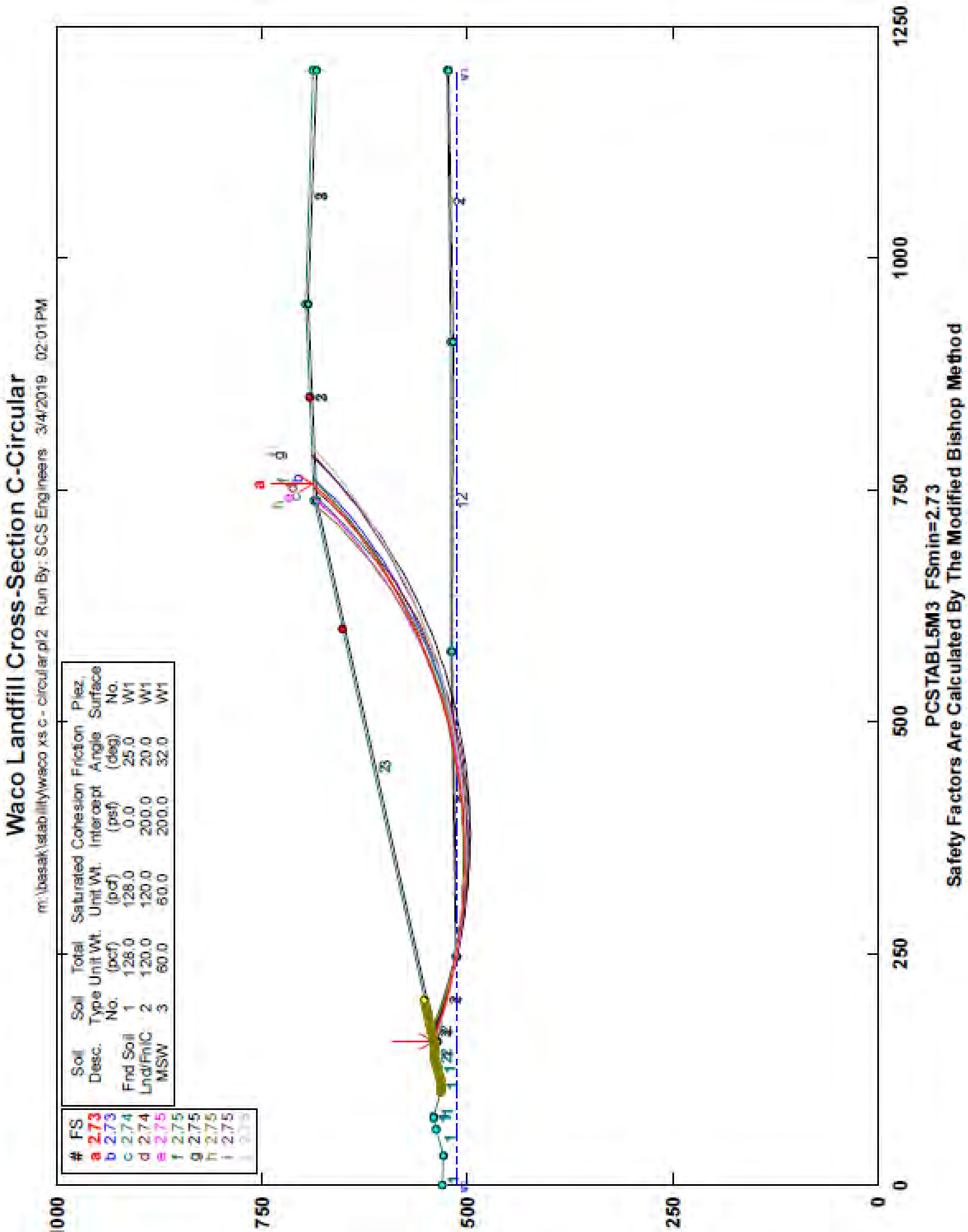
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil | 1 | 128.0 | 128.0 | 0.0 | 25.0 | W1
Lnd/FnlC | 2 | 120.0 | 120.0 | 200.0 | 20.0 | W1
MSW | 3 | 60.0 | 60.0 | 200.0 | 32.0 | W1
0
250
500
750
1000
1250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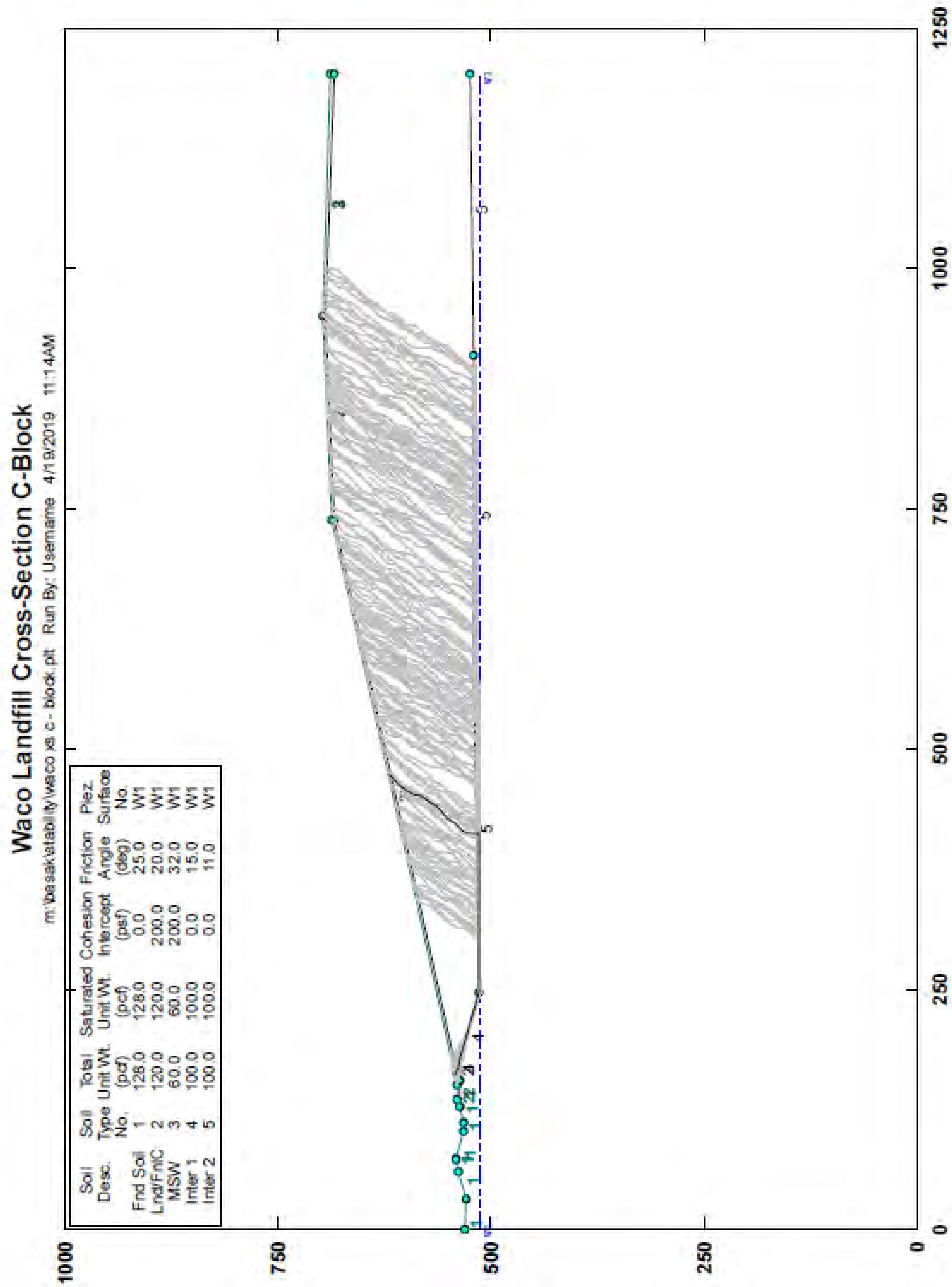
Safety Factors Are Calculated By The Modified Bishop Method

SECTION CC′

Block Failure Surface (Final Conditions)


Waco Landfill Cross-Section C-Block
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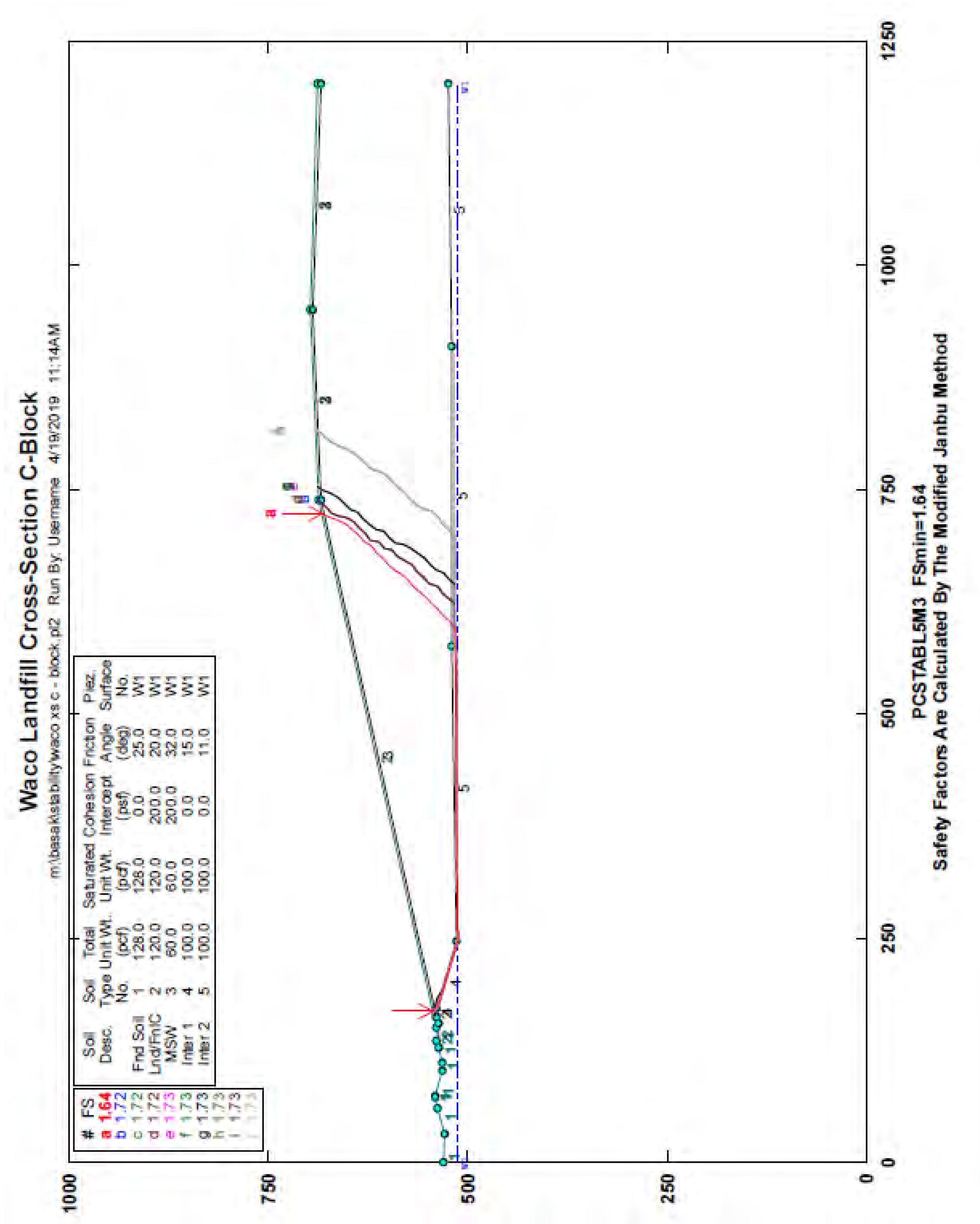
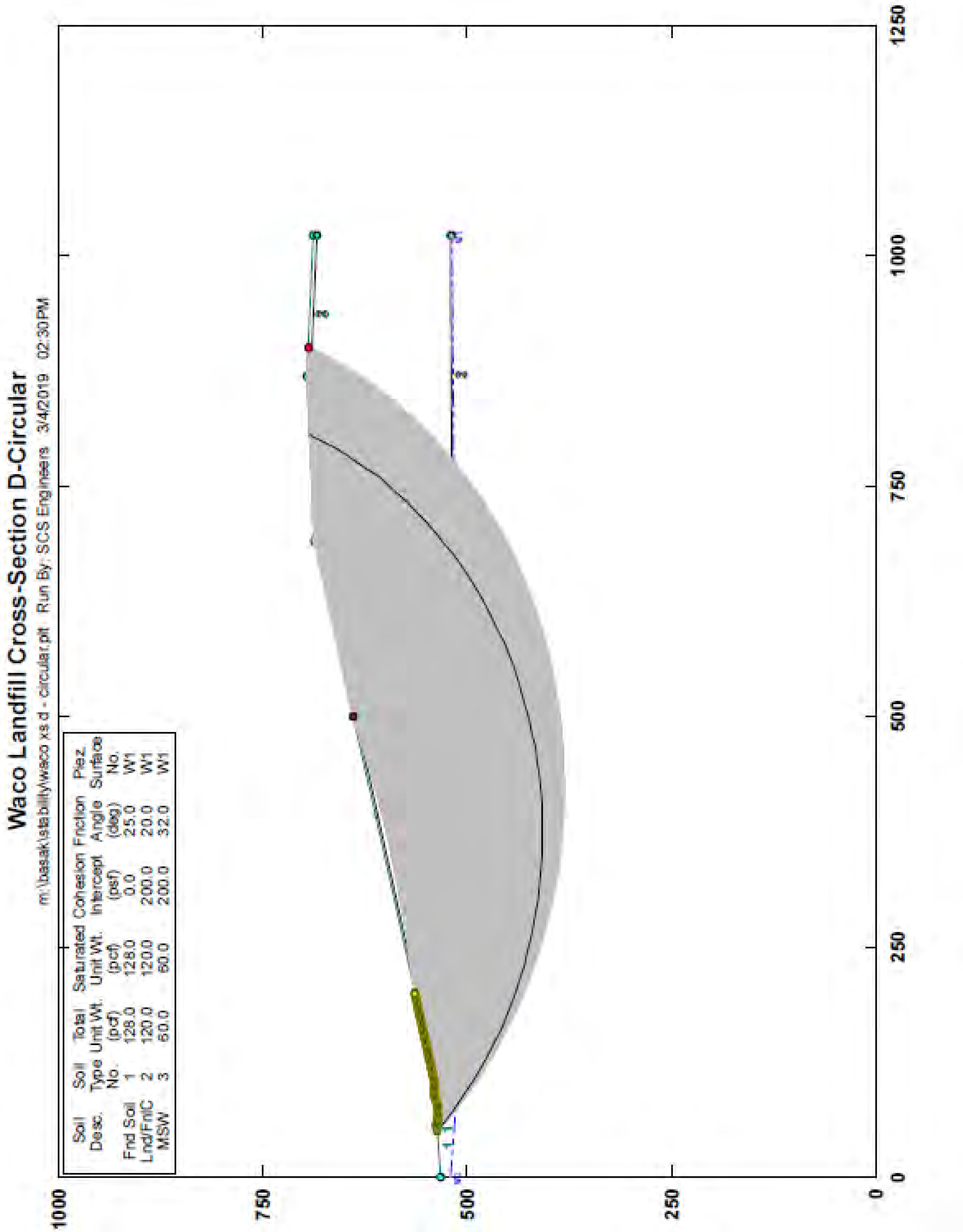
Soil Desc.
Soil Type No.
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
Inter 1 4 100.0 100.0 0.0 15.0 W1
Inter 2 5 100.0 100.0 0.0 11.0 W1
1000
750
500
250
0
0
250
500
750
1000
1250


Waco Landfill Cross-Section C-Block
m:\basak\stability\waco xs c - block.pl2 Run By: Username 4/19/2019 11:14AM
FS
a 1.64
b 1.72
c 1.72
d 1.72
e 1.73
f 1.73
g 1.73
h 1.73
i 1.73
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
Inter 1 4 100.0 100.0 0.0 15.0 W1
Inter 2 5 100.0 100.0 0.0 11.0 W1
1000
750
500
250
0
0
250
500
750
1000
1250
PCSTABL5M3 FSmin=1.64
Safety Factors Are Calculated By The Modified Janbu Method

SECTION DD′

Circular Failure Surface (Final Conditions)


Waco Landfill Cross-Section D-Circular
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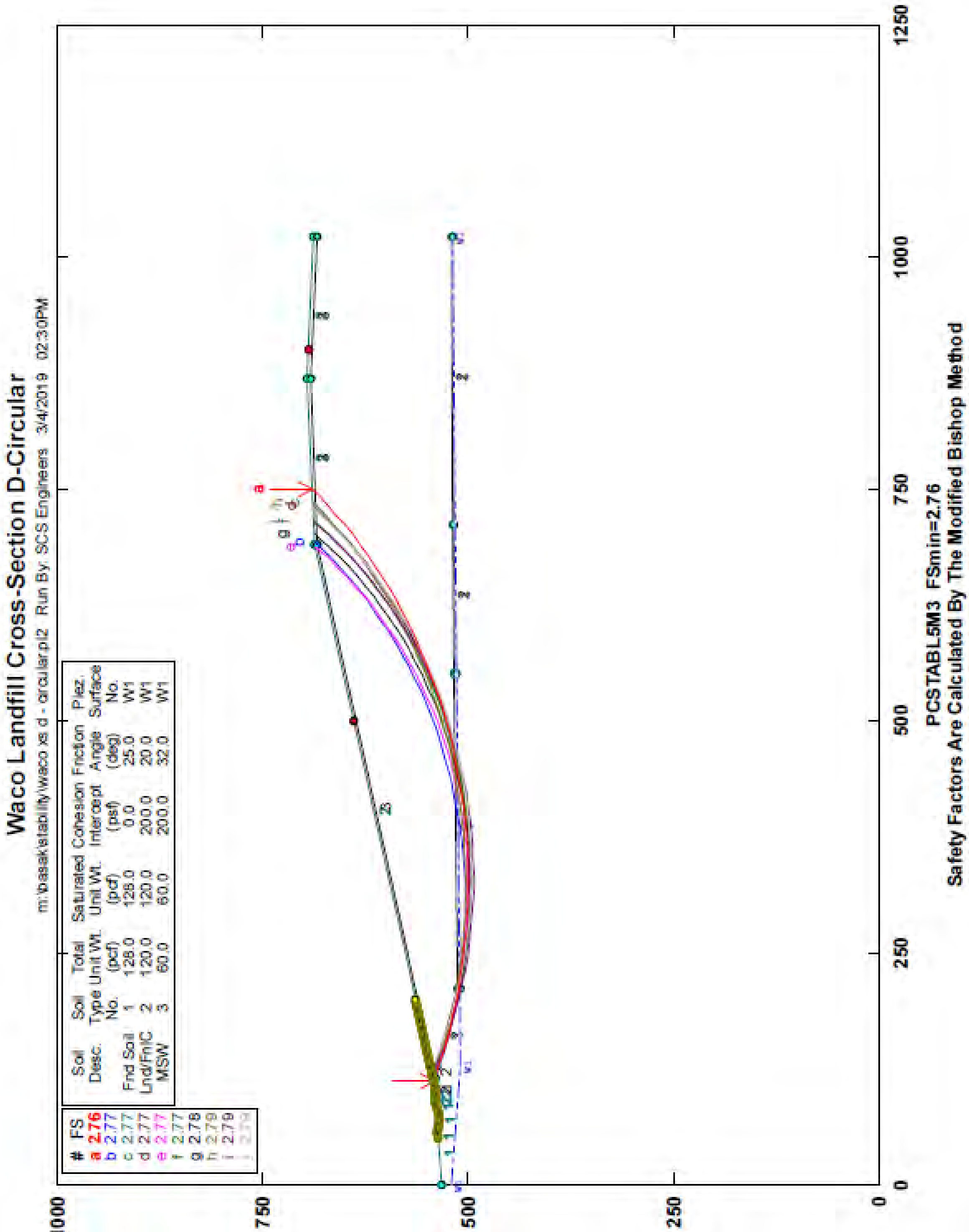
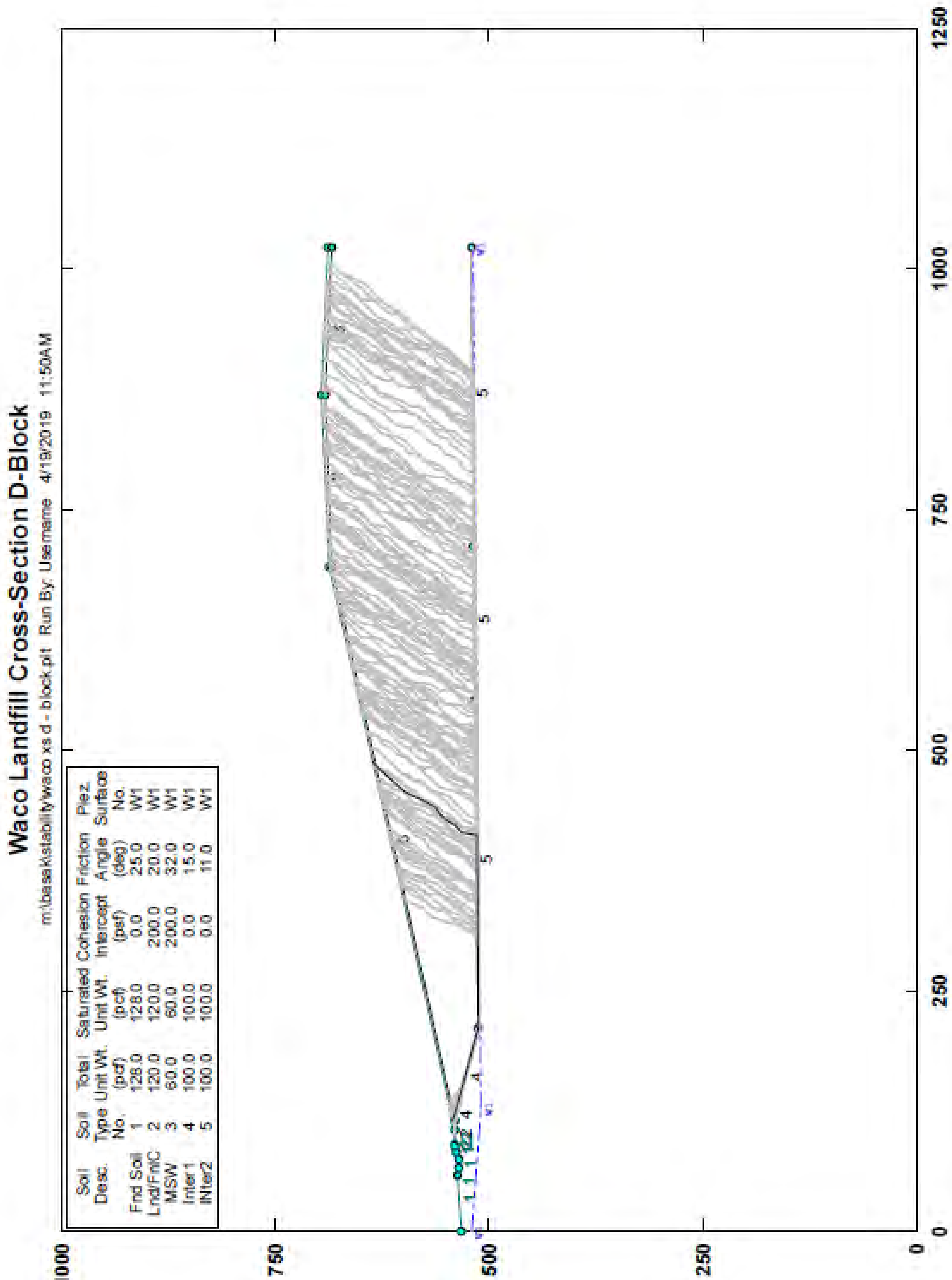
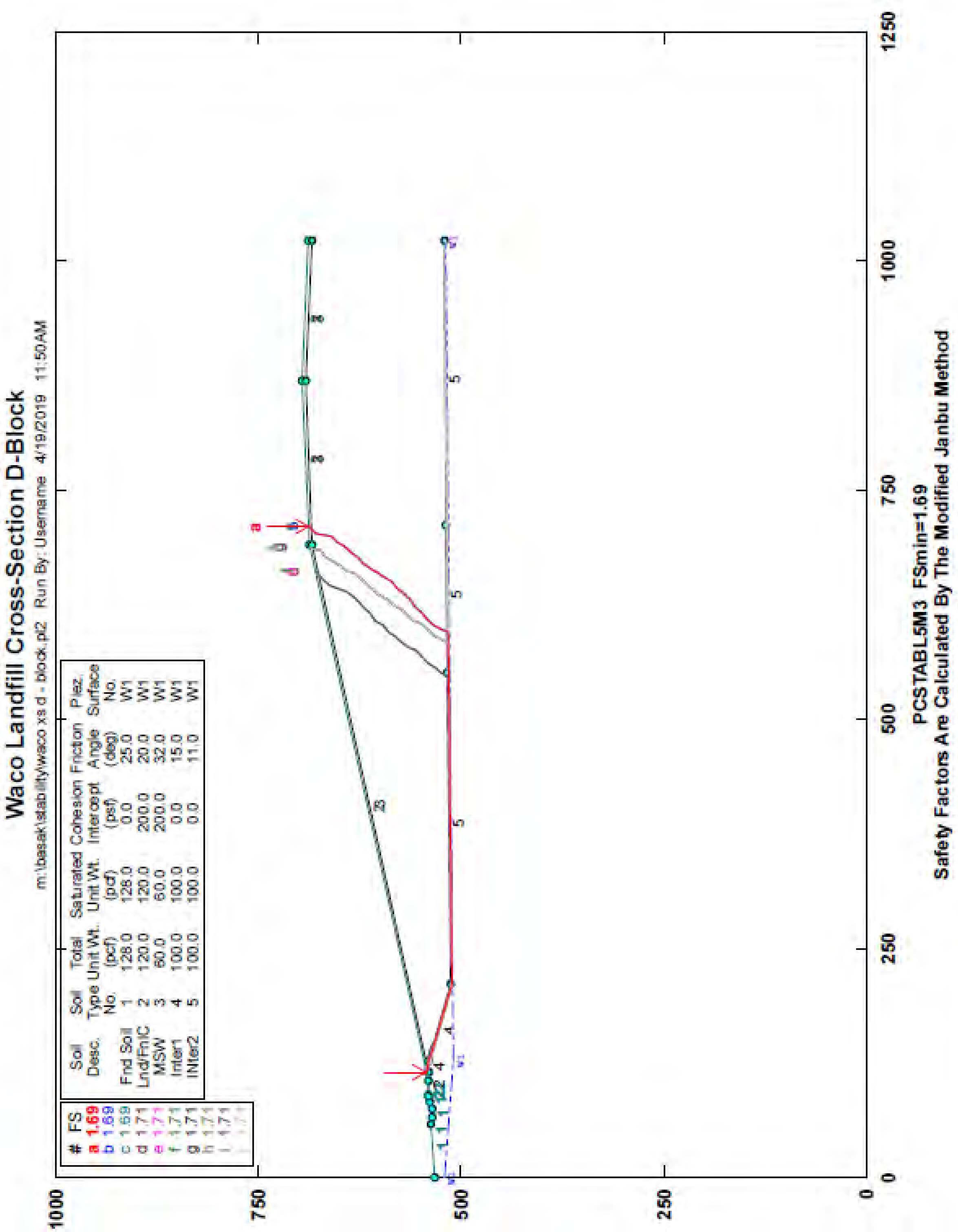
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
1000
750
500
250
0
0
250
500
750
1000
1250


Waco Landfill Cross-Section D-Circular
m:\basak\stability\waco xs d - circular.pl2 Run By: SCS Engineers 3/4/2019 02:30PM
FS
a 2.76
b 2.77
c 2.77
d 2.77
e 2.77
f 2.77
g 2.78
h 2.79
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
PCSTABL5M3 FSmin=2.76
Safety Factors Are Calculated By The Modified Bishop Method

SECTION DD′

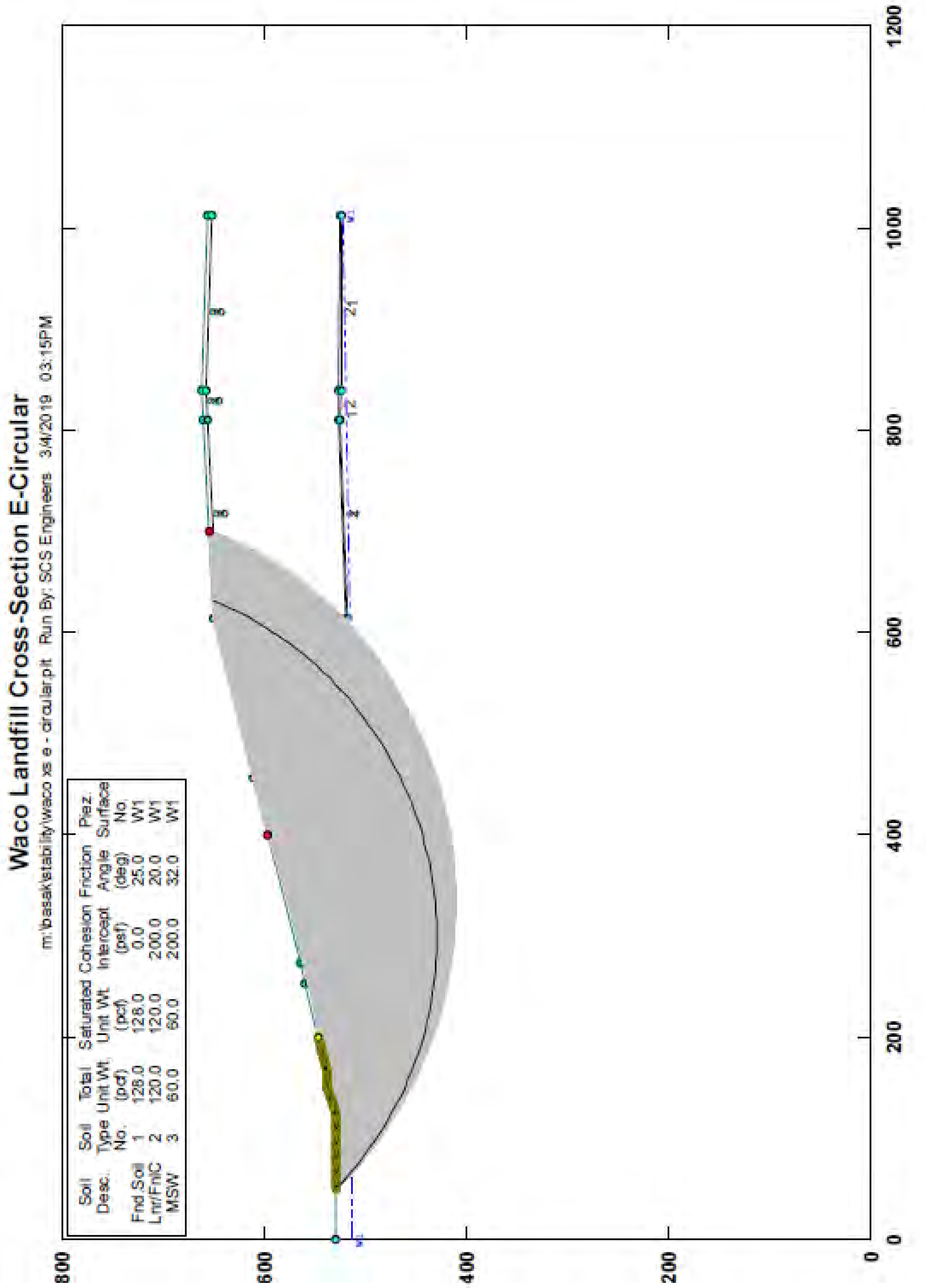
Block Failure Surface (Final Conditions)

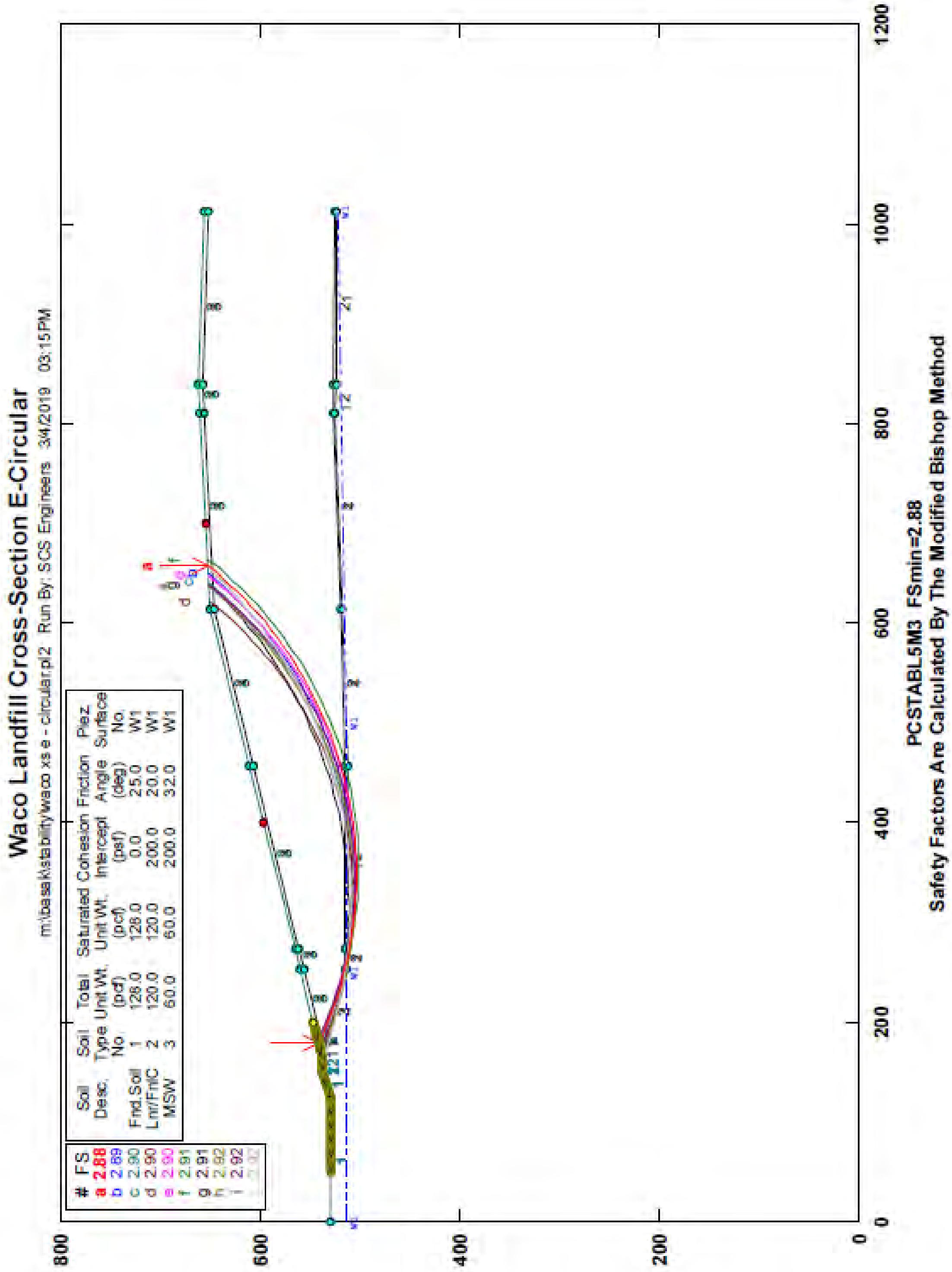

Waco Landfill Cross-Section D-Block
m:\basak\stability\waco xs d - block.pl Run By: Username 4/19/2019 11:50AM
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
Inter1 4 100.0 100.0 0.0 15.0 W1
INter2 5 100.0 100.0 0.0 11.0 W1
0
250
500
750
1000
1250


Waco Landfill Cross-Section D-Block
m:\basak\stability\waco xs d - block.pl2 Run By: Username 4/19/2019 11:50AM
FS
a 1.69
b 1.69
c 1.69
d 1.71
e 1.71
f 1.71
g 1.71
h 1.71
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil 1 128.0 128.0 0.0 25.0 W1
Lnd/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
Inter1 4 100.0 100.0 0.0 15.0 W1
INter2 5 100.0 100.0 0.0 11.0 W1
1000
750
500
250
0
0
250
500
750
1000
1250
PCSTABL5M3 FSmin=1.69
Safety Factors Are Calculated By The Modified Janbu Method

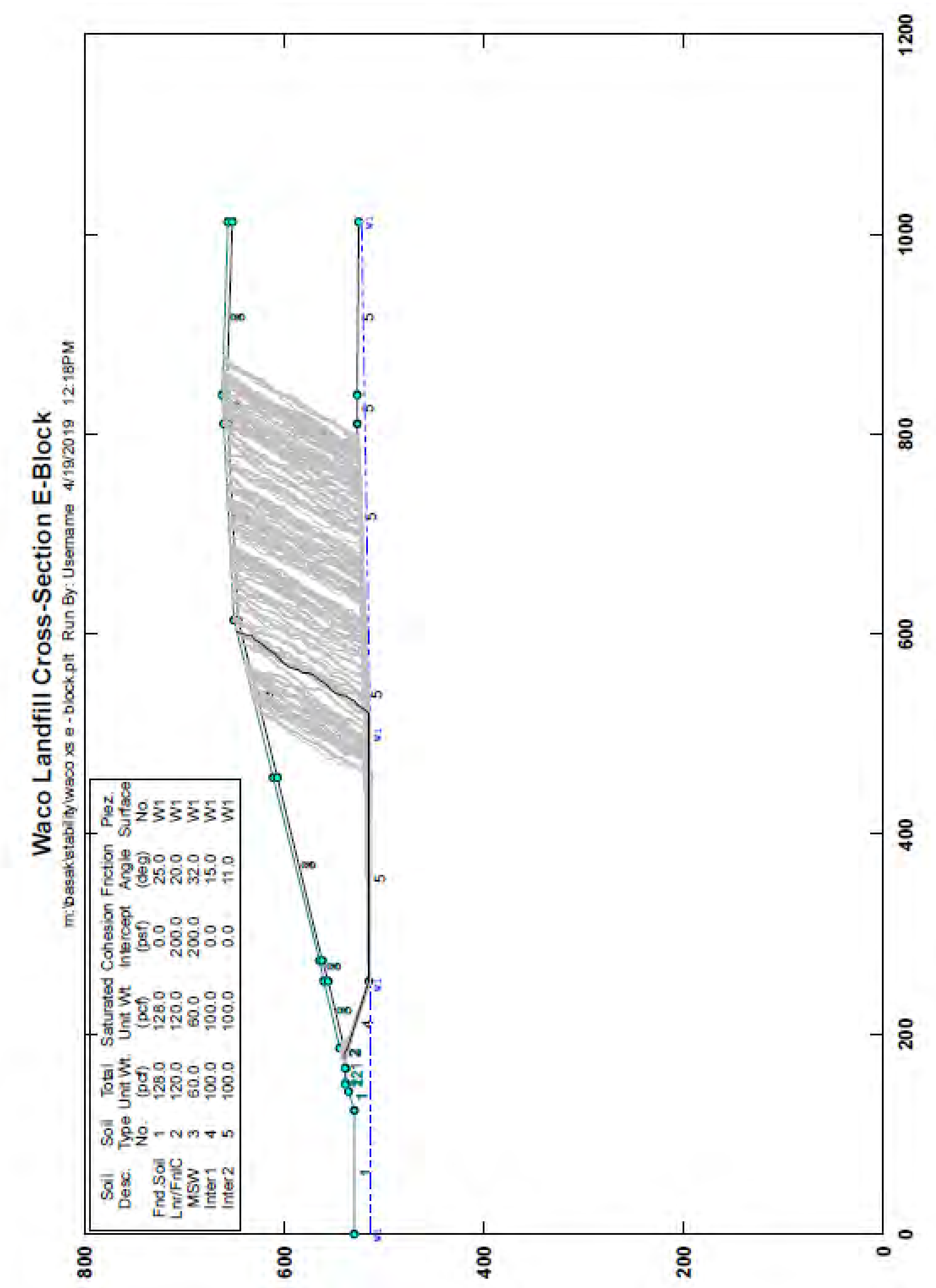
SECTION EE′

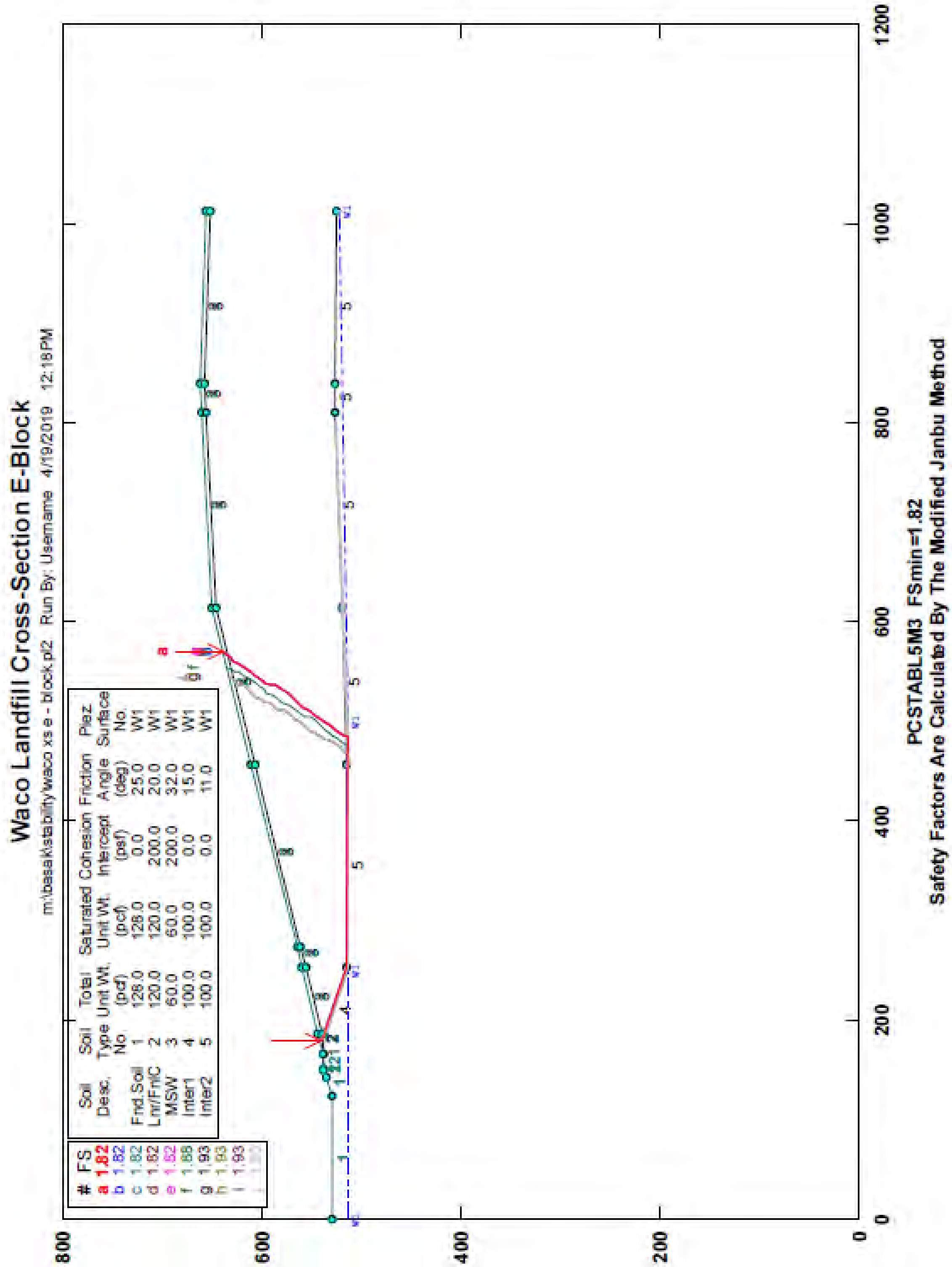
Circular Failure Surface (Final Conditions)


Waco Landfill Cross-Section E-Circular
m:\basak\stability\waco xs e - circular.plt Run By: SCS Engineers 3/4/2019 03:15PM
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil | 1 | 128.0 | 128.0 | 0.0 | 25.0 | W1
Lnr/FnlC | 2 | 120.0 | 120.0 | 200.0 | 20.0 | W1
MSW | 3 | 60.0 | 60.0 | 200.0 | 32.0 | W1
0
200
400
600
800
1000
1200


Waco Landfill Cross-Section E-Circular
m:\basak\stability\waco xs e - circular.pl2 Run By: SCS Engineers 3/4/2019 03:15PM
FS
a 2.88
b 2.89
c 2.90
d 2.90
e 2.90
f 2.91
g 2.91
h 2.92
i 2.92
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
Fnd.Soil 1 128.0 128.0 0.0 25.0 W1
Lnr/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
PCSTABL5M3 FSmin=2.88
Safety Factors Are Calculated By The Modified Bishop Method

SECTION EE′
Block Failure Surface (Final Conditions)


Waco Landfill Cross-Section E-Block
m:\basak\stability\waco xs e - block.plt Run By: Username 4/19/2019 12:18PM
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd Soil | 1 | 128.0 | 128.0 | 0.0 | 25.0 | W1
Lnr/FnlC | 2 | 120.0 | 120.0 | 200.0 | 20.0 | W1
MSW | 3 | 60.0 | 60.0 | 200.0 | 32.0 | W1
Inter1 | 4 | 100.0 | 100.0 | 0.0 | 15.0 | W1
Inter2 | 5 | 100.0 | 100.0 | 0.0 | 11.0 | W1
0
200
400
600
800
1000
1200


Waco Landfill Cross-Section E-Block
m:\basak\stability\waco xs e - block.pl2 Run By: Username 4/19/2019 12:18PM
FS
a 1.82
b 1.82
c 1.82
d 1.82
e 1.82
f 1.88
g 1.93
h 1.93
i 1.93
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fnd.Soil 1 128.0 128.0 0.0 25.0 W1
Lnr/FnlC 2 120.0 120.0 200.0 20.0 W1
MSW 3 60.0 60.0 200.0 32.0 W1
Inter1 4 100.0 100.0 0.0 15.0 W1
Inter2 5 100.0 100.0 0.0 11.0 W1
PCSTABL5M3 FSmin=1.82
Safety Factors Are Calculated By The Modified Janbu Method
0
200
400
600
800
1000
1200

PCSTABL5M SLOPE STABILITY MODEL

COMPUTER OUTPUTS

SECTION AA′

Excavation, Circular Failure Mode (Short-Term, Undrained)

```
                    ** PCSTABL5M3 **
                 by Purdue University 1985
              rev. for SCS Engineers HVA 2008
               --Slope Stability Analysis--
            Simplified Janbu, Simplified Bishop
               or Spencer`s Method of Slices
 Run Date:                 3/4/2019
 Time of Run:              01:18PM
 Run By:                   SCS Engineers
 Input Data Filename:      M:waco xs a - undrained.
 Output Filename:          M:waco xs a - undrained.OUT
 Unit:                     ENGLISH
 Plotted Output Filename:  M:waco xs a - undrained.PLT
 PROBLEM DESCRIPTION   Waco Landfill
                       Cross-Section A-Circ.-undrained
 BOUNDARY COORDINATES
      Note: User origin value specified.
      Add 0.00 to X-values and 0.00 to Y-values listed.

    13 Top   Boundaries
    13 Total Boundaries
 Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
    No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
     1          0.00     519.60      39.00     520.00        1
     2         39.00     520.00     100.00     520.60        1
     3        100.00     520.60     198.60     521.60        1
     4        198.60     521.60     221.70     529.30        1
     5        221.70     529.30     281.70     549.30        1
     6        281.70     549.30     311.70     559.30        1
     7        311.70     559.30     341.70     569.30        1
     8        341.70     569.30     400.00     569.40        1
     9        400.00     569.40     417.40     569.20        1
    10        417.40     569.20     433.90     569.60        1
    11        433.90     569.60     452.30     569.40        1
    12        452.30     569.40     485.70     570.50        1
    13        485.70     570.50     500.00     569.70        1

ISOTROPIC SOIL PARAMETERS
   1 Type(s) of Soil
 Soil  Total  Saturated  Cohesion Friction  Pore   Pressure   Piez.
 Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
  No.  (pcf)    (pcf)     (psf)     (deg)   Param.   (psf)     No.
   1   128.0    128.0    4000.0      0.0    0.00      0.0      1
 1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
 Unit Weight of Water =  62.40
 Piezometric Surface No.  1 Specified by  2 Coordinate Points
   Point      X-Water     Y-Water
    No.        (ft)        (ft)
     1          0.00      519.00
     2       1000.00      519.00
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
10000 Trial Surfaces Have Been Generated.
 100 Surfaces Initiate From Each Of100 Points Equally Spaced
 Along The Ground Surface Between  X = 100.00 ft.
                              and  X = 250.00 ft.
 Each Surface Terminates Between   X = 340.00 ft.
                             and   X = 450.00 ft.
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =400.00 ft.
 10.00 ft. Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Examined.  They Are Ordered - Most Critical
```

First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	106.06	520.66
2	113.14	513.60
3	120.55	506.88
4	128.26	500.52
5	136.26	494.52
6	144.53	488.90
7	153.06	483.67
8	161.82	478.85
9	170.80	474.44
10	179.97	470.46
11	189.32	466.91
12	198.82	463.81
13	208.46	461.14
14	218.22	458.94
15	228.06	457.19
16	237.98	455.90
17	247.95	455.08
18	257.94	454.73
19	267.94	454.84
20	277.92	455.42
21	287.87	456.47
22	297.75	457.98
23	307.56	459.95
24	317.26	462.38
25	326.83	465.26
26	336.27	468.58
27	345.53	472.34
28	354.61	476.53
29	363.49	481.14
30	372.14	486.15
31	380.54	491.57
32	388.69	497.38
33	396.55	503.56
34	404.11	510.10
35	411.36	516.98
36	418.29	524.20
37	424.86	531.73
38	431.08	539.57
39	436.92	547.68
40	442.38	556.06
41	447.44	564.68
42	449.93	569.43

Circle Center At X = 260.5 ; Y = 668.5 and Radius, 213.8
*** 3.937 ***
Individual data on the 51 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.7	179.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	5.4	3053.5	0.0	1287.7	0.0	0.0	0.0	0.0	0.0
3	7.4	9979.8	0.0	5464.8	0.0	0.0	0.0	0.0	0.0
4	7.7	16926.7	0.0	9547.9	0.0	0.0	0.0	0.0	0.0
5	8.0	23974.9	0.0	13406.0	0.0	0.0	0.0	0.0	0.0
6	8.3	31027.3	0.0	17030.7	0.0	0.0	0.0	0.0	0.0
7	8.5	37988.8	0.0	20414.2	0.0	0.0	0.0	0.0	0.0
8	8.8	44767.5	0.0	23548.9	0.0	0.0	0.0	0.0	0.0
9	9.0	51275.2	0.0	26428.0	0.0	0.0	0.0	0.0	0.0

10	9.2	57428.8	0.0	29045.3	0.0	0.0	0.0	0.0	0.0
11	9.3	63150.0	0.0	31395.0	0.0	0.0	0.0	0.0	0.0
12	9.3	66709.0	0.0	32659.7	0.0	0.0	0.0	0.0	0.0
13	0.2	1659.4	0.0	812.3	0.0	0.0	0.0	0.0	0.0
14	9.6	75027.6	0.0	35271.6	0.0	0.0	0.0	0.0	0.0
15	9.8	82986.8	0.0	36790.1	0.0	0.0	0.0	0.0	0.0
16	3.5	31244.0	0.0	13324.5	0.0	0.0	0.0	0.0	0.0
17	6.4	59138.8	0.0	24699.6	0.0	0.0	0.0	0.0	0.0
18	9.9	97141.3	0.0	38970.8	0.0	0.0	0.0	0.0	0.0
19	10.0	103195.5	0.0	39628.3	0.0	0.0	0.0	0.0	0.0
20	10.0	108487.5	0.0	39995.0	0.0	0.0	0.0	0.0	0.0
21	10.0	112967.7	0.0	40070.2	0.0	0.0	0.0	0.0	0.0
22	10.0	116596.6	0.0	39853.6	0.0	0.0	0.0	0.0	0.0
23	3.8	44987.6	0.0	15020.7	0.0	0.0	0.0	0.0	0.0
24	6.2	74356.8	0.0	24325.2	0.0	0.0	0.0	0.0	0.0
25	9.9	121190.7	0.0	38548.0	0.0	0.0	0.0	0.0	0.0
26	9.8	122126.0	0.0	37461.8	0.0	0.0	0.0	0.0	0.0
27	4.1	52044.9	0.0	15598.2	0.0	0.0	0.0	0.0	0.0
28	5.6	70106.0	0.0	20491.4	0.0	0.0	0.0	0.0	0.0
29	9.6	121275.4	0.0	34434.4	0.0	0.0	0.0	0.0	0.0
30	9.4	119520.9	0.0	32499.8	0.0	0.0	0.0	0.0	0.0
31	5.4	68651.3	0.0	18045.1	0.0	0.0	0.0	0.0	0.0
32	3.8	47954.7	0.0	12245.0	0.0	0.0	0.0	0.0	0.0
33	9.1	110279.7	0.0	27810.1	0.0	0.0	0.0	0.0	0.0
34	8.9	102801.5	0.0	25065.2	0.0	0.0	0.0	0.0	0.0
35	8.6	94880.2	0.0	22061.4	0.0	0.0	0.0	0.0	0.0
36	8.4	86604.4	0.0	18805.2	0.0	0.0	0.0	0.0	0.0
37	8.1	78066.6	0.0	15303.9	0.0	0.0	0.0	0.0	0.0
38	7.9	69363.5	0.0	11565.1	0.0	0.0	0.0	0.0	0.0
39	3.5	28431.4	0.0	3972.5	0.0	0.0	0.0	0.0	0.0
40	4.1	32148.2	0.0	3624.4	0.0	0.0	0.0	0.0	0.0
41	7.3	51765.2	0.0	3408.0	0.0	0.0	0.0	0.0	0.0
42	1.9	12701.1	0.0	176.1	0.0	0.0	0.0	0.0	0.0
43	4.1	25235.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	0.9	5156.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	6.6	34794.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	6.2	26902.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	2.8	10125.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	3.0	9288.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	5.5	12343.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	5.1	5900.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	2.5	760.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	104.55	520.65
2	111.62	513.58
3	119.03	506.86
4	126.73	500.48
5	134.73	494.48
6	142.99	488.85
7	151.51	483.61
8	160.27	478.78
9	169.24	474.36
10	178.41	470.37
11	187.75	466.80
12	197.25	463.68
13	206.88	461.00
14	216.63	458.78
15	226.48	457.01
16	236.39	455.70
17	246.35	454.86
18	256.35	454.48

19	266.35	454.57
20	276.33	455.13
21	286.28	456.15
22	296.17	457.63
23	305.98	459.57
24	315.69	461.97
25	325.27	464.82
26	334.71	468.11
27	343.99	471.84
28	353.09	476.00
29	361.98	480.58
30	370.64	485.57
31	379.07	490.95
32	387.24	496.73
33	395.12	502.87
34	402.71	509.38
35	409.99	516.24
36	416.94	523.43
37	423.55	530.93
38	429.81	538.74
39	435.69	546.83
40	441.18	555.18
41	446.29	563.78
42	449.29	569.43

Circle Center At X = 259.4 ; Y = 668.7 and Radius, 214.3

*** 3.938 ***

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.64	520.74
2	120.71	513.67
3	128.11	506.94
4	135.83	500.59
5	143.84	494.61
6	152.14	489.02
7	160.69	483.83
8	169.48	479.07
9	178.49	474.73
10	187.70	470.83
11	197.08	467.38
12	206.62	464.38
13	216.30	461.85
14	226.08	459.78
15	235.95	458.19
16	245.89	457.07
17	255.87	456.43
18	265.87	456.27
19	275.86	456.60
20	285.83	457.40
21	295.75	458.68
22	305.59	460.44
23	315.34	462.67
24	324.97	465.36
25	334.46	468.52
26	343.79	472.13
27	352.93	476.18
28	361.87	480.66
29	370.58	485.58
30	379.04	490.90
31	387.24	496.62
32	395.16	502.74
33	402.77	509.22
34	410.06	516.07

```
    35        417.01      523.26
    36        423.61      530.77
    37        429.84      538.59
    38        435.69      546.70
    39        441.14      555.09
    40        446.18      563.72
    41        449.15      569.43
Circle Center At X =  264.1 ; Y =  664.2  and Radius,  207.9
      ***     3.939   ***
Failure Surface Specified By 42 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
     1        101.52      520.62
     2        108.59      513.54
     3        115.98      506.81
     4        123.68      500.42
     5        131.66      494.40
     6        139.91      488.76
     7        148.42      483.50
     8        157.16      478.65
     9        166.12      474.20
    10        175.27      470.18
    11        184.61      466.58
    12        194.09      463.42
    13        203.72      460.70
    14        213.46      458.44
    15        223.29      456.62
    16        233.20      455.27
    17        243.16      454.37
    18        253.15      453.94
    19        263.15      453.97
    20        273.14      454.47
    21        283.09      455.42
    22        292.99      456.84
    23        302.81      458.72
    24        312.54      461.05
    25        322.14      463.83
    26        331.61      467.05
    27        340.92      470.70
    28        350.05      474.78
    29        358.98      479.29
    30        367.69      484.20
    31        376.16      489.51
    32        384.38      495.21
    33        392.32      501.28
    34        399.98      507.71
    35        407.33      514.49
    36        414.36      521.61
    37        421.04      529.04
    38        427.38      536.78
    39        433.35      544.80
    40        438.95      553.09
    41        444.15      561.63
    42        448.43      569.44
Circle Center At X =  257.5 ; Y =  669.5  and Radius,  215.6
      ***     3.940   ***
Failure Surface Specified By 42 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
     1        107.58      520.68
     2        114.66      513.61
     3        122.06      506.89
     4        129.78      500.53
```

5	137.78	494.54
6	146.06	488.93
7	154.60	483.72
8	163.37	478.92
9	172.36	474.54
10	181.54	470.59
11	190.91	467.07
12	200.42	464.00
13	210.08	461.39
14	219.84	459.23
15	229.70	457.53
16	239.62	456.31
17	249.59	455.55
18	259.59	455.26
19	269.59	455.45
20	279.56	456.11
21	289.50	457.23
22	299.37	458.83
23	309.16	460.89
24	318.83	463.41
25	328.38	466.38
26	337.78	469.80
27	347.00	473.66
28	356.04	477.95
29	364.86	482.67
30	373.44	487.79
31	381.78	493.31
32	389.85	499.22
33	397.62	505.51
34	405.10	512.15
35	412.25	519.14
36	419.06	526.46
37	425.52	534.10
38	431.61	542.03
39	437.32	550.24
40	442.64	558.71
41	447.55	567.42
42	448.57	569.44

Circle Center At X = 260.6 ; Y = 667.0 and Radius, 211.8
*** 3.940 ***
Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	116.67	520.77
2	123.74	513.70
3	131.15	506.98
4	138.87	500.63
5	146.90	494.67
6	155.20	489.10
7	163.77	483.94
8	172.58	479.20
9	181.60	474.89
10	190.83	471.03
11	200.23	467.62
12	209.78	464.67
13	219.47	462.19
14	229.26	460.18
15	239.15	458.65
16	249.09	457.60
17	259.07	457.03
18	269.07	456.95
19	279.07	457.35
20	289.03	458.24

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      21        298.93      459.61
      22        308.76      461.46
      23        318.49      463.79
      24        328.09      466.59
      25        337.54      469.84
      26        346.83      473.56
      27        355.92      477.71
      28        364.80      482.31
      29        373.45      487.33
      30        381.84      492.77
      31        389.96      498.60
      32        397.79      504.83
      33        405.31      511.42
      34        412.50      518.38
      35        419.34      525.67
      36        425.82      533.29
      37        431.92      541.21
      38        437.63      549.42
      39        442.93      557.90
      40        447.82      566.62
      41        449.22      569.43
   Circle Center At X =  265.7 ; Y =  662.9  and Radius,  206.0
         ***     3.941   ***
   Failure Surface Specified By 42 Coordinate Points
     Point      X-Surf      Y-Surf
      No.        (ft)        (ft)
       1        107.58      520.68
       2        114.66      513.62
       3        122.07      506.90
       4        129.78      500.54
       5        137.79      494.55
       6        146.08      488.95
       7        154.62      483.75
       8        163.40      478.96
       9        172.39      474.59
      10        181.58      470.65
      11        190.95      467.15
      12        200.47      464.09
      13        210.13      461.50
      14        219.90      459.36
      15        229.75      457.68
      16        239.68      456.48
      17        249.66      455.74
      18        259.65      455.48
      19        269.65      455.70
      20        279.63      456.38
      21        289.56      457.54
      22        299.43      459.16
      23        309.20      461.26
      24        318.87      463.81
      25        328.41      466.82
      26        337.79      470.27
      27        347.00      474.17
      28        356.02      478.49
      29        364.82      483.24
      30        373.39      488.40
      31        381.70      493.96
      32        389.74      499.91
      33        397.48      506.23
      34        404.92      512.91
      35        412.04      519.94
      36        418.82      527.30
      37        425.23      534.96
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      38        431.28      542.93
      39        436.95      551.17
      40        442.22      559.67
      41        447.08      568.41
      42        447.60      569.45
   Circle Center At X =  260.2 ; Y =  666.6  and Radius,  211.1
         ***     3.942   ***
   Failure Surface Specified By 41 Coordinate Points
     Point      X-Surf      Y-Surf
      No.        (ft)        (ft)
       1        115.15      520.75
       2        122.23      513.69
       3        129.64      506.97
       4        137.37      500.63
       5        145.39      494.66
       6        153.70      489.09
       7        162.27      483.94
       8        171.08      479.20
       9        180.10      474.90
      10        189.33      471.05
      11        198.73      467.64
      12        208.29      464.70
      13        217.98      462.22
      14        227.78      460.22
      15        237.66      458.69
      16        247.60      457.65
      17        257.59      457.09
      18        267.59      457.02
      19        277.58      457.44
      20        287.54      458.34
      21        297.44      459.72
      22        307.27      461.58
      23        316.99      463.91
      24        326.59      466.72
      25        336.04      469.99
      26        345.32      473.71
      27        354.41      477.88
      28        363.29      482.49
      29        371.93      487.52
      30        380.31      492.97
      31        388.43      498.82
      32        396.25      505.05
      33        403.75      511.66
      34        410.93      518.62
      35        417.76      525.93
      36        424.23      533.55
      37        430.31      541.49
      38        436.01      549.70
      39        441.30      558.19
      40        446.17      566.92
      41        447.43      569.45
   Circle Center At X =  264.1 ; Y =  662.8  and Radius,  205.8
         ***     3.944   ***
   Failure Surface Specified By 41 Coordinate Points
     Point      X-Surf      Y-Surf
      No.        (ft)        (ft)
       1        112.12      520.72
       2        119.22      513.68
       3        126.65      506.99
       4        134.39      500.65
       5        142.42      494.70
       6        150.73      489.13
       7        159.30      483.97
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     8         168.10      479.22
     9         177.12      474.90
    10         186.33      471.02
    11         195.72      467.58
    12         205.26      464.59
    13         214.94      462.06
    14         224.72      460.00
    15         234.60      458.41
    16         244.53      457.29
    17         254.51      456.64
    18         264.51      456.48
    19         274.51      456.79
    20         284.47      457.58
    21         294.39      458.84
    22         304.24      460.58
    23         314.00      462.78
    24         323.63      465.45
    25         333.13      468.58
    26         342.47      472.15
    27         351.63      476.17
    28         360.58      480.62
    29         369.32      485.49
    30         377.80      490.78
    31         386.03      496.46
    32         393.98      502.54
    33         401.62      508.98
    34         408.96      515.78
    35         415.95      522.93
    36         422.60      530.40
    37         428.88      538.18
    38         434.79      546.25
    39         440.30      554.59
    40         445.41      563.19
    41         448.73      569.44
Circle Center At X =  263.0 ; Y =  665.7  and Radius,  209.3
      ***     3.945   ***
Failure Surface Specified By 42 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
     1         104.55      520.65
     2         111.62      513.58
     3         119.02      506.85
     4         126.72      500.48
     5         134.72      494.47
     6         143.00      488.86
     7         151.52      483.64
     8         160.29      478.82
     9         169.27      474.43
    10         178.45      470.46
    11         187.81      466.94
    12         197.32      463.85
    13         206.97      461.22
    14         216.73      459.05
    15         226.58      457.34
    16         236.51      456.10
    17         246.48      455.32
    18         256.47      455.02
    19         266.47      455.19
    20         276.45      455.83
    21         286.39      456.94
    22         296.26      458.52
    23         306.05      460.56
    24         315.73      463.06
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     25        325.29      466.01
     26        334.69      469.42
     27        343.92      473.26
     28        352.97      477.53
     29        361.79      482.23
     30        370.39      487.33
     31        378.74      492.84
     32        386.82      498.73
     33        394.61      505.00
     34        402.10      511.63
     35        409.27      518.60
     36        416.09      525.91
     37        422.57      533.53
     38        428.68      541.44
     39        434.41      549.64
     40        439.75      558.09
     41        444.69      566.79
     42        446.04      569.47
  Circle Center At X =  257.9 ; Y =  666.9  and Radius,  211.9
        ***      3.945   ***
```

SECTION BB′

Circular Failure Mode (Interim Conditions)

```
                   ** PCSTABL5M3 **
               by Purdue University 1985
            rev. for SCS Engineers HVA 2008
             --Slope Stability Analysis--
          Simplified Janbu, Simplified Bishop
             or Spencer`s Method of Slices
Run Date:                 3/4/2019
Time of Run:              01:35PM
Run By:                   SCS Engineers
Input Data Filename:      M:waco xs b - circular.
Output Filename:          M:waco xs b - circular.OUT
Unit:                     ENGLISH
Plotted Output Filename:  M:waco xs b - circular.PLT
PROBLEM DESCRIPTION   Waco Landfill
                      Cross-Section B-Circular
BOUNDARY COORDINATES
     Note: User origin value specified.
     Add 0.00 to X-values and 0.00 to Y-values listed.

   15 Top   Boundaries
   40 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	519.90	144.00	522.40	1
2	144.00	522.40	149.50	524.30	2
3	149.50	524.30	662.70	695.30	2
4	662.70	695.30	822.60	694.60	2
5	822.60	694.60	945.40	694.10	2
6	945.40	694.10	1088.40	687.00	2
7	1088.40	687.00	1644.30	547.70	2
8	1644.30	547.70	1659.30	547.70	2
9	1659.30	547.70	1661.00	547.10	2
10	1661.00	547.10	1667.00	545.10	2
11	1667.00	545.10	1672.70	543.20	1
12	1672.70	543.20	1682.70	543.20	1
13	1682.70	543.20	1686.80	544.50	1
14	1686.80	544.50	1700.00	541.60	1
15	1700.00	541.60	1798.50	540.30	1
16	149.00	524.30	152.50	524.20	2
17	152.50	524.20	662.90	694.30	3
18	662.90	694.30	822.60	693.60	3
19	822.60	693.60	945.40	693.10	3
20	945.40	693.10	1088.20	686.00	3
21	1088.20	686.00	1642.40	547.10	3
22	1642.40	547.10	1661.00	547.10	2
23	152.50	524.20	343.90	518.80	2
24	343.90	518.80	547.30	521.90	2
25	547.30	521.90	750.00	518.40	2
26	750.00	518.40	955.70	522.00	2
27	955.70	522.00	1180.60	517.50	2
28	1180.60	517.50	1409.00	519.90	2
29	1409.00	519.90	1533.10	517.40	2
30	1533.10	517.40	1622.90	547.20	2
31	1622.90	547.20	1642.40	547.10	2
32	144.00	522.40	343.90	516.80	1
33	343.90	516.80	547.30	519.90	1
34	547.30	519.90	750.00	516.40	1
35	750.00	516.40	955.70	520.00	1
36	955.70	520.00	1180.60	515.50	1
37	1180.60	515.50	1409.00	517.90	1
38	1409.00	517.90	1533.40	515.40	1
39	1533.40	515.40	1623.20	545.20	1
40	1623.20	545.20	1667.00	545.10	1

```
 ISOTROPIC SOIL PARAMETERS
   3 Type(s) of Soil
  Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
  Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
   No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)    No.
    1   128.0    128.0       0.0      25.0    0.00       0.0      1
    2   120.0    120.0     200.0      20.0    0.00       0.0      1
    3    60.0     60.0     200.0      32.0    0.00       0.0      1
  1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
  Unit Weight of Water =  62.40
  Piezometric Surface No.  1 Specified by  2 Coordinate Points
    Point      X-Water     Y-Water
     No.         (ft)        (ft)
      1          0.00       517.00
      2       1700.00       517.00
  A Critical Failure Surface Searching Method, Using A Random
  Technique For Generating Circular Surfaces, Has Been Specified.
10000 Trial Surfaces Have Been Generated.
  100 Surfaces Initiate From Each Of100 Points Equally Spaced
  Along The Ground Surface Between  X =  50.00 ft.
                                  and  X = 200.00 ft.
  Each Surface Terminates Between   X = 600.00 ft.
                                 and   X = 850.00 ft.
  Unless Further Limitations Were Imposed, The Minimum Elevation
  At Which A Surface Extends Is  Y =  0.00 ft.
  15.00 ft. Line Segments Define Each Trial Failure Surface.
  Following Are Displayed The Ten Most Critical Of The Trial
        Failure Surfaces Examined.  They Are Ordered - Most Critical
        First.
        * * Safety Factors Are Calculated By The Modified Bishop Method * *
        Failure Surface Specified By 44 Coordinate Points
          Point      X-Surf      Y-Surf
           No.        (ft)        (ft)
            1        109.09      521.79
            2        123.45      517.45
            3        137.93      513.52
            4        152.51      510.00
            5        167.18      506.90
            6        181.94      504.22
            7        196.77      501.96
            8        211.66      500.12
            9        226.59      498.71
           10        241.56      497.72
           11        256.55      497.16
           12        271.55      497.03
           13        286.54      497.32
           14        301.53      498.04
           15        316.48      499.19
           16        331.40      500.76
           17        346.27      502.76
           18        361.07      505.17
           19        375.80      508.01
           20        390.44      511.27
           21        404.99      514.94
           22        419.42      519.03
           23        433.73      523.52
           24        447.91      528.42
           25        461.94      533.72
           26        475.81      539.42
           27        489.52      545.51
           28        503.05      551.99
           29        516.39      558.85
           30        529.53      566.09
```

31	542.45	573.70
32	555.16	581.67
33	567.63	590.01
34	579.86	598.69
35	591.84	607.72
36	603.56	617.09
37	615.00	626.78
38	626.16	636.80
39	637.04	647.13
40	647.61	657.77
41	657.88	668.70
42	667.84	679.93
43	677.47	691.43
44	680.46	695.22

Circle Center At X = 268.7 ; Y = 1023.7 and Radius, 526.7

*** 2.105 ***

Individual data on the 57 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	14.4	4218.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1.7	1030.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	12.8	11350.5	0.0	1440.6	0.0	0.0	0.0	0.0	0.0
4	6.1	7432.5	0.0	1642.1	0.0	0.0	0.0	0.0	0.0
5	5.0	7521.4	0.0	1780.3	0.0	0.0	0.0	0.0	0.0
6	0.5	851.3	0.0	199.3	0.0	0.0	0.0	0.0	0.0
7	3.0	5479.7	0.0	1277.2	0.0	0.0	0.0	0.0	0.0
8	0.0	13.4	0.0	3.1	0.0	0.0	0.0	0.0	0.0
9	14.7	33225.1	0.0	7999.3	0.0	0.0	0.0	0.0	0.0
10	14.8	42798.3	0.0	10705.5	0.0	0.0	0.0	0.0	0.0
11	14.8	51657.0	0.0	13018.5	0.0	0.0	0.0	0.0	0.0
12	14.9	59761.9	0.0	14936.3	0.0	0.0	0.0	0.0	0.0
13	14.9	67077.8	0.0	16457.5	0.0	0.0	0.0	0.0	0.0
14	15.0	73574.2	0.0	17580.7	0.0	0.0	0.0	0.0	0.0
15	15.0	79225.0	0.0	18305.2	0.0	0.0	0.0	0.0	0.0
16	15.0	84008.2	0.0	18630.1	0.0	0.0	0.0	0.0	0.0
17	15.0	87907.2	0.0	18555.5	0.0	0.0	0.0	0.0	0.0
18	15.0	90909.5	0.0	18081.2	0.0	0.0	0.0	0.0	0.0
19	15.0	93007.7	0.0	17207.7	0.0	0.0	0.0	0.0	0.0
20	14.9	94198.8	0.0	15935.7	0.0	0.0	0.0	0.0	0.0
21	5.4	34044.0	0.0	5359.0	0.0	0.0	0.0	0.0	0.0
22	7.1	45385.6	0.0	6761.0	0.0	0.0	0.0	0.0	0.0
23	2.4	15063.3	0.0	2146.1	0.0	0.0	0.0	0.0	0.0
24	10.8	68515.5	0.0	9089.7	0.0	0.0	0.0	0.0	0.0
25	4.0	25783.8	0.0	3110.8	0.0	0.0	0.0	0.0	0.0
26	14.7	93440.2	0.0	9740.4	0.0	0.0	0.0	0.0	0.0
27	14.6	91698.7	0.0	6887.8	0.0	0.0	0.0	0.0	0.0
28	14.5	89093.8	0.0	3645.1	0.0	0.0	0.0	0.0	0.0
29	7.3	43550.9	0.0	485.3	0.0	0.0	0.0	0.0	0.0
30	3.1	18578.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	4.0	23536.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	3.1	17965.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	11.2	64920.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	14.2	82068.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	14.0	80889.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	13.9	79278.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	13.7	77249.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	13.5	74821.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	13.3	72014.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	13.1	68850.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	12.9	65351.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	12.7	61544.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

43	12.5	57456.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	12.2	53116.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	12.0	48553.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	11.7	43801.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	11.4	38890.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	11.2	33856.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	10.9	28734.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	10.6	23559.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	10.3	18369.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	4.8	6978.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	0.2	265.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	4.9	5670.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	9.6	6112.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	2.2	451.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	0.8	47.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 44 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	100.00	521.64
2	114.44	517.58
3	128.99	513.92
4	143.63	510.64
5	158.35	507.77
6	173.14	505.29
7	188.00	503.21
8	202.90	501.53
9	217.85	500.25
10	232.82	499.38
11	247.81	498.91
12	262.81	498.84
13	277.81	499.18
14	292.79	499.92
15	307.75	501.06
16	322.67	502.60
17	337.54	504.55
18	352.36	506.90
19	367.10	509.64
20	381.77	512.78
21	396.35	516.32
22	410.83	520.24
23	425.19	524.55
24	439.44	529.25
25	453.55	534.33
26	467.52	539.79
27	481.34	545.63
28	495.00	551.83
29	508.49	558.40
30	521.79	565.33
31	534.90	572.61
32	547.81	580.25
33	560.51	588.22
34	573.00	596.54
35	585.25	605.20
36	597.27	614.17
37	609.04	623.47
38	620.55	633.09
39	631.80	643.00
40	642.78	653.22
41	653.49	663.73
42	663.90	674.53
43	674.02	685.60
44	682.35	695.21

Circle Center At X = 257.8 ; Y = 1055.8 and Radius, 557.0

```
       ***      2.106    ***
Failure Surface Specified By 43 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        113.64      521.87
    2        128.01      517.59
    3        142.51      513.73
    4        157.11      510.29
    5        171.80      507.29
    6        186.58      504.71
    7        201.43      502.57
    8        216.33      500.86
    9        231.28      499.59
   10        246.25      498.76
   11        261.25      498.36
   12        276.25      498.41
   13        291.24      498.89
   14        306.21      499.81
   15        321.15      501.17
   16        336.04      502.96
   17        350.88      505.19
   18        365.64      507.86
   19        380.31      510.95
   20        394.90      514.47
   21        409.37      518.42
   22        423.72      522.78
   23        437.93      527.57
   24        452.00      532.77
   25        465.92      538.38
   26        479.66      544.39
   27        493.22      550.80
   28        506.59      557.61
   29        519.75      564.80
   30        532.69      572.38
   31        545.41      580.33
   32        557.89      588.65
   33        570.13      597.33
   34        582.10      606.37
   35        593.80      615.75
   36        605.23      625.47
   37        616.36      635.52
   38        627.20      645.89
   39        637.73      656.57
   40        647.94      667.56
   41        657.83      678.84
   42        667.38      690.41
   43        671.15      695.26
Circle Center At X =   267.2 ; Y = 1011.1  and Radius,   512.8
       ***      2.107    ***
Failure Surface Specified By 45 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        100.00      521.64
    2        114.27      517.02
    3        128.67      512.81
    4        143.18      509.01
    5        157.80      505.64
    6        172.50      502.69
    7        187.29      500.16
    8        202.14      498.05
    9        217.05      496.38
   10        231.99      495.13
   11        246.97      494.31
```

12	261.97	493.93
13	276.97	493.97
14	291.96	494.45
15	306.93	495.36
16	321.87	496.69
17	336.77	498.46
18	351.61	500.65
19	366.38	503.27
20	381.06	506.31
21	395.66	509.78
22	410.15	513.66
23	424.52	517.95
24	438.76	522.66
25	452.86	527.77
26	466.81	533.29
27	480.60	539.20
28	494.21	545.51
29	507.63	552.21
30	520.85	559.29
31	533.87	566.75
32	546.66	574.58
33	559.23	582.77
34	571.55	591.32
35	583.62	600.22
36	595.44	609.47
37	606.98	619.05
38	618.24	628.96
39	629.21	639.18
40	639.89	649.72
41	650.25	660.56
42	660.30	671.70
43	670.03	683.12
44	679.43	694.81
45	679.74	695.23

Circle Center At X = 267.9 ; Y = 1015.8 and Radius, 521.9

*** 2.107 ***

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	109.09	521.79
2	123.55	517.80
3	138.11	514.21
4	152.77	511.03
5	167.51	508.26
6	182.33	505.90
7	197.20	503.96
8	212.12	502.44
9	227.08	501.33
10	242.07	500.64
11	257.07	500.37
12	272.06	500.52
13	287.05	501.09
14	302.02	502.08
15	316.96	503.49
16	331.84	505.31
17	346.68	507.55
18	361.44	510.20
19	376.12	513.27
20	390.72	516.74
21	405.20	520.62
22	419.58	524.91
23	433.83	529.59
24	447.94	534.67

25	461.91	540.15
26	475.72	546.01
27	489.35	552.26
28	502.81	558.88
29	516.08	565.88
30	529.14	573.25
31	542.00	580.98
32	554.63	589.06
33	567.04	597.50
34	579.20	606.28
35	591.11	615.39
36	602.77	624.84
37	614.15	634.60
38	625.26	644.69
39	636.08	655.07
40	646.60	665.76
41	656.82	676.74
42	666.74	688.00
43	672.78	695.26

Circle Center At X = 259.2 ; Y = 1036.8 and Radius, 536.4
*** 2.107 ***
Failure Surface Specified By 44 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	110.61	521.82
2	124.95	517.42
3	139.41	513.43
4	153.97	509.84
5	168.63	506.67
6	183.37	503.91
7	198.19	501.56
8	213.07	499.63
9	227.99	498.13
10	242.95	497.04
11	257.94	496.37
12	272.93	496.13
13	287.93	496.31
14	302.92	496.91
15	317.89	497.93
16	332.82	499.37
17	347.70	501.24
18	362.53	503.52
19	377.28	506.21
20	391.95	509.33
21	406.54	512.85
22	421.01	516.78
23	435.37	521.12
24	449.60	525.86
25	463.69	531.00
26	477.64	536.53
27	491.42	542.45
28	505.03	548.76
29	518.45	555.45
30	531.68	562.51
31	544.71	569.95
32	557.53	577.75
33	570.12	585.90
34	582.47	594.41
35	594.58	603.26
36	606.44	612.45
37	618.03	621.96
38	629.35	631.80
39	640.39	641.96

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    40        651.14      652.42
    41        661.59      663.18
    42        671.74      674.23
    43        681.57      685.56
    44        689.45      695.18
 Circle Center At X =  274.1 ; Y = 1029.0  and Radius,  532.9
       ***     2.107   ***
 Failure Surface Specified By 44 Coordinate Points
   Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
     1        106.06      521.74
     2        120.35      517.18
     3        134.77      513.04
     4        149.30      509.33
     5        163.94      506.05
     6        178.67      503.21
     7        193.47      500.80
     8        208.34      498.84
     9        223.27      497.31
    10        238.23      496.23
    11        253.21      495.60
    12        268.21      495.40
    13        283.21      495.65
    14        298.19      496.35
    15        313.15      497.49
    16        328.07      499.07
    17        342.93      501.09
    18        357.73      503.55
    19        372.44      506.45
    20        387.07      509.78
    21        401.59      513.55
    22        415.99      517.74
    23        430.26      522.36
    24        444.39      527.40
    25        458.36      532.85
    26        472.17      538.72
    27        485.80      544.99
    28        499.23      551.66
    29        512.46      558.73
    30        525.47      566.19
    31        538.26      574.03
    32        550.81      582.24
    33        563.11      590.83
    34        575.16      599.77
    35        586.93      609.07
    36        598.42      618.71
    37        609.62      628.69
    38        620.52      638.99
    39        631.11      649.61
    40        641.38      660.54
    41        651.32      671.78
    42        660.93      683.30
    43        670.19      695.10
    44        670.32      695.27
 Circle Center At X =  267.3 ; Y = 1001.8  and Radius,  506.4
       ***     2.108   ***
 Failure Surface Specified By 45 Coordinate Points
   Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
     1        103.03      521.69
     2        117.28      517.01
     3        131.66      512.74
     4        146.16      508.89
```

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      5        160.76      505.44
      6        175.45      502.42
      7        190.22      499.81
      8        205.06      497.63
      9        219.96      495.87
     10        234.90      494.54
     11        249.87      493.63
     12        264.86      493.15
     13        279.86      493.10
     14        294.86      493.48
     15        309.84      494.28
     16        324.79      495.51
     17        339.70      497.17
     18        354.55      499.25
     19        369.34      501.75
     20        384.05      504.67
     21        398.68      508.01
     22        413.20      511.77
     23        427.61      515.94
     24        441.89      520.52
     25        456.04      525.50
     26        470.04      530.89
     27        483.88      536.67
     28        497.55      542.85
     29        511.04      549.41
     30        524.33      556.35
     31        537.43      563.67
     32        550.31      571.36
     33        562.96      579.42
     34        575.38      587.83
     35        587.55      596.59
     36        599.47      605.70
     37        611.13      615.14
     38        622.51      624.91
     39        633.61      635.00
     40        644.41      645.40
     41        654.92      656.11
     42        665.11      667.11
     43        674.99      678.40
     44        684.54      689.97
     45        688.61      695.19
Circle Center At X =  274.2 ; Y = 1019.2  and Radius,  526.1
      ***      2.109    ***
Failure Surface Specified By 43 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
      1        115.15      521.90
      2        129.67      518.14
      3        144.29      514.77
      4        158.99      511.80
      5        173.77      509.22
      6        188.61      507.05
      7        203.51      505.28
      8        218.44      503.90
      9        233.41      502.94
     10        248.40      502.37
     11        263.40      502.22
     12        278.40      502.46
     13        293.38      503.11
     14        308.35      504.17
     15        323.28      505.63
     16        338.16      507.49
     17        352.99      509.75
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      18        367.75      512.42
      19        382.44      515.47
      20        397.03      518.93
      21        411.53      522.78
      22        425.92      527.01
      23        440.19      531.64
      24        454.33      536.64
      25        468.33      542.03
      26        482.18      547.79
      27        495.86      553.93
      28        509.38      560.43
      29        522.72      567.29
      30        535.87      574.52
      31        548.81      582.09
      32        561.55      590.01
      33        574.07      598.27
      34        586.37      606.87
      35        598.42      615.79
      36        610.23      625.04
      37        621.79      634.60
      38        633.08      644.47
      39        644.11      654.65
      40        654.85      665.11
      41        665.31      675.86
      42        675.48      686.89
      43        682.74      695.21
   Circle Center At X =  261.8 ; Y = 1058.0  and Radius,  555.8
         ***     2.109   ***
   Failure Surface Specified By 44 Coordinate Points
     Point      X-Surf      Y-Surf
      No.        (ft)        (ft)
       1        121.21      522.00
       2        135.64      517.89
       3        150.17      514.18
       4        164.80      510.88
       5        179.52      507.99
       6        194.32      505.51
       7        209.17      503.44
       8        224.08      501.79
       9        239.03      500.56
      10        254.01      499.75
      11        269.00      499.36
      12        284.00      499.38
      13        299.00      499.83
      14        313.97      500.69
      15        328.92      501.97
      16        343.82      503.67
      17        358.67      505.79
      18        373.46      508.32
      19        388.17      511.26
      20        402.79      514.61
      21        417.31      518.37
      22        431.72      522.53
      23        446.01      527.10
      24        460.16      532.06
      25        474.17      537.42
      26        488.03      543.16
      27        501.72      549.29
      28        515.23      555.80
      29        528.56      562.69
      30        541.69      569.95
      31        554.61      577.57
      32        567.31      585.55
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     33        579.78      593.88
     34        592.02      602.55
     35        604.01      611.57
     36        615.74      620.91
     37        627.21      630.58
     38        638.40      640.57
     39        649.31      650.87
     40        659.92      661.47
     41        670.24      672.36
     42        680.24      683.53
     43        689.94      694.98
     44        690.10      695.18
 Circle Center At X =  275.6 ; Y = 1035.9  and Radius,  536.5
         ***      2.109    ***
```

SECTION BB′

Block Failure Mode (Interim Conditions)

```
                   ** PCSTABL5M3 **
               by Purdue University 1985
            rev. for SCS Engineers HVA 2008
             --Slope Stability Analysis--
          Simplified Janbu, Simplified Bishop
             or Spencer`s Method of Slices
Run Date:                 4/19/2019
Time of Run:              10:07AM
Run By:                   Username
Input Data Filename:      M:waco xs b - block.
Output Filename:          M:waco xs b - block.OUT
Unit:                     ENGLISH
Plotted Output Filename:  M:waco xs b - block.PLT
PROBLEM DESCRIPTION   Waco Landfill
                      Cross-Section B-Block
BOUNDARY COORDINATES
     Note: User origin value specified.
     Add 0.00 to X-values and 0.00 to Y-values listed.

   15 Top   Boundaries
   40 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	519.90	144.00	522.40	1
2	144.00	522.40	149.50	524.30	2
3	149.50	524.30	662.70	695.30	2
4	662.70	695.30	822.60	694.60	2
5	822.60	694.60	945.40	694.10	2
6	945.40	694.10	1088.40	687.00	2
7	1088.40	687.00	1644.30	547.70	2
8	1644.30	547.70	1659.30	547.70	2
9	1659.30	547.70	1661.00	547.10	2
10	1661.00	547.10	1667.00	545.10	2
11	1667.00	545.10	1672.70	543.20	1
12	1672.70	543.20	1682.70	543.20	1
13	1682.70	543.20	1686.80	544.50	1
14	1686.80	544.50	1700.00	541.60	1
15	1700.00	541.60	1798.50	540.30	1
16	149.00	524.30	152.50	524.20	2
17	152.50	524.20	662.90	694.30	3
18	662.90	694.30	822.60	693.60	3
19	822.60	693.60	945.40	693.10	3
20	945.40	693.10	1088.20	686.00	3
21	1088.20	686.00	1642.40	547.10	3
22	1642.40	547.10	1661.00	547.10	2
23	152.50	524.20	343.90	518.80	4
24	343.90	518.80	547.30	521.90	4
25	547.30	521.90	750.00	518.40	4
26	750.00	518.40	955.70	522.00	4
27	955.70	522.00	1180.60	517.50	4
28	1180.60	517.50	1409.00	519.90	4
29	1409.00	519.90	1533.10	517.40	4
30	1533.10	517.40	1622.90	547.20	4
31	1622.90	547.20	1642.40	547.10	4
32	144.00	522.40	343.90	516.80	4
33	343.90	516.80	547.30	519.90	4
34	547.30	519.90	750.00	516.40	4
35	750.00	516.40	955.70	520.00	4
36	955.70	520.00	1180.60	515.50	4
37	1180.60	515.50	1409.00	517.90	4
38	1409.00	517.90	1533.40	515.40	4
39	1533.40	515.40	1623.20	545.20	4
40	1623.20	545.20	1667.00	545.10	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	128.0	128.0	0.0	25.0	0.00	0.0	1
2	120.0	120.0	200.0	20.0	0.00	0.0	1
3	60.0	60.0	200.0	32.0	0.00	0.0	1
4	100.0	100.0	0.0	11.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	517.00
2	1700.00	517.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 10.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	152.50	523.50	152.50	523.50	1.00
2	153.00	523.50	343.90	517.50	1.00
3	350.00	517.00	1180.60	517.00	1.00

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.80	524.73
2	152.50	523.13
3	313.50	518.27
4	459.05	517.27
5	465.90	524.55
6	472.09	532.41
7	479.13	539.51
8	482.01	549.08
9	486.65	557.94
10	493.35	565.36
11	496.09	574.98
12	502.37	582.77
13	508.76	590.46
14	514.44	598.69
15	518.28	607.92
16	522.37	617.05
17	529.37	624.18
18	531.98	633.84
19	537.34	642.28
20	543.05	650.49
21	545.68	656.31

*** 1.401 ***

Individual data on the 26 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.5	21.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2	1.2	200.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	161.0	321985.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	30.4	123364.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	57.0	283024.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	58.1	359616.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	1.2	8304.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.9	12641.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	3.7	23982.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	6.2	38368.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	7.0	41428.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	2.9	15829.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	4.6	23216.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	6.7	31040.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	2.7	11533.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	6.3	23734.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	6.4	22004.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	5.7	17546.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	3.8	10211.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	4.1	8950.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	7.0	12674.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	2.6	3657.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	5.4	5033.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	5.7	3137.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	2.1	504.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.6	37.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	147.42	523.58
2	152.50	523.45
3	285.82	519.49
4	530.02	516.99
5	536.24	524.82
6	543.26	531.94
7	548.33	540.56
8	554.55	548.39
9	561.62	555.46
10	567.49	563.56
11	573.37	571.64
12	577.86	580.58
13	584.32	588.21
14	591.38	595.29
15	593.26	605.12
16	598.79	613.45
17	605.84	620.54
18	610.50	629.39
19	615.38	638.12
20	618.96	647.45
21	619.64	657.43
22	620.69	667.37
23	627.00	675.13
24	634.05	682.23
25	635.31	686.17

*** 1.408 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.73	524.71
2	152.50	523.02
3	331.44	518.00
4	428.43	517.17
5	435.49	524.25
6	442.46	531.42

```
       7          448.97        539.01
       8          452.81        548.24
       9          455.26        557.94
      10          461.62        565.66
      11          465.67        574.80
      12          472.27        582.31
      13          475.91        591.63
      14          481.55        599.88
      15          486.81        608.39
      16          491.05        617.44
      17          496.72        625.68
      18          503.30        633.21
      19          507.81        642.14
      20          508.88        644.05
          ***       1.421    ***
    Failure Surface Specified By 25 Coordinate Points
      Point       X-Surf        Y-Surf
       No.         (ft)          (ft)
       1          151.36        524.92
       2          152.50        523.84
       3          326.04        517.65
       4          554.15        516.73
       5          558.76        525.61
       6          565.58        532.92
       7          571.92        540.66
       8          577.33        549.07
       9          583.98        556.54
      10          591.00        563.66
      11          591.54        573.64
      12          595.92        582.63
      13          598.97        592.16
      14          603.32        601.16
      15          606.02        610.79
      16          612.48        618.42
      17          614.04        628.30
      18          618.58        637.21
      19          623.10        646.13
      20          629.67        653.67
      21          635.94        661.46
      22          638.92        671.00
      23          645.77        678.29
      24          652.27        685.88
      25          652.69        691.96
          ***       1.443    ***
    Failure Surface Specified By 26 Coordinate Points
      Point       X-Surf        Y-Surf
       No.         (ft)          (ft)
       1          150.36        524.59
       2          152.50        523.34
       3          295.23        519.04
       4          626.14        516.82
       5          631.80        525.06
       6          634.49        534.69
       7          640.23        542.89
       8          647.20        550.06
       9          652.74        558.38
      10          658.91        566.25
      11          664.15        574.77
      12          671.04        582.01
      13          677.53        589.62
      14          679.86        599.35
      15          686.45        606.87
      16          692.25        615.01
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    17         696.35      624.13
    18         697.96      634.00
    19         703.79      642.13
    20         707.43      651.45
    21         713.83      659.13
    22         720.37      666.69
    23         723.22      676.28
    24         726.87      685.59
    25         733.93      692.67
    26         734.52      694.99
       ***      1.455   ***
  Failure Surface Specified By 18 Coordinate Points
    Point      X-Surf      Y-Surf
     No.        (ft)        (ft)
      1        150.73      524.71
      2        152.50      523.21
      3        296.68      519.27
      4        377.73      516.80
      5        384.15      524.47
      6        390.51      532.18
      7        397.25      539.57
      8        402.30      548.21
      9        409.29      555.35
     10        416.11      562.67
     11        418.93      572.26
     12        425.68      579.64
     13        427.43      589.48
     14        433.70      597.27
     15        437.50      606.53
     16        444.54      613.63
     17        450.76      621.45
     18        453.07      625.45
       ***      1.465   ***
  Failure Surface Specified By 17 Coordinate Points
    Point      X-Surf      Y-Surf
     No.        (ft)        (ft)
      1        148.44      523.93
      2        152.50      523.47
      3        262.70      519.77
      4        351.57      517.32
      5        355.00      526.71
      6        360.92      534.77
      7        367.74      542.09
      8        373.94      549.93
      9        380.80      557.21
     10        387.12      564.96
     11        393.23      572.87
     12        397.09      582.10
     13        403.59      589.70
     14        409.05      598.07
     15        416.01      605.25
     16        420.54      614.17
     17        420.65      614.65
       ***      1.478   ***
  Failure Surface Specified By 17 Coordinate Points
    Point      X-Surf      Y-Surf
     No.        (ft)        (ft)
      1        150.79      524.73
      2        152.50      523.68
      3        272.49      519.90
      4        410.38      516.63
      5        412.66      526.37
      6        418.83      534.24
```

7	425.54	541.65
8	429.42	550.87
9	434.41	559.53
10	440.89	567.15
11	443.77	576.73
12	446.03	586.47
13	450.75	595.29
14	455.49	604.09
15	461.00	612.43
16	464.74	621.71
17	468.59	630.62

*** 1.520 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.74	524.71
2	152.50	523.60
3	336.90	517.43
4	401.86	516.54
5	406.85	525.21
6	412.61	533.39
7	419.67	540.46
8	423.46	549.72
9	429.72	557.51
10	431.79	567.30
11	438.29	574.90
12	445.00	582.31
13	451.43	589.97
14	451.72	599.97
15	456.13	608.94
16	457.66	618.82
17	464.46	626.16
18	466.59	629.96

*** 1.527 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	149.68	524.36
2	152.50	523.56
3	217.82	521.41
4	378.54	517.09
5	385.58	524.20
6	387.54	534.00
7	391.01	543.38
8	397.88	550.65
9	404.76	557.90
10	410.36	566.19
11	413.76	575.59
12	420.48	582.99
13	425.86	591.43
14	430.07	600.49
15	436.37	608.26
16	440.00	617.58
17	440.82	621.37

*** 1.529 ***

SECTION CC′

Circular Failure Mode (Final Conditions)

```
                    ** PCSTABL5M3 **
                 by Purdue University 1985
              rev. for SCS Engineers HVA 2008
               --Slope Stability Analysis--
            Simplified Janbu, Simplified Bishop
               or Spencer`s Method of Slices
    Run Date:                 3/4/2019
    Time of Run:              02:01PM
    Run By:                   SCS Engineers
    Input Data Filename:      M:waco xs c - circular.
    Output Filename:          M:waco xs c - circular.OUT
    Unit:                     ENGLISH
    Plotted Output Filename:  M:waco xs c - circular.PLT
    PROBLEM DESCRIPTION   Waco Landfill
                          Cross-Section C-Circular
    BOUNDARY COORDINATES
         Note: User origin value specified.
         Add 0.00 to X-values and 0.00 to Y-values listed.

       12 Top   Boundaries
       27 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     530.00      31.40     529.40        1
        2         31.40     529.40      60.20     537.50        1
        3         60.20     537.50      72.30     541.30        1
        4         72.30     541.30      74.30     541.30        1
        5         74.30     541.30     101.60     532.20        1
        6        101.60     532.20     111.60     532.20        1
        7        111.60     532.20     127.30     537.40        1
        8        127.30     537.40     135.00     540.00        2
        9        135.00     540.00     150.00     540.00        2
       10        150.00     540.00     738.00     687.00        2
       11        738.00     687.00     950.60     697.60        2
       12        950.60     697.60    1202.60     688.00        2
       13        127.30     537.40     154.20     537.40        1
       14        154.20     537.40     162.20     539.40        2
       15        162.20     539.40     738.50     683.50        3
       16        738.50     683.50     950.60     694.10        3
       17        950.60     694.10    1202.40     684.50        3
       18        162.20     539.40     171.00     539.30        2
       19        171.00     539.30     247.10     514.20        2
       20        247.10     514.20     575.90     520.20        2
       21        575.90     520.20     909.60     519.40        2
       22        909.60     519.40    1202.60     524.60        2
       23        154.20     537.40     171.00     537.40        1
       24        171.00     537.40     246.80     512.20        1
       25        246.80     512.20     575.90     518.20        1
       26        575.90     518.20     909.60     517.40        1
       27        909.60     517.40    1202.60     522.90        1


 ISOTROPIC SOIL PARAMETERS
     3 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)    No.
      1   128.0    128.0       0.0      25.0    0.00       0.0      1
      2   120.0    120.0     200.0      20.0    0.00       0.0      1
      3    60.0     60.0     200.0      32.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
    Unit Weight of Water =  62.40
    Piezometric Surface No.  1 Specified by  2 Coordinate Points
```

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	513.00
2	1200.00	513.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
10000 Trial Surfaces Have Been Generated.
100 Surfaces Initiate From Each Of100 Points Equally Spaced Along The Ground Surface Between X = 100.00 ft. and X = 200.00 ft.
Each Surface Terminates Between X = 600.00 ft. and X = 850.00 ft.
Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.
15.00 ft. Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	155.56	541.39
2	169.55	536.00
3	183.70	531.00
4	197.98	526.41
5	212.38	522.22
6	226.90	518.44
7	241.51	515.08
8	256.22	512.12
9	271.00	509.59
10	285.85	507.47
11	300.76	505.77
12	315.70	504.50
13	330.68	503.65
14	345.67	503.22
15	360.67	503.22
16	375.67	503.64
17	390.64	504.48
18	405.59	505.75
19	420.49	507.44
20	435.35	509.55
21	450.13	512.08
22	464.84	515.02
23	479.46	518.38
24	493.98	522.16
25	508.38	526.34
26	522.66	530.92
27	536.81	535.91
28	550.81	541.30
29	564.65	547.08
30	578.32	553.25
31	591.82	559.80
32	605.12	566.73
33	618.22	574.04
34	631.11	581.71
35	643.78	589.74
36	656.21	598.13
37	668.40	606.87
38	680.35	615.95
39	692.03	625.36
40	703.44	635.09
41	714.56	645.15

42	725.41	655.52
43	735.95	666.19
44	746.19	677.15
45	755.65	687.88

Circle Center At X = 353.3 ; Y = 1033.8 and Radius, 530.6
*** 2.731 ***
Individual data on the 59 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	5.7	1258.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.9	424.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	3.7	2295.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	3.6	3086.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1.4	1455.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	12.7	16362.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	14.3	25262.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	14.4	32036.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	14.5	38124.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	3.7	10485.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	10.9	33051.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	5.6	17870.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	4.7	15902.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	3.2	11342.4	0.0	66.8	0.0	0.0	0.0	0.0	0.0
15	1.1	4093.8	0.0	55.3	0.0	0.0	0.0	0.0	0.0
16	14.8	57712.0	0.0	2007.9	0.0	0.0	0.0	0.0	0.0
17	14.8	65963.0	0.0	4185.2	0.0	0.0	0.0	0.0	0.0
18	4.8	23026.7	0.0	1758.8	0.0	0.0	0.0	0.0	0.0
19	10.1	50412.8	0.0	4210.7	0.0	0.0	0.0	0.0	0.0
20	14.9	80109.4	0.0	7359.5	0.0	0.0	0.0	0.0	0.0
21	15.0	85945.6	0.0	8354.1	0.0	0.0	0.0	0.0	0.0
22	15.0	90924.6	0.0	8952.4	0.0	0.0	0.0	0.0	0.0
23	15.0	95027.9	0.0	9154.1	0.0	0.0	0.0	0.0	0.0
24	15.0	98241.8	0.0	8958.8	0.0	0.0	0.0	0.0	0.0
25	15.0	100556.5	0.0	8366.9	0.0	0.0	0.0	0.0	0.0
26	14.9	101967.5	0.0	7378.7	0.0	0.0	0.0	0.0	0.0
27	14.9	102474.3	0.0	5995.1	0.0	0.0	0.0	0.0	0.0
28	14.9	102082.3	0.0	4217.1	0.0	0.0	0.0	0.0	0.0
29	14.8	100799.8	0.0	2046.3	0.0	0.0	0.0	0.0	0.0
30	4.6	31086.4	0.0	135.0	0.0	0.0	0.0	0.0	0.0
31	10.1	67554.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	5.4	35913.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	9.2	59781.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.2	1494.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	14.3	92185.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	14.4	92641.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	14.3	91160.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	14.1	89248.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	14.0	86920.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	13.8	84193.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	13.7	81086.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	13.5	77618.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	13.3	73813.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	13.1	69695.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	12.9	65289.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	12.7	60624.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	12.4	55727.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	12.2	50630.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	11.9	45364.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	11.7	39961.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	11.4	34456.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	11.1	28882.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

53	10.8	23277.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	10.5	17675.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	2.1	2841.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	0.5	658.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	7.7	8164.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58	6.2	3882.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	3.3	687.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	161.62	542.90
2	175.48	537.17
3	189.50	531.84
4	203.67	526.92
5	217.97	522.41
6	232.41	518.33
7	246.95	514.66
8	261.60	511.43
9	276.33	508.62
10	291.14	506.24
11	306.02	504.29
12	320.94	502.78
13	335.90	501.71
14	350.89	501.07
15	365.89	500.87
16	380.89	501.10
17	395.87	501.78
18	410.83	502.89
19	425.75	504.43
20	440.62	506.41
21	455.42	508.83
22	470.15	511.67
23	484.79	514.94
24	499.33	518.64
25	513.75	522.76
26	528.05	527.30
27	542.21	532.25
28	556.22	537.61
29	570.06	543.38
30	583.73	549.55
31	597.22	556.12
32	610.51	563.08
33	623.59	570.42
34	636.45	578.14
35	649.08	586.23
36	661.47	594.69
37	673.60	603.50
38	685.48	612.67
39	697.08	622.18
40	708.40	632.02
41	719.43	642.18
42	730.16	652.67
43	740.58	663.46
44	750.67	674.55
45	760.44	685.93
46	762.29	688.21

Circle Center At X = 365.3 ; Y = 1015.2 and Radius, 514.3

*** 2.733 ***

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	164.65	543.66
2	178.32	537.49

```
      3        192.18      531.76
      4        206.22      526.47
      5        220.41      521.63
      6        234.76      517.24
      7        249.23      513.31
      8        263.83      509.84
      9        278.52      506.84
     10        293.31      504.30
     11        308.17      502.24
     12        323.08      500.65
     13        338.04      499.54
     14        353.03      498.89
     15        368.02      498.73
     16        383.02      499.04
     17        398.00      499.83
     18        412.95      501.10
     19        427.85      502.84
     20        442.68      505.05
     21        457.44      507.73
     22        472.11      510.88
     23        486.67      514.49
     24        501.10      518.56
     25        515.40      523.09
     26        529.55      528.08
     27        543.53      533.51
     28        557.34      539.38
     29        570.95      545.68
     30        584.35      552.42
     31        597.53      559.57
     32        610.48      567.15
     33        623.18      575.13
     34        635.62      583.51
     35        647.79      592.28
     36        659.67      601.43
     37        671.26      610.95
     38        682.54      620.84
     39        693.50      631.09
     40        704.13      641.67
     41        714.41      652.59
     42        724.35      663.83
     43        733.92      675.38
     44        743.12      687.22
     45        743.15      687.26
  Circle Center At X =  365.7 ; Y =  970.9  and Radius,  472.1
        ***      2.741    ***
  Failure Surface Specified By 45 Coordinate Points
    Point      X-Surf      Y-Surf
     No.        (ft)        (ft)
      1        164.65      543.66
      2        178.29      537.44
      3        192.13      531.64
      4        206.14      526.29
      5        220.31      521.37
      6        234.63      516.91
      7        249.09      512.89
      8        263.66      509.33
      9        278.33      506.23
     10        293.10      503.59
     11        307.94      501.41
     12        322.84      499.70
     13        337.79      498.46
     14        352.77      497.69
     15        367.77      497.39
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      16         382.77      497.56
      17         397.75      498.20
      18         412.71      499.31
      19         427.63      500.89
      20         442.49      502.94
      21         457.28      505.45
      22         471.98      508.43
      23         486.58      511.86
      24         501.07      515.75
      25         515.42      520.09
      26         529.64      524.89
      27         543.70      530.12
      28         557.58      535.79
      29         571.28      541.90
      30         584.78      548.43
      31         598.08      555.39
      32         611.14      562.75
      33         623.97      570.53
      34         636.55      578.70
      35         648.87      587.26
      36         660.91      596.21
      37         672.66      605.52
      38         684.12      615.21
      39         695.27      625.24
      40         706.09      635.62
      41         716.59      646.34
      42         726.74      657.38
      43         736.55      668.73
      44         745.99      680.39
      45         751.52      687.67
   Circle Center At X =  369.8 ; Y =  975.5  and Radius,  478.1
         ***      2.742   ***
   Failure Surface Specified By 45 Coordinate Points
     Point       X-Surf      Y-Surf
      No.         (ft)        (ft)
       1         157.58      541.89
       2         171.44      536.16
       3         185.47      530.85
       4         199.65      525.96
       5         213.97      521.51
       6         228.42      517.49
       7         242.99      513.91
       8         257.66      510.77
       9         272.41      508.08
      10         287.24      505.84
      11         302.14      504.04
      12         317.08      502.69
      13         332.05      501.80
      14         347.04      501.36
      15         362.04      501.38
      16         377.04      501.84
      17         392.01      502.76
      18         406.94      504.14
      19         421.83      505.96
      20         436.66      508.24
      21         451.41      510.96
      22         466.07      514.12
      23         480.63      517.73
      24         495.08      521.77
      25         509.39      526.26
      26         523.57      531.17
      27         537.58      536.51
      28         551.43      542.26
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        29        565.10      548.44
        30        578.58      555.03
        31        591.85      562.02
        32        604.91      569.41
        33        617.73      577.19
        34        630.31      585.35
        35        642.64      593.89
        36        654.71      602.80
        37        666.50      612.07
        38        678.01      621.69
        39        689.22      631.66
        40        700.12      641.96
        41        710.71      652.59
        42        720.97      663.53
        43        730.90      674.78
        44        740.48      686.32
        45        741.13      687.16
      Circle Center At X =  354.1 ; Y =  997.3  and Radius,  496.0
            ***     2.745    ***
      Failure Surface Specified By 46 Coordinate Points
        Point      X-Surf      Y-Surf
         No.        (ft)        (ft)
         1        157.58      541.89
         2        171.62      536.62
         3        185.80      531.73
         4        200.11      527.24
         5        214.54      523.16
         6        229.08      519.47
         7        243.72      516.19
         8        258.44      513.31
         9        273.24      510.85
        10        288.10      508.79
        11        303.01      507.15
        12        317.96      505.93
        13        332.94      505.12
        14        347.93      504.73
        15        362.93      504.75
        16        377.92      505.19
        17        392.90      506.04
        18        407.85      507.31
        19        422.75      509.00
        20        437.60      511.10
        21        452.39      513.61
        22        467.11      516.53
        23        481.73      519.85
        24        496.26      523.59
        25        510.68      527.72
        26        524.98      532.25
        27        539.15      537.18
        28        553.17      542.50
        29        567.04      548.20
        30        580.75      554.29
        31        594.29      560.76
        32        607.64      567.60
        33        620.79      574.81
        34        633.74      582.38
        35        646.47      590.31
        36        658.98      598.59
        37        671.26      607.21
        38        683.29      616.17
        39        695.06      625.46
        40        706.58      635.07
        41        717.82      645.00
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     42        728.78      655.24
     43        739.46      665.78
     44        749.84      676.61
     45        759.91      687.72
     46        760.24      688.11
  Circle Center At X =  354.6 ; Y = 1044.9  and Radius,  540.2
        ***     2.746   ***
  Failure Surface Specified By 47 Coordinate Points
    Point      X-Surf      Y-Surf
     No.        (ft)        (ft)
      1        160.61      542.65
      2        174.39      536.74
      3        188.34      531.23
      4        202.44      526.11
      5        216.68      521.39
      6        231.05      517.07
      7        245.53      513.16
      8        260.11      509.66
      9        274.79      506.58
     10        289.55      503.91
     11        304.38      501.66
     12        319.27      499.83
     13        334.21      498.42
     14        349.17      497.44
     15        364.16      496.87
     16        379.16      496.74
     17        394.16      497.02
     18        409.14      497.73
     19        424.10      498.86
     20        439.02      500.41
     21        453.89      502.39
     22        468.70      504.78
     23        483.43      507.59
     24        498.08      510.82
     25        512.63      514.46
     26        527.07      518.51
     27        541.40      522.96
     28        555.59      527.82
     29        569.64      533.08
     30        583.53      538.73
     31        597.26      544.77
     32        610.81      551.20
     33        624.18      558.01
     34        637.35      565.19
     35        650.31      572.74
     36        663.05      580.66
     37        675.56      588.93
     38        687.84      597.55
     39        699.86      606.52
     40        711.63      615.82
     41        723.13      625.45
     42        734.35      635.40
     43        745.29      645.67
     44        755.93      656.24
     45        766.27      667.11
     46        776.30      678.26
     47        785.75      689.38
  Circle Center At X =  376.6 ; Y = 1027.6  and Radius,  530.8
        ***     2.749   ***
  Failure Surface Specified By 44 Coordinate Points
    Point      X-Surf      Y-Surf
     No.        (ft)        (ft)
      1        164.65      543.66
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    2        178.34      537.55
    3        192.23      531.87
    4        206.29      526.65
    5        220.51      521.89
    6        234.88      517.58
    7        249.38      513.74
    8        264.00      510.36
    9        278.72      507.46
   10        293.52      505.04
   11        308.39      503.09
   12        323.32      501.62
   13        338.29      500.63
   14        353.28      500.13
   15        368.28      500.11
   16        383.27      500.57
   17        398.24      501.51
   18        413.17      502.93
   19        428.05      504.83
   20        442.86      507.22
   21        457.59      510.07
   22        472.21      513.40
   23        486.72      517.20
   24        501.11      521.46
   25        515.34      526.19
   26        529.42      531.37
   27        543.32      536.99
   28        557.04      543.07
   29        570.55      549.58
   30        583.85      556.53
   31        596.91      563.89
   32        609.73      571.68
   33        622.30      579.87
   34        634.59      588.47
   35        646.60      597.45
   36        658.32      606.82
   37        669.73      616.56
   38        680.82      626.66
   39        691.58      637.11
   40        701.99      647.90
   41        712.06      659.02
   42        721.76      670.47
   43        731.09      682.21
   44        733.88      685.97
Circle Center At X =  361.5 ; Y =  966.0  and Radius,  465.9
      ***      2.749    ***
Failure Surface Specified By 48 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        153.54      540.88
    2        167.55      535.54
    3        181.71      530.57
    4        195.98      525.97
    5        210.38      521.75
    6        224.88      517.91
    7        239.47      514.45
    8        254.15      511.38
    9        268.91      508.69
   10        283.73      506.39
   11        298.61      504.48
   12        313.53      502.96
   13        328.49      501.84
   14        343.47      501.11
   15        358.47      500.77
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    16        373.47      500.82
    17        388.46      501.27
    18        403.44      502.12
    19        418.39      503.35
    20        433.30      504.98
    21        448.16      507.00
    22        462.97      509.41
    23        477.71      512.21
    24        492.36      515.40
    25        506.93      518.96
    26        521.40      522.91
    27        535.77      527.24
    28        550.01      531.94
    29        564.12      537.02
    30        578.10      542.47
    31        591.93      548.28
    32        605.60      554.45
    33        619.11      560.98
    34        632.43      567.86
    35        645.58      575.09
    36        658.53      582.66
    37        671.27      590.57
    38        683.80      598.81
    39        696.12      607.38
    40        708.20      616.27
    41        720.05      625.47
    42        731.64      634.98
    43        742.99      644.79
    44        754.07      654.90
    45        764.89      665.29
    46        775.43      675.97
    47        785.68      686.92
    48        787.97      689.49
Circle Center At X =  363.8 ; Y = 1071.6  and Radius,  570.9
      ***     2.751   ***
Failure Surface Specified By 48 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
    1         152.53      540.63
    2         166.63      535.53
    3         180.86      530.78
    4         195.20      526.39
    5         209.65      522.36
    6         224.20      518.70
    7         238.83      515.41
    8         253.54      512.48
    9         268.33      509.93
   10         283.17      507.75
   11         298.06      505.95
   12         312.99      504.52
   13         327.95      503.46
   14         342.94      502.79
   15         357.93      502.49
   16         372.93      502.56
   17         387.93      503.02
   18         402.90      503.85
   19         417.85      505.06
   20         432.77      506.65
   21         447.64      508.61
   22         462.46      510.95
   23         477.21      513.65
   24         491.89      516.73
   25         506.49      520.18
```

26	521.00	523.99
27	535.41	528.17
28	549.70	532.71
29	563.88	537.60
30	577.93	542.85
31	591.85	548.46
32	605.61	554.41
33	619.23	560.71
34	632.68	567.35
35	645.96	574.32
36	659.06	581.63
37	671.97	589.26
38	684.69	597.22
39	697.20	605.49
40	709.50	614.08
41	721.58	622.98
42	733.43	632.17
43	745.04	641.66
44	756.42	651.44
45	767.54	661.50
46	778.41	671.85
47	789.01	682.46
48	796.08	689.90

Circle Center At X = 362.3 ; Y = 1098.1 and Radius, 595.6
*** 2.752 ***
** PCSTABL5M3 **

SECTION CC′
Block Failure Mode (Final Conditions)

```
                    ** PCSTABL5M3 **
                by Purdue University 1985
             rev. for SCS Engineers HVA 2008
              --Slope Stability Analysis--
           Simplified Janbu, Simplified Bishop
              or Spencer`s Method of Slices
Run Date:                 4/19/2019
Time of Run:              11:14AM
Run By:                   Username
Input Data Filename:      M:waco xs c - block.
Output Filename:          M:waco xs c - block.OUT
Unit:                     ENGLISH
Plotted Output Filename:  M:waco xs c - block.PLT
PROBLEM DESCRIPTION   Waco Landfill
                      Cross-Section C-Block
BOUNDARY COORDINATES
     Note: User origin value specified.
     Add 0.00 to X-values and 0.00 to Y-values listed.

   12 Top   Boundaries
   22 Total Boundaries
Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
   No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
    1         0.00     530.00      31.40     529.40        1
    2        31.40     529.40      60.20     537.50        1
    3        60.20     537.50      72.30     541.30        1
    4        72.30     541.30      74.30     541.30        1
    5        74.30     541.30     101.60     532.20        1
    6       101.60     532.20     111.60     532.20        1
    7       111.60     532.20     127.30     537.40        1
    8       127.30     537.40     135.00     540.00        2
    9       135.00     540.00     150.00     540.00        2
   10       150.00     540.00     738.00     687.00        2
   11       738.00     687.00     950.60     697.60        2
   12       950.60     697.60    1202.60     688.00        2
   13       127.30     537.40     154.20     537.40        1
   14       154.20     537.40     162.20     539.40        2
   15       162.20     539.40     738.50     683.50        3
   16       738.50     683.50     950.60     694.10        3
   17       950.60     694.10    1202.40     684.50        3
   18       162.20     539.40     171.00     539.30        4
   19       171.00     539.30     247.10     514.20        4
   20       247.10     514.20     575.90     520.20        5
   21       575.90     520.20     909.60     519.40        5
   22       909.60     519.40    1202.60     524.90        5
ISOTROPIC SOIL PARAMETERS
  5 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction  Pore   Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept  Angle  Pressure Constant Surface
 No.  (pcf)    (pcf)     (psf)    (deg)   Param.    (psf)    No.
  1   128.0    128.0       0.0     25.0    0.00       0.0      1
  2   120.0    120.0     200.0     20.0    0.00       0.0      1
  3    60.0     60.0     200.0     32.0    0.00       0.0      1
  4   100.0    100.0       0.0     15.0    0.00       0.0      1
  5   100.0    100.0       0.0     11.0    0.00       0.0      1
1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
Unit Weight of Water =  62.40
Piezometric Surface No.  1 Specified by  2 Coordinate Points
  Point      X-Water     Y-Water
   No.        (ft)        (ft)
    1         0.00      513.00
    2      1200.00      513.00
A Critical Failure Surface Searching Method, Using A Random
```

Technique For Generating Sliding Block Surfaces, Has Been Specified.
500 Trial Surfaces Have Been Generated.
3 Boxes Specified For Generation Of Central Block Base
Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 10.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	171.00	538.50	200.00	529.50	1.00
2	247.10	513.00	247.10	513.00	1.00
3	300.00	514.00	900.00	518.00	1.00

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Janbu Method * *
Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	168.46	544.61
2	169.11	544.25
3	176.27	537.27
4	247.10	513.27
5	595.86	516.15
6	602.45	523.67
7	609.20	531.05
8	615.67	538.67
9	622.70	545.78
10	629.19	553.40
11	635.54	561.12
12	642.52	568.28
13	649.59	575.35
14	656.02	583.01
15	659.26	592.47
16	665.86	599.99
17	672.88	607.11
18	679.91	614.22
19	686.72	621.54
20	691.84	630.13
21	698.86	637.26
22	705.35	644.86
23	711.10	653.05
24	715.07	662.23
25	718.03	671.78
26	721.00	681.32
27	722.64	683.16

*** 1.635 ***

Individual data on the 31 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.6	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.6	639.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	4.2	2455.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.5	346.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	70.8	145380.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	328.8	1895978.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	20.0	166815.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	3.5	29169.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	3.1	24910.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	6.7	52709.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	6.5	48311.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	7.0	50063.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

13	6.5	43964.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	6.4	40763.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	7.0	42396.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	7.1	40656.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	6.4	34755.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	3.2	16128.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	6.6	29886.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	7.0	29466.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	7.0	27244.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	6.8	24120.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	5.1	16182.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	7.0	19465.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	6.5	15815.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	5.7	11797.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	4.0	6376.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	3.0	3241.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	2.2	1414.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.7	225.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	1.6	140.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	165.73	543.93
2	171.22	538.51
3	247.10	512.68
4	622.81	515.85
5	627.65	524.60
6	634.71	531.69
7	641.72	538.82
8	645.01	548.26
9	651.88	555.52
10	658.43	563.08
11	665.48	570.17
12	670.84	578.62
13	674.77	587.81
14	681.83	594.89
15	684.45	604.54
16	691.38	611.75
17	693.15	621.60
18	700.22	628.67
19	707.22	635.81
20	713.33	643.72
21	718.99	651.97
22	719.68	661.94
23	723.48	671.20
24	730.55	678.27
25	737.23	685.70
26	737.86	686.96

*** 1.715 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	165.73	543.93
2	171.22	538.51
3	247.10	512.68
4	622.81	515.85
5	627.65	524.60
6	634.71	531.69
7	641.72	538.82
8	645.01	548.26
9	651.88	555.52
10	658.43	563.08
11	665.48	570.17

```
     12         670.84      578.62
     13         674.77      587.81
     14         681.83      594.89
     15         684.45      604.54
     16         691.38      611.75
     17         693.15      621.60
     18         700.22      628.67
     19         707.22      635.81
     20         713.33      643.72
     21         718.99      651.97
     22         719.68      661.94
     23         723.48      671.20
     24         730.55      678.27
     25         737.23      685.70
     26         737.86      686.96
        ***      1.715   ***
   Failure Surface Specified By 26 Coordinate Points
     Point      X-Surf      Y-Surf
      No.        (ft)        (ft)
      1         165.73      543.93
      2         171.22      538.51
      3         247.10      512.68
      4         622.81      515.85
      5         627.65      524.60
      6         634.71      531.69
      7         641.72      538.82
      8         645.01      548.26
      9         651.88      555.52
     10         658.43      563.08
     11         665.48      570.17
     12         670.84      578.62
     13         674.77      587.81
     14         681.83      594.89
     15         684.45      604.54
     16         691.38      611.75
     17         693.15      621.60
     18         700.22      628.67
     19         707.22      635.81
     20         713.33      643.72
     21         718.99      651.97
     22         719.68      661.94
     23         723.48      671.20
     24         730.55      678.27
     25         737.23      685.70
     26         737.86      686.96
        ***      1.715   ***
   Failure Surface Specified By 28 Coordinate Points
     Point      X-Surf      Y-Surf
      No.        (ft)        (ft)
      1         162.66      543.16
      2         163.95      541.91
      3         173.95      541.85
      4         183.01      537.63
      5         191.11      531.76
      6         247.10      512.57
      7         642.88      516.05
      8         649.77      523.30
      9         656.51      530.69
     10         660.22      539.98
     11         666.56      547.71
     12         673.59      554.82
     13         678.76      563.38
     14         684.40      571.64
```

```
   15        688.40      580.80
   16        689.83      590.70
   17        696.19      598.42
   18        703.24      605.51
   19        704.95      615.36
   20        711.08      623.26
   21        717.30      631.09
   22        724.22      638.31
   23        728.24      647.47
   24        734.73      655.07
   25        740.88      662.96
   26        745.91      671.60
   27        748.06      681.37
   28        752.98      687.75
      ***      1.732   ***
Failure Surface Specified By 28 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
    1        162.66      543.16
    2        163.95      541.91
    3        173.95      541.85
    4        183.01      537.63
    5        191.11      531.76
    6        247.10      512.57
    7        642.88      516.05
    8        649.77      523.30
    9        656.51      530.69
   10        660.22      539.98
   11        666.56      547.71
   12        673.59      554.82
   13        678.76      563.38
   14        684.40      571.64
   15        688.40      580.80
   16        689.83      590.70
   17        696.19      598.42
   18        703.24      605.51
   19        704.95      615.36
   20        711.08      623.26
   21        717.30      631.09
   22        724.22      638.31
   23        728.24      647.47
   24        734.73      655.07
   25        740.88      662.96
   26        745.91      671.60
   27        748.06      681.37
   28        752.98      687.75
      ***      1.732   ***
Failure Surface Specified By 28 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
    1        162.66      543.16
    2        163.95      541.91
    3        173.95      541.85
    4        183.01      537.63
    5        191.11      531.76
    6        247.10      512.57
    7        642.88      516.05
    8        649.77      523.30
    9        656.51      530.69
   10        660.22      539.98
   11        666.56      547.71
   12        673.59      554.82
   13        678.76      563.38
```

```
     14         684.40      571.64
     15         688.40      580.80
     16         689.83      590.70
     17         696.19      598.42
     18         703.24      605.51
     19         704.95      615.36
     20         711.08      623.26
     21         717.30      631.09
     22         724.22      638.31
     23         728.24      647.47
     24         734.73      655.07
     25         740.88      662.96
     26         745.91      671.60
     27         748.06      681.37
     28         752.98      687.75
        ***      1.732   ***
 Failure Surface Specified By 27 Coordinate Points
   Point        X-Surf       Y-Surf
    No.          (ft)         (ft)
     1          165.79      543.95
     2          167.68      542.06
     3          176.34      537.06
     4          247.10      512.55
     5          698.25      516.20
     6          704.75      523.80
     7          711.77      530.93
     8          718.79      538.05
     9          725.79      545.19
    10          727.43      555.05
    11          731.83      564.03
    12          737.90      571.98
    13          744.96      579.07
    14          751.93      586.24
    15          757.91      594.25
    16          764.55      601.72
    17          769.29      610.53
    18          772.07      620.14
    19          778.93      627.41
    20          784.89      635.44
    21          790.29      643.86
    22          794.77      652.80
    23          798.75      661.98
    24          803.23      670.91
    25          808.47      679.43
    26          814.60      687.33
    27          816.22      690.90
        ***      1.734   ***
 Failure Surface Specified By 27 Coordinate Points
   Point        X-Surf       Y-Surf
    No.          (ft)         (ft)
     1          165.79      543.95
     2          167.68      542.06
     3          176.34      537.06
     4          247.10      512.55
     5          698.25      516.20
     6          704.75      523.80
     7          711.77      530.93
     8          718.79      538.05
     9          725.79      545.19
    10          727.43      555.05
    11          731.83      564.03
    12          737.90      571.98
    13          744.96      579.07
```

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     14        751.93      586.24
     15        757.91      594.25
     16        764.55      601.72
     17        769.29      610.53
     18        772.07      620.14
     19        778.93      627.41
     20        784.89      635.44
     21        790.29      643.86
     22        794.77      652.80
     23        798.75      661.98
     24        803.23      670.91
     25        808.47      679.43
     26        814.60      687.33
     27        816.22      690.90
        ***      1.734   ***
 Failure Surface Specified By 27 Coordinate Points
   Point       X-Surf      Y-Surf
    No.         (ft)        (ft)
      1        165.79      543.95
      2        167.68      542.06
      3        176.34      537.06
      4        247.10      512.55
      5        698.25      516.20
      6        704.75      523.80
      7        711.77      530.93
      8        718.79      538.05
      9        725.79      545.19
     10        727.43      555.05
     11        731.83      564.03
     12        737.90      571.98
     13        744.96      579.07
     14        751.93      586.24
     15        757.91      594.25
     16        764.55      601.72
     17        769.29      610.53
     18        772.07      620.14
     19        778.93      627.41
     20        784.89      635.44
     21        790.29      643.86
     22        794.77      652.80
     23        798.75      661.98
     24        803.23      670.91
     25        808.47      679.43
     26        814.60      687.33
     27        816.22      690.90
        ***      1.734   ***
```

SECTION DD′

Circular Failure Mode (Final Conditions)

```
                    ** PCSTABL5M3 **
                by Purdue University 1985
             rev. for SCS Engineers HVA 2008
              --Slope Stability Analysis--
           Simplified Janbu, Simplified Bishop
              or Spencer`s Method of Slices
    Run Date:                 3/4/2019
    Time of Run:              02:30PM
    Run By:                   SCS Engineers
    Input Data Filename:      M:waco xs d - circular.
    Output Filename:          M:waco xs d - circular.OUT
    Unit:                     ENGLISH
    Plotted Output Filename:  M:waco xs d - circular.PLT
    PROBLEM DESCRIPTION   Waco Landfill
                          Cross-Section D-Circular
    BOUNDARY COORDINATES
         Note: User origin value specified.
         Add 0.00 to X-values and 0.00 to Y-values listed.

       10 Top   Boundaries
       24 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     531.80      57.80     537.70        1
        2         57.80     537.70      65.30     535.60        1
        3         65.30     535.60      75.30     535.60        1
        4         75.30     535.60      82.60     538.00        1
        5         82.60     538.00      88.60     540.00        2
        6         88.60     540.00      90.30     540.60        2
        7         90.30     540.60     105.30     540.60        2
        8        105.30     540.60     690.80     687.00        2
        9        690.80     687.00     869.50     695.50        2
       10        869.50     695.50    1021.90     688.00        2
       11         88.60     540.00     115.40     540.00        2
       12        115.40     540.00     690.80     683.50        3
       13        690.80     683.50     869.50     692.00        3
       14        869.50     692.00    1021.90     684.50        3
       15        115.40     540.00     126.60     540.00        2
       16        126.60     540.00     211.00     511.90        2
       17        211.00     511.90     550.80     516.50        2
       18        550.80     516.50     710.80     518.70        2
       19        710.80     518.70    1021.90     520.90        2
       20         82.60     538.00     126.30     538.00        1
       21        126.30     538.00     210.70     509.90        1
       22        210.70     509.90     550.80     514.50        1
       23        550.80     514.50     710.80     516.70        1
       24        710.80     516.70    1021.90     518.90        1

   ISOTROPIC SOIL PARAMETERS
     3 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction  Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)     No.
      1   128.0    128.0       0.0     25.0    0.00       0.0      1
      2   120.0    120.0     200.0     20.0    0.00       0.0      1
      3    60.0     60.0     200.0     32.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
    Unit Weight of Water =  62.40
    Piezometric Surface No.  1 Specified by  3 Coordinate Points
      Point      X-Water     Y-Water
       No.        (ft)        (ft)
        1          0.00      520.00
        2        126.30      509.50
```

```
        3       1020.00      518.00
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
  10000 Trial Surfaces Have Been Generated.
    100 Surfaces Initiate From Each Of100 Points Equally Spaced
    Along The Ground Surface Between  X =  50.00 ft.
                                 and  X = 200.00 ft.
    Each Surface Terminates Between   X = 500.00 ft.
                                and   X = 900.00 ft.
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =  0.00 ft.
    15.00 ft. Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Examined.  They Are Ordered - Most Critical
          First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Failure Surface Specified By 48 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1        112.12      542.31
              2        126.07      536.79
              3        140.16      531.65
              4        154.39      526.89
              5        168.73      522.50
              6        183.19      518.50
              7        197.74      514.88
              8        212.39      511.64
              9        227.12      508.80
             10        241.92      506.34
             11        256.77      504.28
             12        271.68      502.62
             13        286.63      501.35
             14        301.60      500.47
             15        316.59      499.99
             16        331.59      499.91
             17        346.59      500.23
             18        361.57      500.95
             19        376.53      502.06
             20        391.46      503.57
             21        406.34      505.47
             22        421.16      507.76
             23        435.92      510.45
             24        450.60      513.53
             25        465.19      516.99
             26        479.69      520.84
             27        494.08      525.08
             28        508.35      529.69
             29        522.50      534.68
             30        536.51      540.04
             31        550.37      545.77
             32        564.07      551.87
             33        577.61      558.33
             34        590.97      565.14
             35        604.15      572.31
             36        617.14      579.82
             37        629.91      587.68
             38        642.48      595.87
             39        654.83      604.38
             40        666.94      613.23
             41        678.82      622.39
             42        690.45      631.86
             43        701.83      641.64
             44        712.94      651.72
```

45	723.78	662.08
46	734.34	672.73
47	744.62	683.66
48	750.11	689.82

Circle Center At X = 327.1 ; Y = 1065.9 and Radius, 566.0

*** 2.763 ***

Individual data on the 63 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.8	909.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1.0	390.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	5.1	2893.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	3.1	2533.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.2	213.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.3	285.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	13.6	16641.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	14.2	24789.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	14.3	31845.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	14.5	38274.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	6.7	19598.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	7.9	24464.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	12.8	42873.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.7	2278.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	1.2	4159.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	6.5	24031.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	1.8	6872.8	0.0	20.6	0.0	0.0	0.0	0.0	0.0
18	6.4	25675.4	0.0	412.0	0.0	0.0	0.0	0.0	0.0
19	14.8	65296.9	0.0	2768.8	0.0	0.0	0.0	0.0	0.0
20	14.9	73369.8	0.0	5013.3	0.0	0.0	0.0	0.0	0.0
21	14.9	80710.5	0.0	6889.8	0.0	0.0	0.0	0.0	0.0
22	14.9	87291.8	0.0	8397.2	0.0	0.0	0.0	0.0	0.0
23	15.0	93089.4	0.0	9534.3	0.0	0.0	0.0	0.0	0.0
24	9.4	61103.6	0.0	6404.3	0.0	0.0	0.0	0.0	0.0
25	5.6	36979.8	0.0	3896.0	0.0	0.0	0.0	0.0	0.0
26	15.0	102257.2	0.0	10694.6	0.0	0.0	0.0	0.0	0.0
27	15.0	105598.2	0.0	10717.0	0.0	0.0	0.0	0.0	0.0
28	15.0	108097.4	0.0	10367.5	0.0	0.0	0.0	0.0	0.0
29	15.0	109749.5	0.0	9646.4	0.0	0.0	0.0	0.0	0.0
30	14.9	110553.6	0.0	8554.0	0.0	0.0	0.0	0.0	0.0
31	14.9	110511.8	0.0	7091.3	0.0	0.0	0.0	0.0	0.0
32	14.8	109630.5	0.0	5259.1	0.0	0.0	0.0	0.0	0.0
33	14.8	107920.1	0.0	3058.9	0.0	0.0	0.0	0.0	0.0
34	10.0	71818.4	0.0	633.8	0.0	0.0	0.0	0.0	0.0
35	2.8	19700.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	2.0	13878.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	7.2	50935.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	7.4	51736.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	14.5	101632.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	14.4	100518.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	14.3	98988.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	14.1	97054.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	14.0	94729.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	13.9	92027.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	13.7	88964.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	13.5	85559.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	13.4	81831.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	13.2	77800.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	13.0	73489.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	12.8	68922.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	12.6	64123.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	12.3	59117.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
 53   12.1      53934.1       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 54   11.9      48599.6       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 55   11.6      43144.0       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 56    0.3       1226.8       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 57   11.0      35628.9       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 58   11.1      29742.3       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 59   10.8      22708.3       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 60   10.6      15787.8       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 61   10.3       9013.9       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 62    2.2       1099.6       0.0        0.0      0.0      0.0      0.0      0.0      0.0
 63    3.3        684.5       0.0        0.0      0.0      0.0      0.0      0.0      0.0
          Failure Surface Specified By 44 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1        110.61      541.93
              2        124.54      536.36
              3        138.63      531.22
              4        152.86      526.50
              5        167.24      522.20
              6        181.73      518.33
              7        196.33      514.90
              8        211.03      511.91
              9        225.81      509.35
             10        240.66      507.24
             11        255.57      505.56
             12        270.52      504.34
             13        285.50      503.56
             14        300.49      503.22
             15        315.49      503.34
             16        330.48      503.90
             17        345.45      504.90
             18        360.38      506.36
             19        375.26      508.25
             20        390.07      510.59
             21        404.81      513.37
             22        419.46      516.59
             23        434.01      520.24
             24        448.45      524.33
             25        462.75      528.84
             26        476.91      533.78
             27        490.93      539.14
             28        504.77      544.91
             29        518.44      551.09
             30        531.91      557.68
             31        545.19      564.66
             32        558.25      572.04
             33        571.08      579.80
             34        583.68      587.95
             35        596.03      596.46
             36        608.12      605.34
             37        619.94      614.58
             38        631.48      624.16
             39        642.73      634.08
             40        653.67      644.34
             41        664.31      654.91
             42        674.63      665.80
             43        684.62      676.99
             44        693.12      687.11
          Circle Center At X =  304.2 ; Y = 1006.4  and Radius,  503.2
                ***     2.766   ***
          Failure Surface Specified By 47 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
```

1	112.12	542.31
2	125.98	536.57
3	140.00	531.22
4	154.15	526.27
5	168.45	521.71
6	182.86	517.56
7	197.38	513.80
8	212.00	510.46
9	226.71	507.53
10	241.50	505.01
11	256.35	502.90
12	271.26	501.21
13	286.20	499.93
14	301.18	499.08
15	316.17	498.64
16	331.17	498.62
17	346.17	499.02
18	361.14	499.84
19	376.09	501.08
20	391.00	502.74
21	405.86	504.81
22	420.65	507.29
23	435.37	510.19
24	450.00	513.50
25	464.53	517.21
26	478.95	521.33
27	493.26	525.86
28	507.43	530.78
29	521.45	536.09
30	535.33	541.79
31	549.03	547.88
32	562.57	554.35
33	575.91	561.20
34	589.07	568.41
35	602.01	575.99
36	614.74	583.93
37	627.24	592.23
38	639.50	600.86
39	651.52	609.84
40	663.28	619.15
41	674.77	628.78
42	686.00	638.74
43	696.94	649.00
44	707.59	659.56
45	717.94	670.42
46	727.98	681.56
47	734.38	689.07

Circle Center At X = 324.3 ; Y = 1035.3 and Radius, 536.7
*** 2.766 ***
Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	119.70	544.20
2	133.44	538.19
3	147.35	532.58
4	161.42	527.38
5	175.64	522.59
6	189.99	518.23
7	204.46	514.28
8	219.04	510.76
9	233.72	507.66
10	248.48	505.00
11	263.31	502.77

```
     12         278.20      500.97
     13         293.14      499.61
     14         308.11      498.68
     15         323.11      498.20
     16         338.11      498.15
     17         353.10      498.54
     18         368.08      499.37
     19         383.02      500.63
     20         397.93      502.34
     21         412.77      504.47
     22         427.55      507.05
     23         442.25      510.05
     24         456.85      513.48
     25         471.35      517.33
     26         485.72      521.61
     27         499.97      526.30
     28         514.07      531.41
     29         528.02      536.93
     30         541.80      542.86
     31         555.40      549.18
     32         568.81      555.90
     33         582.02      563.01
     34         595.02      570.51
     35         607.79      578.37
     36         620.32      586.61
     37         632.61      595.22
     38         644.64      604.17
     39         656.41      613.48
     40         667.89      623.12
     41         679.10      633.10
     42         690.00      643.40
     43         700.60      654.01
     44         710.88      664.93
     45         720.85      676.15
     46         730.47      687.65
     47         731.49      688.94
Circle Center At X =  332.2 ; Y = 1011.3  and Radius,  513.1
      ***     2.766    ***
Failure Surface Specified By 44 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1       116.67      543.44
    2       130.36      537.33
    3       144.25      531.65
    4       158.31      526.43
    5       172.53      521.66
    6       186.90      517.35
    7       201.40      513.50
    8       216.01      510.12
    9       230.72      507.20
   10       245.53      504.77
   11       260.40      502.80
   12       275.32      501.32
   13       290.29      500.32
   14       305.28      499.79
   15       320.28      499.75
   16       335.27      500.19
   17       350.25      501.11
   18       365.18      502.51
   19       380.06      504.38
   20       394.88      506.74
   21       409.61      509.56
   22       424.24      512.86
```

```
      23        438.76      516.63
      24        453.15      520.86
      25        467.40      525.55
      26        481.49      530.69
      27        495.41      536.29
      28        509.14      542.33
      29        522.67      548.80
      30        535.98      555.71
      31        549.07      563.04
      32        561.92      570.78
      33        574.51      578.93
      34        586.83      587.49
      35        598.87      596.43
      36        610.62      605.76
      37        622.07      615.45
      38        633.19      625.51
      39        643.99      635.92
      40        654.45      646.68
      41        664.56      657.76
      42        674.31      669.16
      43        683.68      680.87
      44        687.70      686.22
   Circle Center At X =  314.1 ; Y =  967.1  and Radius,  467.4
         ***      2.767    ***
   Failure Surface Specified By 46 Coordinate Points
     Point      X-Surf      Y-Surf
      No.        (ft)        (ft)
       1        116.67      543.44
       2        130.31      537.22
       3        144.15      531.41
       4        158.15      526.04
       5        172.31      521.09
       6        186.62      516.58
       7        201.05      512.50
       8        215.61      508.88
       9        230.27      505.70
      10        245.01      502.96
      11        259.84      500.69
      12        274.73      498.86
      13        289.67      497.49
      14        304.64      496.58
      15        319.63      496.13
      16        334.63      496.14
      17        349.62      496.61
      18        364.60      497.53
      19        379.53      498.91
      20        394.42      500.75
      21        409.24      503.05
      22        423.99      505.79
      23        438.65      508.99
      24        453.20      512.63
      25        467.63      516.72
      26        481.93      521.24
      27        496.09      526.20
      28        510.08      531.60
      29        523.91      537.41
      30        537.55      543.65
      31        550.99      550.30
      32        564.23      557.37
      33        577.24      564.83
      34        590.02      572.68
      35        602.55      580.93
      36        614.82      589.55
```

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     37        626.83      598.55
     38        638.55      607.91
     39        649.98      617.62
     40        661.11      627.68
     41        671.92      638.07
     42        682.42      648.79
     43        692.58      659.83
     44        702.39      671.17
     45        711.86      682.80
     46        715.98      688.20
Circle Center At X =  326.9 ; Y =  986.2  and Radius,  490.1
      ***     2.769   ***
Failure Surface Specified By 45 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1        115.15      543.06
     2        128.82      536.89
     3        142.68      531.15
     4        156.71      525.85
     5        170.90      520.98
     6        185.24      516.57
     7        199.70      512.60
     8        214.28      509.08
     9        228.97      506.02
    10        243.74      503.42
    11        258.59      501.29
    12        273.50      499.62
    13        288.45      498.41
    14        303.43      497.68
    15        318.43      497.41
    16        333.43      497.61
    17        348.41      498.27
    18        363.37      499.41
    19        378.28      501.01
    20        393.14      503.08
    21        407.93      505.61
    22        422.62      508.60
    23        437.22      512.04
    24        451.71      515.94
    25        466.06      520.30
    26        480.27      525.09
    27        494.33      530.33
    28        508.21      536.01
    29        521.91      542.11
    30        535.42      548.65
    31        548.71      555.59
    32        561.78      562.96
    33        574.61      570.72
    34        587.20      578.88
    35        599.52      587.44
    36        611.57      596.37
    37        623.34      605.67
    38        634.81      615.34
    39        645.97      625.36
    40        656.81      635.72
    41        667.33      646.42
    42        677.50      657.44
    43        687.33      668.77
    44        696.80      680.41
    45        702.24      687.54
Circle Center At X =  319.5 ; Y =  977.7  and Radius,  480.3
      ***     2.775   ***
Failure Surface Specified By 47 Coordinate Points
```

Point No.	X-Surf (ft)	Y-Surf (ft)
1	115.15	543.06
2	129.13	537.61
3	143.24	532.54
4	157.49	527.86
5	171.86	523.56
6	186.35	519.66
7	200.93	516.15
8	215.61	513.04
9	230.36	510.33
10	245.18	508.03
11	260.06	506.13
12	274.99	504.63
13	289.95	503.54
14	304.93	502.86
15	319.93	502.58
16	334.93	502.71
17	349.92	503.25
18	364.89	504.20
19	379.83	505.56
20	394.72	507.32
21	409.57	509.49
22	424.34	512.05
23	439.05	515.02
24	453.66	518.39
25	468.18	522.16
26	482.60	526.32
27	496.89	530.87
28	511.05	535.80
29	525.08	541.12
30	538.95	546.82
31	552.67	552.90
32	566.21	559.34
33	579.58	566.15
34	592.75	573.32
35	605.73	580.85
36	618.49	588.73
37	631.04	596.95
38	643.35	605.51
39	655.43	614.41
40	667.27	623.62
41	678.85	633.16
42	690.16	643.01
43	701.20	653.16
44	711.96	663.61
45	722.44	674.35
46	732.62	685.37
47	735.92	689.15

Circle Center At X = 322.5 ; Y = 1054.0 and Radius, 551.4

*** 2.786 ***

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	116.67	543.44
2	130.19	536.96
3	143.92	530.90
4	157.83	525.28
5	171.90	520.11
6	186.14	515.37
7	200.51	511.09
8	215.01	507.25
9	229.63	503.88

```
      10        244.34      500.97
      11        259.14      498.52
      12        274.01      496.54
      13        288.93      495.03
      14        303.90      493.99
      15        318.89      493.42
      16        333.89      493.32
      17        348.88      493.69
      18        363.86      494.53
      19        378.80      495.84
      20        393.70      497.63
      21        408.53      499.88
      22        423.28      502.59
      23        437.94      505.77
      24        452.49      509.41
      25        466.92      513.50
      26        481.22      518.05
      27        495.36      523.04
      28        509.34      528.47
      29        523.14      534.34
      30        536.76      540.65
      31        550.16      547.37
      32        563.35      554.52
      33        576.31      562.08
      34        589.02      570.04
      35        601.48      578.39
      36        613.67      587.14
      37        625.57      596.26
      38        637.19      605.75
      39        648.50      615.60
      40        659.49      625.81
      41        670.16      636.35
      42        680.49      647.23
      43        690.48      658.42
      44        700.11      669.92
      45        709.37      681.72
      46        714.06      688.11
 Circle Center At X =   329.5 ; Y =  970.2  and Radius,  476.9
       ***      2.788    ***
 Failure Surface Specified By 46 Coordinate Points
   Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
       1        122.73      544.96
       2        136.35      538.68
       3        150.16      532.82
       4        164.13      527.37
       5        178.27      522.36
       6        192.55      517.77
       7        206.97      513.61
       8        221.50      509.90
       9        236.14      506.62
      10        250.87      503.80
      11        265.68      501.41
      12        280.55      499.48
      13        295.48      498.00
      14        310.44      496.97
      15        325.43      496.39
      16        340.43      496.27
      17        355.43      496.60
      18        370.41      497.38
      19        385.36      498.62
      20        400.26      500.31
      21        415.11      502.45
```

```
         22        429.88      505.04
         23        444.57      508.07
         24        459.16      511.55
         25        473.64      515.46
         26        488.00      519.81
         27        502.21      524.60
         28        516.28      529.81
         29        530.18      535.45
         30        543.90      541.50
         31        557.44      547.97
         32        570.77      554.84
         33        583.89      562.12
         34        596.78      569.78
         35        609.44      577.84
         36        621.84      586.27
         37        633.99      595.07
         38        645.86      604.24
         39        657.45      613.76
         40        668.74      623.63
         41        679.74      633.84
         42        690.42      644.37
         43        700.77      655.23
         44        710.79      666.39
         45        720.47      677.85
         46        729.19      688.83
      Circle Center At X =  337.0 ; Y =  991.9  and Radius,  495.7
            ***      2.789   ***
```

SECTION DD′

Block Failure Mode (Final Conditions)

```
                    ** PCSTABL5M3 **
                by Purdue University 1985
             rev. for SCS Engineers HVA 2008
              --Slope Stability Analysis--
           Simplified Janbu, Simplified Bishop
              or Spencer`s Method of Slices
    Run Date:                 4/19/2019
    Time of Run:              11:50AM
    Run By:                   Username
    Input Data Filename:      M:waco xs d - block.
    Output Filename:          M:waco xs d - block.OUT
    Unit:                     ENGLISH
    Plotted Output Filename:  M:waco xs d - block.PLT
    PROBLEM DESCRIPTION   Waco Landfill
                          Cross-Section D-Block
    BOUNDARY COORDINATES
         Note: User origin value specified.
         Add 0.00 to X-values and 0.00 to Y-values listed.

       10 Top   Boundaries
       19 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     531.80      57.80     537.70        1
        2         57.80     537.70      65.30     535.60        1
        3         65.30     535.60      75.30     535.60        1
        4         75.30     535.60      82.60     538.00        1
        5         82.60     538.00      88.60     540.00        2
        6         88.60     540.00      90.30     540.60        2
        7         90.30     540.60     105.30     540.60        2
        8        105.30     540.60     690.80     687.00        2
        9        690.80     687.00     869.50     695.50        2
       10        869.50     695.50    1021.90     688.00        2
       11         88.60     540.00     115.40     540.00        2
       12        115.40     540.00     690.80     683.50        3
       13        690.80     683.50     869.50     692.00        3
       14        869.50     692.00    1021.90     684.50        3
       15        115.40     540.00     126.60     540.00        4
       16        126.60     540.00     211.00     511.90        4
       17        211.00     511.90     550.80     516.50        5
       18        550.80     516.50     710.80     518.70        5
       19        710.80     518.70    1021.90     520.90        5
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction  Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept  Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)    (deg)   Param.    (psf)    No.
      1   128.0    128.0      0.0     25.0    0.00       0.0      1
      2   120.0    120.0    200.0     20.0    0.00       0.0      1
      3    60.0     60.0    200.0     32.0    0.00       0.0      1
      4   100.0    100.0      0.0     15.0    0.00       0.0      1
      5   100.0    100.0      0.0     11.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
    Unit Weight of Water =  62.40
    Piezometric Surface No.  1 Specified by  3 Coordinate Points
      Point      X-Water     Y-Water
       No.        (ft)        (ft)
        1          0.00      520.00
        2        126.35      509.50
        3       1020.00      518.00
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Sliding Block Surfaces, Has Been
    Specified.
```

```
    500 Trial Surfaces Have Been Generated.
    3 Boxes Specified For Generation Of Central Block Base
    Length Of Line Segments For Active And Passive Portions Of
    Sliding Block Is  10.0
    Box         X-Left      Y-Left     X-Right    Y-Right      Height
    No.          (ft)        (ft)        (ft)       (ft)         (ft)
     1          126.60      539.00      150.00     531.50       1.00
     2          211.00      511.50      212.00     511.50       1.00
     3          300.00      512.50      900.00     519.50       1.00
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Examined.  They Are Ordered - Most Critical
          First.
          * * Safety Factors Are Calculated By The Modified Janbu Method * *
          Failure Surface Specified By 28 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1        115.49      543.15
              2        118.28      542.23
              3        128.05      540.10
              4        137.04      535.72
              5        211.21      511.11
              6        595.28      515.82
              7        598.73      525.21
              8        602.59      534.43
              9        609.66      541.51
             10        616.72      548.59
             11        622.85      556.49
             12        629.84      563.64
             13        636.17      571.39
             14        643.23      578.46
             15        650.24      585.60
             16        654.72      594.54
             17        659.37      603.39
             18        664.80      611.79
             19        669.53      620.60
             20        676.60      627.67
             21        681.80      636.21
             22        688.55      643.59
             23        692.83      652.63
             24        699.90      659.70
             25        701.31      669.60
             26        702.23      679.56
             27        709.30      686.63
             28        710.36      687.93
                ***     1.692   ***
               Individual data on the    34  slices
                              Water   Water     Tie     Tie     Earthquake
                              Force   Force    Force   Force       Force   Surcharge
 Slice  Width   Weight         Top     Bot     Norm     Tan     Hor     Ver     Load
  No.    (ft)    (lbs)        (lbs)   (lbs)   (lbs)   (lbs)   (lbs)   (lbs)   (lbs)
  1     2.8      269.9        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  2     3.2      921.5        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  3     6.5     3052.6        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  4     3.8     2431.5        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  5     5.2     4469.1        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  6    74.0   168670.4        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  7     0.2      735.0        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  8   339.6  2043991.5        0.0      0.0     0.0     0.0     0.0     0.0     0.0
  9    44.5   390308.1        0.0      0.0     0.0     0.0     0.0     0.0     0.0
 10     0.5     4298.2        0.0      0.0     0.0     0.0     0.0     0.0     0.0
 11     3.0    26058.8        0.0      0.0     0.0     0.0     0.0     0.0     0.0
 12     3.9    32005.7        0.0      0.0     0.0     0.0     0.0     0.0     0.0
 13     7.1    55691.0        0.0      0.0     0.0     0.0     0.0     0.0     0.0
```

14	7.1	53398.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	6.1	44131.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	7.0	47962.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	6.3	41170.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	7.1	43554.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	7.0	40954.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	4.5	24417.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	4.7	23221.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	5.4	24647.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	4.7	19405.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	7.1	26260.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	5.2	17353.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	6.8	19925.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	2.3	5980.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	2.0	4888.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	7.1	14678.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	1.4	2215.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.9	909.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	4.7	2612.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	2.4	673.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	1.1	79.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	115.49	543.15
2	118.28	542.23
3	128.05	540.10
4	137.04	535.72
5	211.21	511.11
6	595.28	515.82
7	598.73	525.21
8	602.59	534.43
9	609.66	541.51
10	616.72	548.59
11	622.85	556.49
12	629.84	563.64
13	636.17	571.39
14	643.23	578.46
15	650.24	585.60
16	654.72	594.54
17	659.37	603.39
18	664.80	611.79
19	669.53	620.60
20	676.60	627.67
21	681.80	636.21
22	688.55	643.59
23	692.83	652.63
24	699.90	659.70
25	701.31	669.60
26	702.23	679.56
27	709.30	686.63
28	710.36	687.93

*** 1.692 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	115.49	543.15
2	118.28	542.23
3	128.05	540.10
4	137.04	535.72
5	211.21	511.11
6	595.28	515.82
7	598.73	525.21

```
      8         602.59      534.43
      9         609.66      541.51
     10         616.72      548.59
     11         622.85      556.49
     12         629.84      563.64
     13         636.17      571.39
     14         643.23      578.46
     15         650.24      585.60
     16         654.72      594.54
     17         659.37      603.39
     18         664.80      611.79
     19         669.53      620.60
     20         676.60      627.67
     21         681.80      636.21
     22         688.55      643.59
     23         692.83      652.63
     24         699.90      659.70
     25         701.31      669.60
     26         702.23      679.56
     27         709.30      686.63
     28         710.36      687.93
        ***      1.692   ***
  Failure Surface Specified By 29 Coordinate Points
    Point       X-Surf      Y-Surf
     No.         (ft)        (ft)
      1         111.79      542.22
      2         112.39      541.74
      3         122.19      539.76
      4         132.19      539.74
      5         141.86      537.20
      6         149.83      531.15
      7         211.51      511.16
      8         545.91      515.48
      9         550.79      524.21
     10         556.29      532.57
     11         561.12      541.32
     12         568.10      548.48
     13         574.89      555.82
     14         578.87      565.00
     15         583.96      573.60
     16         589.96      581.61
     17         595.73      589.77
     18         602.30      597.32
     19         607.74      605.71
     20         614.80      612.78
     21         621.85      619.88
     22         628.89      626.98
     23         635.73      634.27
     24         639.96      643.34
     25         643.04      652.85
     26         646.16      662.35
     27         652.41      670.16
     28         659.42      677.29
     29         661.37      679.64
        ***      1.706   ***
  Failure Surface Specified By 29 Coordinate Points
    Point       X-Surf      Y-Surf
     No.         (ft)        (ft)
      1         111.79      542.22
      2         112.39      541.74
      3         122.19      539.76
      4         132.19      539.74
      5         141.86      537.20
```

6	149.83	531.15
7	211.51	511.16
8	545.91	515.48
9	550.79	524.21
10	556.29	532.57
11	561.12	541.32
12	568.10	548.48
13	574.89	555.82
14	578.87	565.00
15	583.96	573.60
16	589.96	581.61
17	595.73	589.77
18	602.30	597.32
19	607.74	605.71
20	614.80	612.78
21	621.85	619.88
22	628.89	626.98
23	635.73	634.27
24	639.96	643.34
25	643.04	652.85
26	646.16	662.35
27	652.41	670.16
28	659.42	677.29
29	661.37	679.64

*** 1.706 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	111.79	542.22
2	112.39	541.74
3	122.19	539.76
4	132.19	539.74
5	141.86	537.20
6	149.83	531.15
7	211.51	511.16
8	545.91	515.48
9	550.79	524.21
10	556.29	532.57
11	561.12	541.32
12	568.10	548.48
13	574.89	555.82
14	578.87	565.00
15	583.96	573.60
16	589.96	581.61
17	595.73	589.77
18	602.30	597.32
19	607.74	605.71
20	614.80	612.78
21	621.85	619.88
22	628.89	626.98
23	635.73	634.27
24	639.96	643.34
25	643.04	652.85
26	646.16	662.35
27	652.41	670.16
28	659.42	677.29
29	661.37	679.64

*** 1.706 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.92	544.01
2	125.50	537.82

```
     3        135.29      535.79
     4        211.67      511.05
     5        583.26      515.66
     6        587.34      524.79
     7        592.53      533.34
     8        597.88      541.79
     9        604.84      548.97
    10        608.19      558.39
    11        614.21      566.38
    12        620.15      574.42
    13        624.75      583.30
    14        630.72      591.32
    15        634.47      600.59
    16        640.93      608.23
    17        647.01      616.16
    18        652.77      624.34
    19        659.66      631.59
    20        660.42      641.56
    21        667.16      648.94
    22        671.85      657.78
    23        676.95      666.38
    24        684.00      673.47
    25        685.92      683.28
    26        687.42      686.16
        ***      1.710   ***
Failure Surface Specified By 26 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
     1        118.92      544.01
     2        125.50      537.82
     3        135.29      535.79
     4        211.67      511.05
     5        583.26      515.66
     6        587.34      524.79
     7        592.53      533.34
     8        597.88      541.79
     9        604.84      548.97
    10        608.19      558.39
    11        614.21      566.38
    12        620.15      574.42
    13        624.75      583.30
    14        630.72      591.32
    15        634.47      600.59
    16        640.93      608.23
    17        647.01      616.16
    18        652.77      624.34
    19        659.66      631.59
    20        660.42      641.56
    21        667.16      648.94
    22        671.85      657.78
    23        676.95      666.38
    24        684.00      673.47
    25        685.92      683.28
    26        687.42      686.16
        ***      1.710   ***
Failure Surface Specified By 26 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
     1        118.92      544.01
     2        125.50      537.82
     3        135.29      535.79
     4        211.67      511.05
     5        583.26      515.66
```

6	587.34	524.79
7	592.53	533.34
8	597.88	541.79
9	604.84	548.97
10	608.19	558.39
11	614.21	566.38
12	620.15	574.42
13	624.75	583.30
14	630.72	591.32
15	634.47	600.59
16	640.93	608.23
17	647.01	616.16
18	652.77	624.34
19	659.66	631.59
20	660.42	641.56
21	667.16	648.94
22	671.85	657.78
23	676.95	666.38
24	684.00	673.47
25	685.92	683.28
26	687.42	686.16

*** 1.710 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.92	544.01
2	125.50	537.82
3	135.29	535.79
4	211.67	511.05
5	583.26	515.66
6	587.34	524.79
7	592.53	533.34
8	597.88	541.79
9	604.84	548.97
10	608.19	558.39
11	614.21	566.38
12	620.15	574.42
13	624.75	583.30
14	630.72	591.32
15	634.47	600.59
16	640.93	608.23
17	647.01	616.16
18	652.77	624.34
19	659.66	631.59
20	660.42	641.56
21	667.16	648.94
22	671.85	657.78
23	676.95	666.38
24	684.00	673.47
25	685.92	683.28
26	687.42	686.16

*** 1.710 ***

SECTION EE′

Circular Failure Mode (Final Conditions)

```
                  ** PCSTABL5M3 **
                by Purdue University 1985
             rev. for SCS Engineers HVA 2008
              --Slope Stability Analysis--
           Simplified Janbu, Simplified Bishop
              or Spencer`s Method of Slices
Run Date:                 3/4/2019
Time of Run:              03:15PM
Run By:                   SCS Engineers
Input Data Filename:      M:waco xs e - circular.
Output Filename:          M:waco xs e - circular.OUT
Unit:                     ENGLISH
Plotted Output Filename:  M:waco xs e - circular.PLT
PROBLEM DESCRIPTION   Waco Landfill
                      Cross-Section E-Circular
BOUNDARY COORDINATES
     Note: User origin value specified.
     Add 0.00 to X-values and 0.00 to Y-values listed.

   13 Top   Boundaries
   37 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	528.90	123.40	528.90	1
2	123.40	528.90	143.10	535.50	1
3	143.10	535.50	149.40	537.60	1
4	149.40	537.60	150.80	538.00	2
5	150.80	538.00	165.80	538.00	2
6	165.80	538.00	186.80	543.40	2
7	186.80	543.40	253.60	560.00	2
8	253.60	560.00	273.60	565.00	2
9	273.60	565.00	456.90	610.80	2
10	456.90	610.80	613.70	650.00	2
11	613.70	650.00	811.00	659.90	2
12	811.00	659.90	839.10	661.30	2
13	839.10	661.30	1012.30	655.70	2
14	165.80	538.00	186.80	539.60	2
15	186.80	539.60	253.60	556.40	3
16	253.60	556.40	273.60	561.40	3
17	273.60	561.40	456.90	607.10	3
18	456.90	607.10	613.70	646.50	3
19	613.70	646.50	811.00	656.30	3
20	811.00	656.30	839.10	657.70	3
21	839.10	657.70	1012.30	652.20	3
22	149.40	537.60	186.80	537.60	1
23	186.80	537.60	253.60	515.30	2
24	253.60	515.30	273.60	515.20	2
25	273.60	515.20	456.90	514.30	2
26	456.90	514.30	613.70	519.70	2
27	613.70	519.70	811.00	526.50	2
28	811.00	526.50	839.10	526.30	2
29	839.10	526.30	1012.30	525.30	2
30	186.80	537.60	187.00	535.50	1
31	187.00	535.50	253.30	513.30	1
32	253.30	513.30	273.60	513.20	1
33	273.60	513.20	456.30	512.30	1
34	456.30	512.30	613.70	517.70	1
35	613.70	517.70	811.00	524.50	1
36	811.00	524.50	839.10	524.30	1
37	839.10	524.30	1012.30	523.30	1

```
 ISOTROPIC SOIL PARAMETERS
     3 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)    No.
      1   128.0    128.0       0.0      25.0    0.00       0.0      1
      2   120.0    120.0     200.0      20.0    0.00       0.0      1
      3    60.0     60.0     200.0      32.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
    Unit Weight of Water =  62.40
    Piezometric Surface No.  1 Specified by  4 Coordinate Points
      Point      X-Water     Y-Water
       No.         (ft)        (ft)
        1          0.00      513.00
        2        250.00      513.00
        3        500.00      513.00
        4       1012.00      523.00
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
  10000 Trial Surfaces Have Been Generated.
    100 Surfaces Initiate From Each Of100 Points Equally Spaced
    Along The Ground Surface Between  X =  50.00 ft.
                                 and  X = 200.00 ft.
    Each Surface Terminates Between   X = 400.00 ft.
                                and   X = 700.00 ft.
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =  0.00 ft.
    10.00 ft. Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Examined.  They Are Ordered - Most Critical
          First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Failure Surface Specified By 54 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1        178.79      541.34
              2        187.89      537.20
              3        197.10      533.30
              4        206.40      529.62
              5        215.79      526.19
              6        225.26      522.99
              7        234.82      520.03
              8        244.44      517.31
              9        254.13      514.83
             10        263.88      512.60
             11        273.68      510.62
             12        283.53      508.88
             13        293.41      507.39
             14        303.34      506.16
             15        313.29      505.17
             16        323.26      504.43
             17        333.25      503.95
             18        343.25      503.71
             19        353.25      503.73
             20        363.24      504.00
             21        373.23      504.53
             22        383.20      505.30
             23        393.15      506.33
             24        403.06      507.60
             25        412.95      509.13
             26        422.79      510.90
             27        432.58      512.92
             28        442.32      515.19
```

29	452.00	517.70
30	461.62	520.45
31	471.16	523.45
32	480.62	526.68
33	490.00	530.16
34	499.28	533.87
35	508.47	537.81
36	517.56	541.98
37	526.54	546.38
38	535.41	551.00
39	544.16	555.85
40	552.78	560.91
41	561.27	566.19
42	569.63	571.68
43	577.84	577.39
44	585.91	583.29
45	593.83	589.40
46	601.59	595.71
47	609.19	602.21
48	616.62	608.89
49	623.89	615.77
50	630.98	622.82
51	637.88	630.05
52	644.61	637.46
53	651.14	645.03
54	657.00	652.17

Circle Center At X = 347.5 ; Y = 900.5 and Radius, 396.8
*** 2.878 ***
Individual data on the 67 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.4	837.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	3.6	1902.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.8	484.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.3	164.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	9.2	7620.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	9.3	11473.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	9.4	15125.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	9.5	18559.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	9.6	21760.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	9.6	24713.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	9.2	25850.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.5	1556.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	6.9	21317.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	1.1	3753.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	1.7	5812.6	0.0	22.2	0.0	0.0	0.0	0.0	0.0
16	9.7	34766.1	0.0	855.8	0.0	0.0	0.0	0.0	0.0
17	0.1	291.2	0.0	11.7	0.0	0.0	0.0	0.0	0.0
18	9.8	38989.7	0.0	2028.2	0.0	0.0	0.0	0.0	0.0
19	9.9	42624.5	0.0	3034.0	0.0	0.0	0.0	0.0	0.0
20	9.9	45947.5	0.0	3884.4	0.0	0.0	0.0	0.0	0.0
21	10.0	48947.4	0.0	4578.8	0.0	0.0	0.0	0.0	0.0
22	0.9	4626.4	0.0	449.4	0.0	0.0	0.0	0.0	0.0
23	9.1	46987.7	0.0	4667.3	0.0	0.0	0.0	0.0	0.0
24	10.0	53939.1	0.0	5497.8	0.0	0.0	0.0	0.0	0.0
25	10.0	55915.1	0.0	5721.9	0.0	0.0	0.0	0.0	0.0
26	10.0	57536.1	0.0	5788.7	0.0	0.0	0.0	0.0	0.0
27	10.0	58798.2	0.0	5698.4	0.0	0.0	0.0	0.0	0.0
28	10.0	59698.0	0.0	5450.8	0.0	0.0	0.0	0.0	0.0
29	10.0	60234.5	0.0	5046.3	0.0	0.0	0.0	0.0	0.0
30	9.9	60407.3	0.0	4484.9	0.0	0.0	0.0	0.0	0.0

31	9.9	60218.3	0.0	3767.2	0.0	0.0	0.0	0.0	0.0
32	9.9	59670.4	0.0	2893.5	0.0	0.0	0.0	0.0	0.0
33	9.8	58767.9	0.0	1864.5	0.0	0.0	0.0	0.0	0.0
34	7.4	43643.3	0.0	631.2	0.0	0.0	0.0	0.0	0.0
35	2.4	13878.0	0.0	49.4	0.0	0.0	0.0	0.0	0.0
36	0.3	2009.1	0.0	0.9	0.0	0.0	0.0	0.0	0.0
37	6.0	34451.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	3.4	19677.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	9.7	55532.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	4.9	28060.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	4.7	26964.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	9.5	54329.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	9.5	53454.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	9.4	52408.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	9.3	51195.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	9.2	49821.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	9.1	48295.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	9.0	46623.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	8.9	44813.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	8.7	42875.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	8.6	40817.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
52	8.5	38648.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	8.4	36380.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	8.2	34023.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	8.1	31588.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	7.9	29086.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
57	7.8	26529.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58	7.6	23929.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59	4.5	13176.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	2.9	8071.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
61	7.3	18084.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62	7.1	14841.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	6.9	11650.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64	6.7	8527.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	6.5	5484.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66	2.8	1488.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67	3.0	636.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 54 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	172.73	539.78
2	181.93	535.86
3	191.22	532.17
4	200.60	528.71
5	210.06	525.47
6	219.60	522.47
7	229.21	519.71
8	238.89	517.18
9	248.62	514.89
10	258.41	512.84
11	268.25	511.03
12	278.12	509.46
13	288.03	508.14
14	297.98	507.05
15	307.94	506.22
16	317.92	505.62
17	327.92	505.28
18	337.92	505.17
19	347.92	505.32
20	357.91	505.70
21	367.89	506.34
22	377.85	507.21
23	387.79	508.34

24	397.69	509.70
25	407.56	511.31
26	417.39	513.16
27	427.17	515.25
28	436.89	517.57
29	446.56	520.14
30	456.16	522.94
31	465.69	525.98
32	475.14	529.25
33	484.50	532.75
34	493.78	536.48
35	502.97	540.44
36	512.05	544.62
37	521.03	549.02
38	529.90	553.64
39	538.65	558.48
40	547.28	563.53
41	555.79	568.79
42	564.16	574.26
43	572.40	579.93
44	580.49	585.80
45	588.44	591.87
46	596.24	598.13
47	603.88	604.58
48	611.36	611.22
49	618.67	618.03
50	625.82	625.03
51	632.79	632.20
52	639.59	639.53
53	646.20	647.04
54	650.22	651.83

Circle Center At X = 337.1 ; Y = 912.8 and Radius, 407.6

*** 2.894 ***

Failure Surface Specified By 53 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	177.27	540.95
2	186.49	537.07
3	195.80	533.42
4	205.20	530.01
5	214.68	526.84
6	224.24	523.90
7	233.87	521.21
8	243.57	518.76
9	253.32	516.56
10	263.13	514.61
11	272.99	512.90
12	282.88	511.44
13	292.81	510.23
14	302.76	509.28
15	312.73	508.57
16	322.72	508.12
17	332.72	507.92
18	342.72	507.97
19	352.72	508.27
20	362.70	508.83
21	372.67	509.63
22	382.61	510.69
23	392.53	512.00
24	402.40	513.56
25	412.24	515.37
26	422.03	517.42
27	431.76	519.72

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    28        441.43      522.27
    29        451.03      525.06
    30        460.56      528.09
    31        470.01      531.36
    32        479.38      534.86
    33        488.65      538.61
    34        497.83      542.58
    35        506.90      546.79
    36        515.86      551.22
    37        524.71      555.88
    38        533.44      560.76
    39        542.04      565.86
    40        550.51      571.17
    41        558.85      576.70
    42        567.04      582.43
    43        575.09      588.37
    44        582.98      594.51
    45        590.72      600.85
    46        598.29      607.38
    47        605.69      614.10
    48        612.93      621.00
    49        619.99      628.09
    50        626.86      635.35
    51        633.55      642.78
    52        640.06      650.38
    53        640.86      651.36
Circle Center At X =  335.7 ; Y =  904.2  and Radius,  396.3
      ***      2.897    ***
Failure Surface Specified By 51 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
     1        172.73      539.78
     2        181.90      535.79
     3        191.17      532.05
     4        200.54      528.55
     5        210.00      525.31
     6        219.54      522.32
     7        229.16      519.59
     8        238.85      517.12
     9        248.60      514.90
    10        258.41      512.95
    11        268.27      511.26
    12        278.16      509.83
    13        288.10      508.67
    14        298.06      507.78
    15        308.04      507.15
    16        318.03      506.79
    17        328.03      506.69
    18        338.03      506.86
    19        348.02      507.30
    20        357.99      508.01
    21        367.95      508.98
    22        377.87      510.22
    23        387.76      511.72
    24        397.60      513.49
    25        407.39      515.52
    26        417.12      517.81
    27        426.79      520.36
    28        436.39      523.17
    29        445.91      526.23
    30        455.35      529.54
    31        464.69      533.11
    32        473.93      536.93
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     33         483.07      540.99
     34         492.10      545.29
     35         501.01      549.83
     36         509.79      554.61
     37         518.44      559.62
     38         526.96      564.87
     39         535.33      570.33
     40         543.56      576.02
     41         551.62      581.93
     42         559.53      588.05
     43         567.27      594.38
     44         574.84      600.92
     45         582.24      607.65
     46         589.45      614.58
     47         596.47      621.70
     48         603.30      629.01
     49         609.93      636.49
     50         616.36      644.15
     51         621.31      650.38
Circle Center At X =  326.6 ; Y =  880.9  and Radius,  374.2
      ***      2.899   ***
Failure Surface Specified By 53 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
      1         181.82      542.12
      2         190.86      537.84
      3         200.01      533.81
      4         209.26      530.02
      5         218.61      526.48
      6         228.06      523.18
      7         237.58      520.14
      8         247.19      517.35
      9         256.86      514.82
     10         266.60      512.54
     11         276.39      510.53
     12         286.24      508.77
     13         296.12      507.27
     14         306.05      506.04
     15         316.00      505.07
     16         325.98      504.37
     17         335.97      503.93
     18         345.96      503.76
     19         355.96      503.85
     20         365.96      504.20
     21         375.94      504.83
     22         385.90      505.71
     23         395.83      506.86
     24         405.73      508.27
     25         415.59      509.95
     26         425.40      511.88
     27         435.16      514.08
     28         444.85      516.53
     29         454.48      519.24
     30         464.03      522.20
     31         473.50      525.42
     32         482.88      528.88
     33         492.17      532.59
     34         501.35      536.55
     35         510.42      540.75
     36         519.38      545.19
     37         528.22      549.86
     38         536.94      554.77
     39         545.52      559.91
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     40        553.96      565.27
     41        562.25      570.86
     42        570.40      576.66
     43        578.38      582.68
     44        586.21      588.90
     45        593.87      595.33
     46        601.35      601.97
     47        608.66      608.80
     48        615.78      615.82
     49        622.71      623.02
     50        629.45      630.41
     51        635.99      637.97
     52        642.33      645.71
     53        646.96      651.67
Circle Center At X =  347.5 ; Y =  880.8  and Radius,  377.1
      ***      2.900    ***
Failure Surface Specified By 55 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1        181.82      542.12
     2        190.83      537.77
     3        199.94      533.66
     4        209.16      529.78
     5        218.47      526.14
     6        227.88      522.74
     7        237.37      519.59
     8        246.93      516.68
     9        256.57      514.01
    10        266.27      511.59
    11        276.04      509.43
    12        285.85      507.51
    13        295.71      505.85
    14        305.61      504.43
    15        315.54      503.28
    16        325.50      502.38
    17        335.48      501.73
    18        345.48      501.35
    19        355.47      501.22
    20        365.47      501.34
    21        375.47      501.72
    22        385.45      502.36
    23        395.41      503.25
    24        405.34      504.40
    25        415.24      505.81
    26        425.10      507.47
    27        434.92      509.38
    28        444.68      511.54
    29        454.39      513.95
    30        464.03      516.61
    31        473.59      519.52
    32        483.09      522.67
    33        492.49      526.06
    34        501.81      529.69
    35        511.03      533.57
    36        520.15      537.67
    37        529.16      542.01
    38        538.05      546.58
    39        546.83      551.38
    40        555.47      556.40
    41        563.99      561.64
    42        572.37      567.10
    43        580.61      572.77
    44        588.70      578.65
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      45        596.63      584.73
      46        604.41      591.02
      47        612.02      597.50
      48        619.46      604.18
      49        626.73      611.05
      50        633.82      618.10
      51        640.73      625.33
      52        647.45      632.74
      53        653.98      640.31
      54        660.31      648.05
      55        663.77      652.51
Circle Center At X =  355.6 ; Y =  890.8  and Radius,  389.6
      ***      2.906    ***
Failure Surface Specified By 53 Coordinate Points
  Point       X-Surf      Y-Surf
    No.        (ft)        (ft)
     1        163.64      538.00
     2        173.07      534.69
     3        182.58      531.59
     4        192.16      528.71
     5        201.79      526.04
     6        211.49      523.59
     7        221.24      521.36
     8        231.03      519.35
     9        240.87      517.57
    10        250.75      516.00
    11        260.66      514.66
    12        270.60      513.54
    13        280.56      512.64
    14        290.53      511.97
    15        300.52      511.53
    16        310.52      511.31
    17        320.52      511.31
    18        330.52      511.54
    19        340.51      512.00
    20        350.49      512.68
    21        360.44      513.59
    22        370.38      514.72
    23        380.29      516.07
    24        390.16      517.65
    25        400.00      519.45
    26        409.79      521.46
    27        419.54      523.70
    28        429.23      526.16
    29        438.87      528.84
    30        448.44      531.73
    31        457.94      534.84
    32        467.38      538.16
    33        476.73      541.70
    34        486.00      545.44
    35        495.19      549.39
    36        504.29      553.55
    37        513.28      557.91
    38        522.18      562.47
    39        530.98      567.24
    40        539.66      572.19
    41        548.23      577.35
    42        556.68      582.69
    43        565.01      588.23
    44        573.21      593.95
    45        581.28      599.85
    46        589.22      605.94
    47        597.02      612.20
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      48        604.67      618.64
      49        612.18      625.24
      50        619.53      632.02
      51        626.73      638.95
      52        633.78      646.05
      53        638.71      651.25
  Circle Center At X =  315.3 ; Y =  955.0  and Radius,  443.7
        ***     2.909   ***
  Failure Surface Specified By 53 Coordinate Points
    Point      X-Surf      Y-Surf
     No.        (ft)        (ft)
      1         169.70      539.00
      2         178.88      535.05
      3         188.16      531.33
      4         197.54      527.84
      5         207.00      524.60
      6         216.54      521.59
      7         226.15      518.83
      8         235.82      516.32
      9         245.56      514.05
     10         255.36      512.03
     11         265.20      510.25
     12         275.08      508.73
     13         285.00      507.46
     14         294.95      506.44
     15         304.92      505.67
     16         314.91      505.16
     17         324.90      504.90
     18         334.90      504.89
     19         344.90      505.14
     20         354.89      505.64
     21         364.86      506.39
     22         374.81      507.40
     23         384.73      508.66
     24         394.61      510.17
     25         404.46      511.93
     26         414.25      513.94
     27         424.00      516.19
     28         433.68      518.70
     29         443.29      521.44
     30         452.83      524.44
     31         462.30      527.67
     32         471.68      531.14
     33         480.96      534.85
     34         490.15      538.79
     35         499.24      542.96
     36         508.22      547.37
     37         517.08      552.00
     38         525.82      556.85
     39         534.44      561.93
     40         542.93      567.22
     41         551.28      572.72
     42         559.48      578.43
     43         567.54      584.35
     44         575.45      590.48
     45         583.20      596.80
     46         590.78      603.31
     47         598.20      610.02
     48         605.45      616.91
     49         612.51      623.99
     50         619.40      631.24
     51         626.10      638.66
     52         632.61      646.25
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    53         636.60      651.15
 Circle Center At X =  330.2 ; Y =  899.0  and Radius,  394.2
       ***     2.915   ***
 Failure Surface Specified By 52 Coordinate Points
   Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
     1        181.82      542.12
     2        190.88      537.88
     3        200.04      533.89
     4        209.32      530.14
     5        218.69      526.65
     6        228.15      523.41
     7        237.69      520.43
     8        247.32      517.71
     9        257.01      515.25
    10        266.76      513.05
    11        276.57      511.11
    12        286.43      509.45
    13        296.34      508.05
    14        306.27      506.91
    15        316.23      506.05
    16        326.22      505.45
    17        336.21      505.13
    18        346.21      505.07
    19        356.21      505.29
    20        366.20      505.78
    21        376.17      506.53
    22        386.12      507.56
    23        396.03      508.85
    24        405.91      510.41
    25        415.74      512.24
    26        425.52      514.33
    27        435.24      516.68
    28        444.89      519.30
    29        454.47      522.18
    30        463.96      525.31
    31        473.37      528.70
    32        482.68      532.34
    33        491.89      536.24
    34        501.00      540.38
    35        509.98      544.76
    36        518.85      549.39
    37        527.59      554.25
    38        536.19      559.35
    39        544.65      564.68
    40        552.97      570.24
    41        561.13      576.02
    42        569.13      582.01
    43        576.97      588.22
    44        584.63      594.65
    45        592.12      601.27
    46        599.43      608.10
    47        606.55      615.12
    48        613.48      622.33
    49        620.21      629.72
    50        626.74      637.29
    51        633.07      645.04
    52        637.83      651.21
 Circle Center At X =  343.2 ; Y =  875.1  and Radius,  370.0
       ***     2.917   ***
 Failure Surface Specified By 55 Coordinate Points
   Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
```

1	162.12	538.00
2	171.53	534.62
3	181.01	531.44
4	190.56	528.47
5	200.17	525.70
6	209.84	523.15
7	219.56	520.81
8	229.33	518.68
9	239.15	516.76
10	249.00	515.05
11	258.89	513.56
12	268.81	512.29
13	278.75	511.23
14	288.72	510.38
15	298.70	509.76
16	308.69	509.35
17	318.69	509.15
18	328.69	509.18
19	338.68	509.42
20	348.67	509.88
21	358.65	510.55
22	368.61	511.44
23	378.55	512.55
24	388.46	513.88
25	398.34	515.42
26	408.19	517.17
27	417.99	519.14
28	427.75	521.31
29	437.46	523.70
30	447.12	526.31
31	456.71	529.12
32	466.25	532.13
33	475.71	535.36
34	485.11	538.79
35	494.42	542.42
36	503.66	546.25
37	512.81	550.29
38	521.87	554.52
39	530.84	558.94
40	539.71	563.56
41	548.47	568.38
42	557.13	573.38
43	565.68	578.57
44	574.11	583.94
45	582.43	589.49
46	590.62	595.23
47	598.69	601.14
48	606.62	607.22
49	614.43	613.48
50	622.09	619.90
51	629.61	626.49
52	636.99	633.24
53	644.22	640.15
54	651.30	647.21
55	656.01	652.12

Circle Center At X = 322.6 ; Y = 969.5 and Radius, 460.4

*** 2.918 ***

SECTION EE′

Block Failure Mode (Final Conditions)

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                    ** PCSTABL5M3 **
                by Purdue University 1985
             rev. for SCS Engineers HVA 2008
              --Slope Stability Analysis--
           Simplified Janbu, Simplified Bishop
              or Spencer`s Method of Slices
    Run Date:                 4/19/2019
    Time of Run:              12:18PM
    Run By:                   Username
    Input Data Filename:      M:waco xs e - block.
    Output Filename:          M:waco xs e - block.OUT
    Unit:                     ENGLISH
    Plotted Output Filename:  M:waco xs e - block.PLT
    PROBLEM DESCRIPTION   Waco Landfill
                          Cross-Section E-Block
    BOUNDARY COORDINATES
         Note: User origin value specified.
         Add 0.00 to X-values and 0.00 to Y-values listed.

       13 Top   Boundaries
       28 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00     528.90     123.40     528.90        1
        2        123.40     528.90     143.10     535.50        1
        3        143.10     535.50     149.40     537.60        1
        4        149.40     537.60     150.80     538.00        2
        5        150.80     538.00     165.80     538.00        2
        6        165.80     538.00     186.80     543.40        2
        7        186.80     543.40     253.60     560.00        2
        8        253.60     560.00     273.60     565.00        2
        9        273.60     565.00     456.90     610.80        2
       10        456.90     610.80     613.70     650.00        2
       11        613.70     650.00     811.00     659.90        2
       12        811.00     659.90     839.10     661.30        2
       13        839.10     661.30    1012.30     655.70        2
       14        165.80     538.00     186.80     539.60        2
       15        186.80     539.60     253.60     556.40        3
       16        253.60     556.40     273.60     561.40        3
       17        273.60     561.40     456.90     607.10        3
       18        456.90     607.10     613.70     646.50        3
       19        613.70     646.50     811.00     656.30        3
       20        811.00     656.30     839.10     657.70        3
       21        839.10     657.70    1012.30     652.20        3
       22        149.40     537.60     186.80     537.60        1
       23        186.80     537.60     253.60     515.30        4
       24        253.60     515.30     456.90     514.30        5
       25        456.90     514.30     613.70     519.70        5
       26        613.70     519.70     811.00     526.50        5
       27        811.00     526.50     839.10     526.30        5
       28        839.10     526.30    1012.30     525.30        5
   ISOTROPIC SOIL PARAMETERS
     5 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction  Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)    No.
      1   128.0    128.0       0.0     25.0    0.00       0.0      1
      2   120.0    120.0     200.0     20.0    0.00       0.0      1
      3    60.0     60.0     200.0     32.0    0.00       0.0      1
      4   100.0    100.0       0.0     15.0    0.00       0.0      1
      5   100.0    100.0       0.0     11.0    0.00       0.0      1
    1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED
    Unit Weight of Water =  62.40
```

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	513.00
2	250.00	513.00
3	500.00	513.00
4	1012.00	523.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

500 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	186.70	537.00	200.00	532.00	1.00
2	253.60	514.30	253.60	514.00	1.00
3	456.90	513.00	800.00	525.50	1.00

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	179.33	541.48
2	179.41	541.44
3	182.97	537.92
4	187.72	536.35
5	253.60	514.56
6	484.10	513.61
7	486.49	518.00
8	488.79	522.44
9	492.10	526.19
10	494.95	530.29
11	497.86	534.36
12	500.05	538.86
13	503.45	542.52
14	506.59	546.42
15	509.61	550.40
16	512.02	554.78
17	514.25	559.25
18	517.78	562.80
19	521.16	566.48
20	524.56	570.15
21	527.84	573.92
22	531.12	577.69
23	533.25	582.22
24	536.59	585.94
25	537.08	590.91
26	538.28	595.77
27	541.20	599.82
28	544.06	603.93
29	547.32	607.72
30	550.35	611.69
31	553.53	615.55
32	555.89	619.96
33	559.35	623.57
34	560.80	628.36
35	564.31	631.92
36	567.32	635.91
37	570.22	639.13

*** 1.822 ***

Individual data on the 43 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.3	396.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	1.3	574.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.0	557.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	2.9	2037.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.9	628.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	65.9	121028.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	20.0	62479.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	183.3	856590.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	27.2	171308.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.9	5815.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	1.5	9343.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	2.3	14090.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	3.3	19544.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	2.9	16334.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	2.9	16075.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	2.2	11588.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	3.4	17328.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	3.1	15435.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	3.0	14296.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	2.4	10898.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	2.2	9579.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	3.5	14422.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	3.4	13259.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	3.4	12765.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	3.3	11764.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	3.3	11175.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	2.1	6786.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	3.3	9987.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.5	1349.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	1.2	2974.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	2.9	6544.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	2.9	5817.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	3.3	6016.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	3.0	5034.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	3.2	4676.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	2.4	2987.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	3.5	3688.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	1.5	1238.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	3.5	2236.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	2.0	995.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	1.0	361.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	2.9	432.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	179.33	541.48
2	179.41	541.44
3	182.97	537.92
4	187.72	536.35
5	253.60	514.56
6	484.10	513.61
7	486.49	518.00
8	488.79	522.44
9	492.10	526.19
10	494.95	530.29
11	497.86	534.36

12	500.05	538.86
13	503.45	542.52
14	506.59	546.42
15	509.61	550.40
16	512.02	554.78
17	514.25	559.25
18	517.78	562.80
19	521.16	566.48
20	524.56	570.15
21	527.84	573.92
22	531.12	577.69
23	533.25	582.22
24	536.59	585.94
25	537.08	590.91
26	538.28	595.77
27	541.20	599.82
28	544.06	603.93
29	547.32	607.72
30	550.35	611.69
31	553.53	615.55
32	555.89	619.96
33	559.35	623.57
34	560.80	628.36
35	564.31	631.92
36	567.32	635.91
37	570.22	639.13

*** 1.822 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	179.33	541.48
2	179.41	541.44
3	182.97	537.92
4	187.72	536.35
5	253.60	514.56
6	484.10	513.61
7	486.49	518.00
8	488.79	522.44
9	492.10	526.19
10	494.95	530.29
11	497.86	534.36
12	500.05	538.86
13	503.45	542.52
14	506.59	546.42
15	509.61	550.40
16	512.02	554.78
17	514.25	559.25
18	517.78	562.80
19	521.16	566.48
20	524.56	570.15
21	527.84	573.92
22	531.12	577.69
23	533.25	582.22
24	536.59	585.94
25	537.08	590.91
26	538.28	595.77
27	541.20	599.82
28	544.06	603.93
29	547.32	607.72
30	550.35	611.69
31	553.53	615.55
32	555.89	619.96
33	559.35	623.57

34	560.80	628.36
35	564.31	631.92
36	567.32	635.91
37	570.22	639.13

*** 1.822 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	179.33	541.48
2	179.41	541.44
3	182.97	537.92
4	187.72	536.35
5	253.60	514.56
6	484.10	513.61
7	486.49	518.00
8	488.79	522.44
9	492.10	526.19
10	494.95	530.29
11	497.86	534.36
12	500.05	538.86
13	503.45	542.52
14	506.59	546.42
15	509.61	550.40
16	512.02	554.78
17	514.25	559.25
18	517.78	562.80
19	521.16	566.48
20	524.56	570.15
21	527.84	573.92
22	531.12	577.69
23	533.25	582.22
24	536.59	585.94
25	537.08	590.91
26	538.28	595.77
27	541.20	599.82
28	544.06	603.93
29	547.32	607.72
30	550.35	611.69
31	553.53	615.55
32	555.89	619.96
33	559.35	623.57
34	560.80	628.36
35	564.31	631.92
36	567.32	635.91
37	570.22	639.13

*** 1.822 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	179.33	541.48
2	179.41	541.44
3	182.97	537.92
4	187.72	536.35
5	253.60	514.56
6	484.10	513.61
7	486.49	518.00
8	488.79	522.44
9	492.10	526.19
10	494.95	530.29
11	497.86	534.36
12	500.05	538.86
13	503.45	542.52
14	506.59	546.42

15	509.61	550.40
16	512.02	554.78
17	514.25	559.25
18	517.78	562.80
19	521.16	566.48
20	524.56	570.15
21	527.84	573.92
22	531.12	577.69
23	533.25	582.22
24	536.59	585.94
25	537.08	590.91
26	538.28	595.77
27	541.20	599.82
28	544.06	603.93
29	547.32	607.72
30	550.35	611.69
31	553.53	615.55
32	555.89	619.96
33	559.35	623.57
34	560.80	628.36
35	564.31	631.92
36	567.32	635.91
37	570.22	639.13

*** 1.822 ***

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	178.49	541.26
2	181.83	539.48
3	185.44	536.02
4	190.43	535.77
5	253.60	514.13
6	473.72	513.11
7	477.14	516.76
8	480.04	520.83
9	483.47	524.47
10	485.28	529.13
11	488.81	532.67
12	491.93	536.58
13	495.34	540.23
14	498.83	543.82
15	502.29	547.43
16	505.17	551.51
17	505.49	556.50
18	507.93	560.87
19	510.90	564.89
20	513.75	569.00
21	517.18	572.64
22	518.30	577.51
23	520.83	581.82
24	524.30	585.42
25	526.44	589.94
26	528.66	594.42
27	531.92	598.21
28	535.26	601.94
29	538.76	605.51
30	540.49	610.20
31	543.53	614.17
32	546.16	618.42
33	549.44	622.19
34	550.29	627.12
35	552.62	631.54
36	553.92	635.06

```
      ***     1.880    ***
Failure Surface Specified By 35 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
    1        180.21      541.70
    2        183.11      538.82
    3        187.77      537.01
    4        192.18      534.64
    5        253.60      513.99
    6        467.85      513.76
    7        470.64      517.91
    8        474.11      521.50
    9        476.84      525.69
   10        480.14      529.45
   11        481.08      534.36
   12        482.90      539.02
   13        485.93      542.99
   14        488.93      546.99
   15        490.72      551.66
   16        494.23      555.22
   17        497.69      558.84
   18        501.07      562.52
   19        502.32      567.36
   20        505.86      570.90
   21        508.51      575.13
   22        511.41      579.21
   23        512.15      584.15
   24        515.51      587.85
   25        518.85      591.57
   26        519.86      596.47
   27        521.74      601.10
   28        524.46      605.30
   29        527.97      608.86
   30        531.41      612.49
   31        534.95      616.03
   32        537.42      620.37
   33        538.88      625.15
   34        542.32      628.78
   35        544.82      632.78
      ***     1.926    ***
Failure Surface Specified By 35 Coordinate Points
  Point       X-Surf      Y-Surf
   No.         (ft)        (ft)
    1        180.21      541.70
    2        183.11      538.82
    3        187.77      537.01
    4        192.18      534.64
    5        253.60      513.99
    6        467.85      513.76
    7        470.64      517.91
    8        474.11      521.50
    9        476.84      525.69
   10        480.14      529.45
   11        481.08      534.36
   12        482.90      539.02
   13        485.93      542.99
   14        488.93      546.99
   15        490.72      551.66
   16        494.23      555.22
   17        497.69      558.84
   18        501.07      562.52
   19        502.32      567.36
   20        505.86      570.90
```

21	508.51	575.13
22	511.41	579.21
23	512.15	584.15
24	515.51	587.85
25	518.85	591.57
26	519.86	596.47
27	521.74	601.10
28	524.46	605.30
29	527.97	608.86
30	531.41	612.49
31	534.95	616.03
32	537.42	620.37
33	538.88	625.15
34	542.32	628.78
35	544.82	632.78

*** 1.926 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	180.21	541.70
2	183.11	538.82
3	187.77	537.01
4	192.18	534.64
5	253.60	513.99
6	467.85	513.76
7	470.64	517.91
8	474.11	521.50
9	476.84	525.69
10	480.14	529.45
11	481.08	534.36
12	482.90	539.02
13	485.93	542.99
14	488.93	546.99
15	490.72	551.66
16	494.23	555.22
17	497.69	558.84
18	501.07	562.52
19	502.32	567.36
20	505.86	570.90
21	508.51	575.13
22	511.41	579.21
23	512.15	584.15
24	515.51	587.85
25	518.85	591.57
26	519.86	596.47
27	521.74	601.10
28	524.46	605.30
29	527.97	608.86
30	531.41	612.49
31	534.95	616.03
32	537.42	620.37
33	538.88	625.15
34	542.32	628.78
35	544.82	632.78

*** 1.926 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	180.21	541.70
2	183.11	538.82
3	187.77	537.01
4	192.18	534.64
5	253.60	513.99

6	467.85	513.76
7	470.64	517.91
8	474.11	521.50
9	476.84	525.69
10	480.14	529.45
11	481.08	534.36
12	482.90	539.02
13	485.93	542.99
14	488.93	546.99
15	490.72	551.66
16	494.23	555.22
17	497.69	558.84
18	501.07	562.52
19	502.32	567.36
20	505.86	570.90
21	508.51	575.13
22	511.41	579.21
23	512.15	584.15
24	515.51	587.85
25	518.85	591.57
26	519.86	596.47
27	521.74	601.10
28	524.46	605.30
29	527.97	608.86
30	531.41	612.49
31	534.95	616.03
32	537.42	620.37
33	538.88	625.15
34	542.32	628.78
35	544.82	632.78
***	1.926	***

APPENDIX 5B

- Veneer Stability Analysis – Liner System
- Veneer Stability Analysis – Final Cover System

SCS Engineers
TBPE Reg. # F-3407

Inclusive of Pages 5-B-1 to 5-B-13

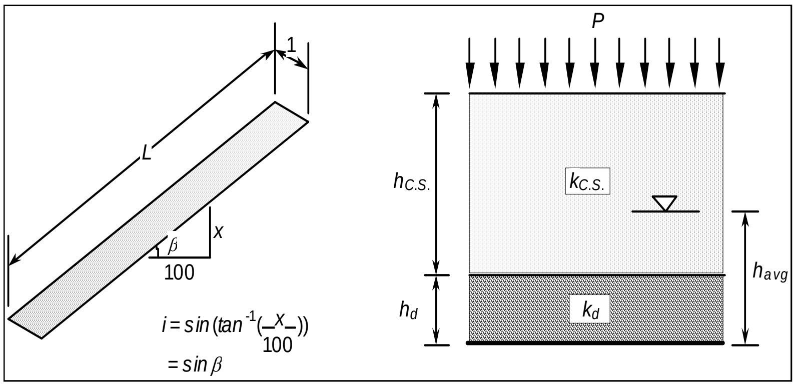
VENEER STABILITY ANALYSES

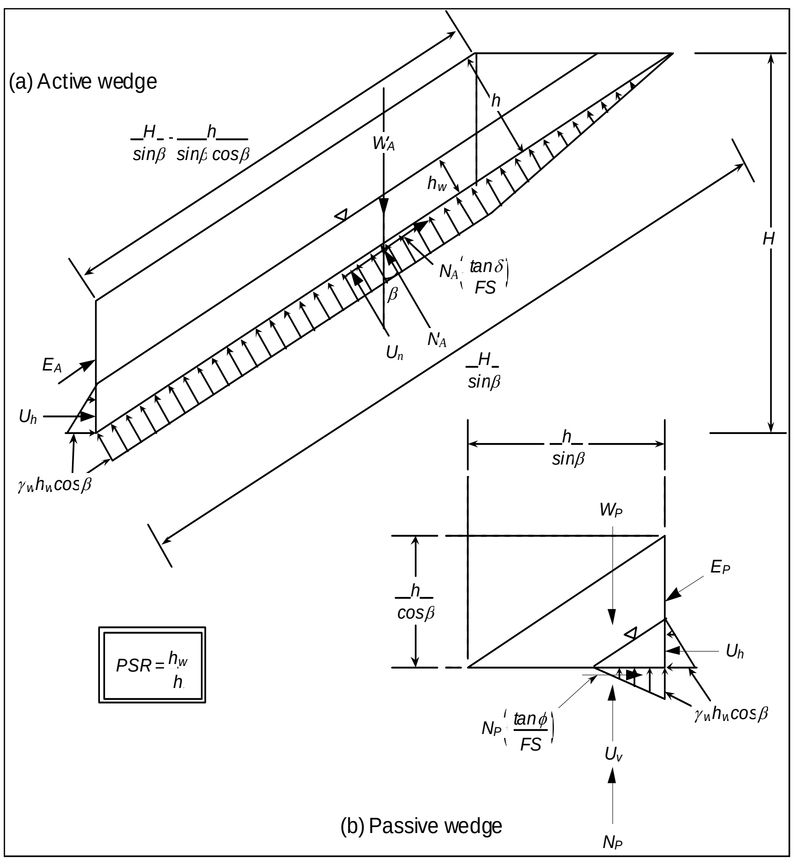
LINER SYSTEM

LINER STABILITY CALCULATION (SEEPAGE FORCES)

Veneer (Liner) System Stability
Project: City of Waco Landfill
Location: McLennan and Limestone Counties, TX
Prepared by: SCS ENGINEERS
Date: February 12, 2019

Consideration: To evaluate the stability of the cover system with seepage forces applied using the method described by Koerner and Soong (1998) referenced below.





Ref.: R.M. Koerner, and T-Y.Soong, 1998. "Analysis and Design of Veneer Cover Soils". Proceeding of 6th International Conference on Geosynthetics, Vol. 1, pp. 1-23, Atlanta, Georgia, USA.

LINER STABILITY CALCULATION (SEEPAGE FORCES)

Parameters:

DLC	=	drainage layer capacity
$FLUX_{allow}$	=	allowable flow rate of the drainage layer per unit width of slope
k_d	=	permeability of drainage soil or geosynthetic
h_d	=	thickness of the drainage soil or geosynthetic
i	=	sin β = slope gradient
$FLUX_{req'd}$	=	actual flow rate per unit width of slope
PERC	=	the rate of percolation
P	=	probable maximum (hourly) precipitation (25-year storm event)
RC	=	runoff coefficient
L	=	length of drainage slope
k_{cs}	=	permeability of cover soil
β	=	slope angle
w	=	1.0 m = unit width of drainage slope
PSR	=	parallel submergence ratio
h_{avg}	=	average head buildup above the geomembrane
h_{cs}	=	thickness of cover soil
FS	=	factor of safety against instability
W_A	=	total weight of the active wedge
W_P	=	total weight of the passive wedge
U_h	=	resultant of the pore pressures acting on the interwedge surfaces
U_n	=	resultant of the pore pressures acting perpendicular to the slope
U_v	=	resultant of the vertical pore pressures acting on the passive wedge
N_A	=	effective force normal to the failure plane of the active wedge
h	=	thickness of the cover soil
H	=	vertical height of the slope measured from the toe
h_w	=	(PSR)(h) = height of the free water surface measured from the geomembrane
γ_{dry}	=	dry unit weight of the cover soil
$\gamma_{sat'd}$	=	saturated unit weight of the cover soil
γ_w	=	unit weight of water
ϕ	=	cover soil friction angle
δ	=	interface friction angle between cover soil and geomembrane

LINER STABILITY CALCULATION (SEEPAGE FORCES)

Calculate Drainage Layer Capacity (DLC):

PERC = P(1-RC), for $P(1-RC) \leq k_{cs}$
PERC = k_{cs}, for $P(1-RC) > k_{cs}$

k_{CS} =	1.00E-05	cm/s	=	3.60E-01	mm/hr
P =	8.40	mm/hr			
RC =	0.40				

P(1-RC) = 5.04 mm/hr

PERC = 0.36 mm/hr

$$FLUX_{req'd} = \frac{PERC}{1000} \times L(\cos\beta) \times w$$

L =	46.00	m			
β =	18.44	°	=	0.32	rad

$L(\cos\beta)$ = 43.64 m

$FLUX_{req'd}$ = 0.02 m^3/hr

$$FLUX_{allow} = k_d \times i \times h_d$$

k_d =	4.00E+00	cm/s	=	4.00E-02	m/s
h_d =	6.35	mm	=	0.01	m
i =	0.32				

$FLUX_{allow}$ = 0.29 m^3/hr

$$DLC = \frac{FLUX_{allow}}{FLUX_{req'd}}$$

DLC = 18.41

Notes:
1) If only one soil layer above geomembrane, treat it as a drainage layer.
2) DLC needs to be greater than one to avoid saturation of the drainage layer.

LINER STABILITY CALCULATION (SEEPAGE FORCES)

Calculate Parallel Submergence Ratio (PSR):

$$h_{avg} = \frac{FLUX_{req'd}/3600}{k_d \times i}\text{ , for DLC} \geq 1.0$$

$$h_{avg} = \frac{[FLUX_{req'd}/(3600 \times i)] - [h_d \times (k_d - k_{cs})]}{k_{cs}}\text{, for DLC} < 1.0$$

h_{avg} for DLC $\geq$ 1.0 = 0.00 m

h_{avg} for DLC < 1.0 = -2402.03 m

h_{avg} = 0.000 m

$$PSR = \frac{h_{avg}}{h_{cs} + h_d}$$

if PSR $\geq$ 1, set PSR = 1

h_{CS} = 610.00 mm = 0.61 m

PSR = 0.001

PSR = 0.001

Calculate Factor of Safety (FS):

$$W_A = \frac{\gamma_{dry}(h - h_w)[2H\cos\beta - (h + h_w)] + \gamma_{sat'd}(h_w)(2H\cos\beta - h_w)}{\sin 2\beta}$$

γ_{dry} = 18.00 kN/m^3

$\gamma_{sat'd}$ = 18.86 kN/m^3

$h = h_d + h_{cs}$ = 616.35 mm = 0.62 m

h_w = 0.34 mm = 0.00 m

$H = L \times \sin\beta$ = 14.55 m

W_A = 498.96 kN

$$U_h = \frac{\gamma_w (h_w)^2}{2}$$

γ_w = 9.81 kN/m^3

U_h = 0.00 kN

$$U_n = \frac{\gamma_w(h_w)(\cos\beta)(2H\cos\beta - h_w)}{\sin 2\beta}$$

U_n = 0.15 kN

LINER STABILITY CALCULATION (SEEPAGE FORCES)

$N_A = W_A(\cos\beta) + U_h(\sin\beta) - U_n$

$N_A =$ 473.19 kN

$W_P = \dfrac{\gamma_{dry}(h^2 - h_w^2) + \gamma_{sat'd}(h_w)^2}{\sin 2\beta}$

$W_P =$ 11.39 kN

$U_V = U_h(\cot\beta)$

$U_V =$ 0.00 kN

$FS = \dfrac{-b + (b^2 - 4ac)^{1/2}}{2a}$

$a = W_A(\sin\beta)(\cos\beta) - U_h(\cos^2\beta) + U_h$

a = 149.72

$b = -W_A(\sin^2\beta)(\tan\phi) + U_h(\sin\beta)(\cos\beta)(\tan\phi) - N_A(\cos\beta)(\tan\delta) - (W_P - U_V)(\tan\phi)$

ϕ =	28.00 °	=	0.49	rad
δ =	22.70 °	=	0.40	rad

b = -220.38

$c = N_A(\sin\beta)(\tan\delta)(\tan\phi)$

c = 33.29

FS = 1.30

Summary:

DLC	**18.41**
PSR	**0.001**
FS	**1.30**

At the critical interface friction angle of **22.7** degrees (23 degrees) for all soil-geosynthetic and geosynthetic-geosynthetic interfaces, the factor of safety is calculated as **1.3** indicating that there is adequate shear strength available to prevent the liner system from sliding during construction. Therefore the liner system is stable under the slope conditions analyzed.
The resulting drainage layer capacity of greater than 1.0, indicating the saturation of the liner soil would not occur. Therefore the anticipated flow capacity within the drainage layer is sufficient to handle a 25-year 24-hour storm event.

Geocomposite drainage net has a thickness of 250 mil and a hydraulic conductivity of at least 4 cm/sec.
Slope length = 150 feet (50 m) at 3:1 sideslope
Liner soil hydraulic conductivity = 1 x 10^{-5} cm/sec.

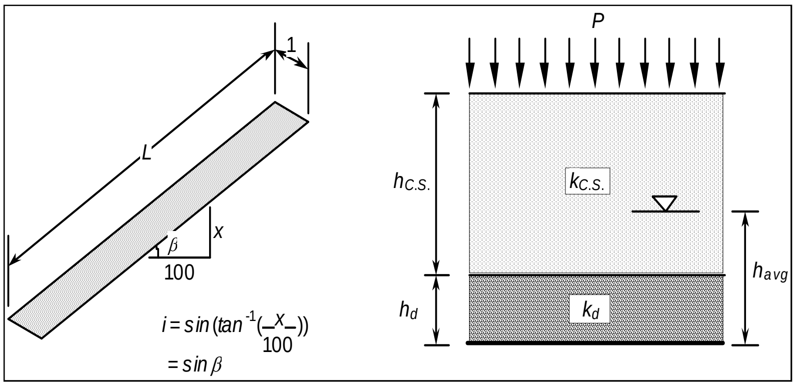
VENEER STABILITY ANALYSES

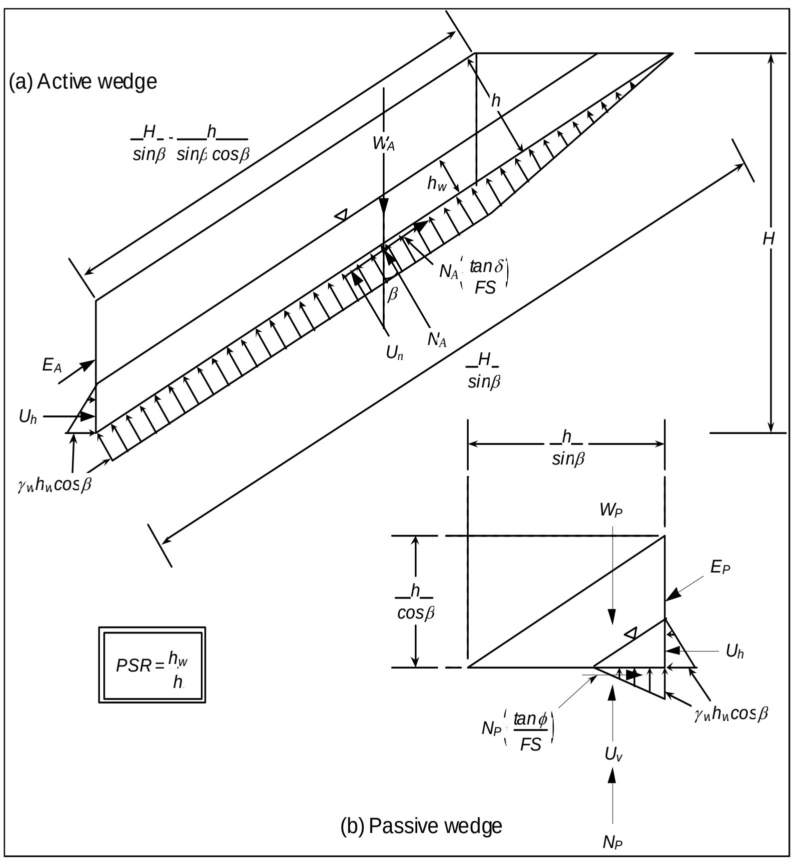
FINAL COVER SYSTEM

COVER STABILITY CALCULATION (SEEPAGE FORCES)

Veneer (Final Cover) System Stability
Project: City of Waco Landfill
Location: McLennan and Limestone Counties, TX
Prepared by: SCS ENGINEERS
Date: February 12, 2019

Consideration: To evaluate the stability of the cover system with seepage forces applied using the method described by Koerner and Soong (1998) referenced below.





Ref.: R.M. Koerner, and T-Y.Soong, 1998. "Analysis and Design of Veneer Cover Soils". Proceeding of 6th International Conference on Geosynthetics, Vol. 1, pp. 1-23, Atlanta, Georgia, USA.

COVER STABILITY CALCULATION (SEEPAGE FORCES)

Parameters:

DLC	=	drainage layer capacity
$FLUX_{allow}$	=	allowable flow rate of the drainage layer per unit width of slope
k_d	=	permeability of drainage soil or geosynthetic
h_d	=	thickness of the drainage soil or geosynthetic
i	=	sin β = slope gradient
$FLUX_{req'd}$	=	actual flow rate per unit width of slope
PERC	=	the rate of percolation
P	=	probable maximum (hourly) precipitation (25-year storm event)
RC	=	runoff coefficient
L	=	length of drainage slope
k_{cs}	=	permeability of cover soil
β	=	slope angle
w	=	1.0 m = unit width of drainage slope
PSR	=	parallel submergence ratio
h_{avg}	=	average head buildup above the geomembrane
h_{cs}	=	thickness of cover soil
FS	=	factor of safety against instability
W_A	=	total weight of the active wedge
W_P	=	total weight of the passive wedge
U_h	=	resultant of the pore pressures acting on the interwedge surfaces
U_n	=	resultant of the pore pressures acting perpendicular to the slope
U_v	=	resultant of the vertical pore pressures acting on the passive wedge
N_A	=	effective force normal to the failure plane of the active wedge
h	=	thickness of the cover soil
H	=	vertical height of the slope measured from the toe
h_w	=	(PSR)(h) = height of the free water surface measured from the geomembrane
γ_{dry}	=	dry unit weight of the cover soil
$\gamma_{sat'd}$	=	saturated unit weight of the cover soil
γ_w	=	unit weight of water
ϕ	=	cover soil friction angle
δ	=	interface friction angle between cover soil and geomembrane

COVER STABILITY CALCULATION (SEEPAGE FORCES)

Calculate Drainage Layer Capacity (DLC):

$PERC = P(1-RC)$, for $P(1-RC) \leq k_{cs}$
$PERC = k_{cs}$, for $P(1-RC) > k_{cs}$

k_{CS} =	1.00E-05	cm/s	=	3.60E-01	mm/hr
P =	8.40	mm/hr			
RC =	0.40				

P(1-RC) = 5.04 mm/hr

PERC = 0.36 mm/hr

$$FLUX_{req'd} = \frac{PERC}{1000} \times L(\cos\beta) \times w$$

L =	180.00	m			
β =	14.04	°	=	0.25	rad

$L(\cos\beta)$ = 174.62 m

$FLUX_{req'd}$ = 0.06 m^3/hr

$$FLUX_{allow} = k_d \times i \times h_d$$

k_d =	4.00E+00	cm/s	=	4.00E-02	m/s
h_d =	6.35	mm	=	0.01	m
i =	0.24				

$FLUX_{allow}$ = 0.22 m^3/hr

$$DLC = \frac{FLUX_{allow}}{FLUX_{req'd}}$$

DLC = 3.53

Notes:
1) If only one soil layer above geomembrane, treat it as a drainage layer.
2) DLC needs to be greater than one to avoid saturation of the drainage layer.

COVER STABILITY CALCULATION (SEEPAGE FORCES)

Calculate Parallel Submergence Ratio (PSR):

$$h_{avg} = \frac{FLUX_{req'd}/3600}{k_d \times i}\text{ , for DLC} \geq 1.0$$

$$h_{avg} = \frac{[FLUX_{req'd}/(3600 \times i)] - [h_d \times (k_d - k_{cs})]}{k_{cs}}\text{, for DLC} < 1.0$$

h_{avg} for DLC $\geq$ 1.0 = 0.00 m

h_{avg} for DLC < 1.0 = -1820.19 m

h_{avg} = 0.002 m

$$PSR = \frac{h_{avg}}{h_{cs} + h_d}$$

if PSR $\geq$ 1, set PSR = 1

h_{CS} = 610.00 mm = 0.61 m

PSR = 0.003

PSR = 0.003

Calculate Factor of Safety (FS):

$$W_A = \frac{\gamma_{dry}(h - h_w)[2H\cos\beta - (h + h_w)] + \gamma_{sat'd}(h_w)(2H\cos\beta - h_w)}{\sin 2\beta}$$

γ_{dry} = 18.00 kN/m^3

$\gamma_{sat'd}$ = 18.86 kN/m^3

$h = h_d + h_{cs}$ = 616.35 mm = 0.62 m

h_w = 1.80 mm = 0.00 m

$H = L \times \sin\beta$ = 43.67 m

W_A = 1982.73 kN

$$U_h = \frac{\gamma_w (h_w)^2}{2}$$

γ_w = 9.81 kN/m^3

U_h = 0.00 kN

$$U_n = \frac{\gamma_w(h_w)(\cos\beta)(2H\cos\beta - h_w)}{\sin 2\beta}$$

U_n = 3.08 kN

COVER STABILITY CALCULATION (SEEPAGE FORCES)

$N_A = W_A(\cos\beta) + U_h(\sin\beta) - U_n$

$N_A =$ 1920.41 kN

$W_P = \dfrac{\gamma_{dry}(h^2 - h_w^2) + \gamma_{sat'd}(h_w)^2}{\sin 2\beta}$

$W_P =$ 14.53 kN

$U_V = U_h(\cot\beta)$

$U_V =$ 0.00 kN

$FS = \dfrac{-b + (b^2 - 4ac)^{1/2}}{2a}$

$a = W_A(\sin\beta)(\cos\beta) - U_h(\cos^2\beta) + U_h$

a = 466.64

$b = -W_A (\sin^2\beta)(\tan\phi) + U_h(\sin\beta)(\cos\beta)(\tan\phi) - N_A(\cos\beta)(\tan\delta) - (W_P - U_V)(\tan\phi)$

$\phi =$ 28.00 ° = 0.49 rad
$\delta =$ 20.30 ° = 0.35 rad

b = -758.93

$c = N_A(\sin\beta)(\tan\delta)(\tan\phi)$

c = 91.63

FS = 1.50

Summary:

DLC	**3.53**
PSR	**0.003**
FS	**1.50**

At the critical interface friction angle of **20.3** degrees for all soil-geosynthetic and geosynthetic-geosynthetic interfaces, the factor of safety is calculated as **1.5** indicating that there is adequate shear strength available to prevent the cover system from sliding. Therefore the cover system is stable under the slope conditions analyzed.

The resulting drainage layer capacity of greater than 1.0, indicating the saturation of the cover soil above the liner would not occur. Therefore the anticipated flow capacity within the drainage layer is sufficient to handle a 25-year 24-hour storm event.

Geocomposite drainage net has a thickness of 250 mil and a hydraulic conductivity of at least 4 cm/sec.
Slope length = 586 feet (178.3 m, use 180 m) at 4:1 sideslope
Final cover soil hydraulic conductivity = 1×10^{-5} cm/sec.

APPENDIX 5C

SETTLEMENT ANALYSES

- **Liner System Settlement Analysis**
- **Final Cover Settlement Analysis**

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5/13/2020

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TBPE Reg. # F-3407

Inclusive of Pages 5-C-1 to 5-C-13

LINER SYSTEM

SETTLEMENT ANALYSIS

Date: April 22, 2019
Project: City of Waco Landfill, McLennan and Limestone Counties, TX
Project No.: 16216088.00

Spreadsheet to calculate the amount of foundation soils consolidation/settlement.
East Disposal Area - Cross Section 1

Equation: $S = C_c * [H/(1+e_o)] * \log(P/P_o)$, where

S = total settlement due to consolidation; feet
C_c = Average compression index; (Cc = w / 100), or C_c = 0.007(LL-7), or use previous reported value)
w = Moisture Content; %
H = thickness of the foundation soil layer; feet
e_o = average initial void ratio of the foundation soil layer before surcharge (e_o = (w x S.G.) / 100, or use previous reported value)
P = total pressure acting on mid-height of the foundation soil layer, ($P = P_o + s$);psf.
s = surcharge ($s = (H_s \times g_{MSW}) + (F \times g_{Fill}) - (C \times g_{Foundation\ Soil})$)
H_s = Height of Waste in feet
P_o = present effective overburden pressure at mid-height of the foundation soil layer; psf ($P_o = (H_o \times g_{Foundation\ Soil}) / 2$)

ASSUMPTIONS:

1. Average unit wt. of liner/fnl cvr, g_{Fill} (pcf):	120
2. Average unit wt. of MSW, g_{MSW} (pcf):	60
3. Unit weight of foundation soil, $g_{Foundation\ Soil}$ (pcf):	125
4. Moisture Content (WDA average) (%):	18
5. Liquid Limit (WDA average):	63
6. C_c (using (Cc = w / 100)):	0.180
7. C_c (using (Cc = 0.007(LL-7)):	0.392
8. Specific Gravity, S.G. (assumed for clays)	2.7
10. Thickness of Final Cover System (ft)	3.5

Location of Consideration Point	EG el. feet	GWT El. feet	Top of Bedrock El. feet	Subgrade El. feet	Top of Protective Soil Layer feet	Top of Final Cover feet	Thickness of Found. Soil to Bedrock H feet	Existing Ground to Bedrock H_o feet	Fill F feet	Cut C feet	Height of Waste H_s feet	Natural Moisture Content w %	Specific Gravity S.G.	C_c (average) -	Surcharge (ΔP) s psf	e_o -	P'_o psf	P' ($P'_o + \Delta P$) psf	Settlement S feet
SECTION 1																			
A_1 (x=2.7)	542.5	513.7	517.0	542.5	546.5	549.9	25.5	25.5	0.0	0.0	0.0	18	2.7	0.286	900	0.513	1,594	2,494	0.94
A_2 (x=105.45) [1]	545.9	513.7	517.0	509.8	513.8	575.0	0.0	28.9	0.0	36.0	57.6	18	2.7	0.286	N/A	0.486	N/A	N/A	0.00
A_3 (x=300) [1]	560.0	515.2	512.0	511.8	515.8	623.0	0.0	48.0	0.0	48.2	103.7	18	2.7	0.286	N/A	0.486	N/A	N/A	0.00
A_4 (x=560.95)	561.3	517.1	509.0	514.4	518.4	687.0	5.4	52.3	0.0	46.9	165.1	18	2.7	0.286	5108	0.486	5,867	10,975	0.28
A_5 (x=740.1)	562.2	518.4	511.0	516.2	520.2	695.8	5.2	51.2	0.0	46.0	172.1	18	2.7	0.286	5611	0.486	5,777	11,387	0.29
A_6 (x=915.6)	563.1	519.7	513.0	517.9	521.9	687.0	4.9	50.1	0.0	45.1	161.6	18	2.7	0.286	5063	0.486	5,685	10,748	0.26
A_7 (x=1252.5)	562.0	522.2	517.0	521.3	525.3	602.8	4.3	45.0	0.0	40.6	74.0	18	2.7	0.286	312	0.513	5,162	5,474	0.02
A_8 (x=1378)	561.8	523.1	517.0	563.2	567.2	571.4	46.2	45.0	1.3	-1.4	0.7	18	2.7	0.286	1272	0.513	2,731	4,003	1.45
																		Max. Settlement (Cell Floor)	0.29
																		Max. Settlement (Side Slope)	1.45

[1] Thickness of foundation soil remaining following excavation is zero. Therefore, settlement = 0 ft.

Analysis Location	Point A_1	Point A_2	Point A_3	Point A_4	Point A_5	Point A_6	Point A_7	Point A_8
x-Coordinate	2.7	104.4	300.0	561.0	740.1	915.6	1252.5	1378.0
Pre-settlement Top of Subgrade, ft	542.5	509.8	511.8	514.4	516.2	517.9	521.3	563.2
Total Settlement, ft	0.94	0.00	0.00	0.28	0.29	0.26	0.02	1.45
Post-settlement Top of Subgrade, ft	541.56	509.8	511.8	514.1	515.9	517.7	521.3	561.7

Analysis Location	Point A_1 to Point A_2	Point A_2 to Point A_3	Point A_3 to Point A_4	Point A_4 to Point A_5	Point A_5 to Point A_6	Point A_6 to Point A_7	Point A_7 to Point A_8
Presettlement Corridor Slope, %	32.11	-1.00	-1.00	-1.00	-1.00	-1.00	-33.38
Postsettlement Corridor Slope, %	31.19	-1.00	-0.89	-0.99	-1.02	-1.07	-32.24
Initial Length, ft	106.82	195.61	260.96	179.16	175.51	336.92	132.31
Final Length, ft	106.53	195.61	260.96	179.16	175.51	336.92	131.86
Strain, % (- values=no tension)	-0.265%	0.000%	-0.001%	0.000%	0.000%	0.001%	-0.337%

Date: April 22, 2019
Project: City of Waco Landfill, McLennan and Limestone Counties, TX
Project No.: 16216088.00

Spreadsheet to calculate the amount of foundation soils consolidation/settlement.
West Disposal Area - Cross Section 2

Equation: $S = C_c * [H/(1+e_o)] * \log(P/P_o)$, where

S = total settlement due to consolidation; feet
C_c = Average compression index; ($Cc = w / 100$), or $C_c = 0.007(LL-7)$, or use previous reported value)
w = Moisture Content; %
H = thickness of the foundation soil layer; feet
e_o = average initial void ratio of the foundation soil layer before surcharge ($e_o = (w \times S.G.) / 100$, or use previous reported value)
P = total pressure acting on mid-height of the foundation soil layer, ($P = P_o + s$);psf.
s = surcharge ($s = (H_s \times g_{MSW}) + (F \times g_{Fill}) - (C \times g_{Foundation\ Soil})$)
H_s = Height of Waste in feet
P_o = present effective overburden pressure at mid-height of the foundation soil layer; psf ($P_o = (H_o \times g_{Foundation\ Soil}) / 2$)

ASSUMPTIONS:

1. Average unit wt. of liner/fnl cvr, g_{Fill} (pcf):	120
2. Average unit wt. of MSW, g_{MSW} (pcf):	60
3. Unit weight of foundation soil, $g_{Foundation\ Soil}$ (pcf):	125
4. Moisture Content (WDA average) (%):	18
5. Liquid Limit (WDA average):	63
6. C_c (using ($Cc = w / 100$)):	0.180
7. C_c (using ($Cc = 0.007(LL-7)$)):	0.392
8. Specific Gravity, S.G. (assumed for clays)	2.7
10. Thickness of Final Cover System (ft)	3.5

Location of Consideration Point	EG el. feet	GWT El. feey	Top of Bedrock El. feet	Subgrade El. feet	Top of Protective Soil Layer feet	Top of Final Cover feet	Thickness of Found. Soil to Bedrock H feet	Existing Ground to Bedrock H_o feet	Fill F feet	Cut C feet	Height of Waste H_s feet	Natural Moisture Content w %	Specific Gravity S.G.	C_c (average) -	Surcharge (ΔP) s psf	e_o -	P'_o psf	P' ($P'_o + \Delta P$) psf	Settlement S feet
SECTION 2																			
A_1 (x=0)	554.7	525.0	515.0	520.7	524.7	629.6	5.7	39.7	0.0	34.0	101.4	18	2.7	0.286	3,002	0.4860	4,160	7,162	0.26
A_2 (x=218.4)	554.0	525.0	515.8	518.5	522.5	650.0	2.7	38.2	0.0	35.5	124.0	18	2.7	0.286	3,888	0.4860	4,116	8,005	0.15
A_3 (x=417.2) [1]	550.0	525.0	518.5	516.5	520.5	657.7	0.0	31.5	0.0	33.5	133.7	18	2.7	0.286	N/A	0.4860	N/A	N/A	0.00
A_4 (x=1,108.5) [1]	537.8	525.0	512.5	509.6	513.6	565.5	0.0	25.3	0.0	28.2	48.4	18	2.7	0.286	N/A	0.4860	N/A	N/A	0.00
A_5 (x=1,218.5)	538.0	525.0	512.5	535.7	539.7	546.0	23.2	25.5	0.0	2.3	2.8	18	2.7	0.286	781	0.4860	1,738	2,518	0.72
																		Max. Settlement (Cell Floor)	0.26
																		Max. Settlement (Side Slope)	0.72

1 Thickness of foundation soil remaining following excavation is zero. Therefore, settlement = 0 ft.

Analysis Location	Point A_1	Point A_2	Point A_3	Point A_4	Point A_5
x-Coordinate	0.0	218.4	417.2	1108.5	1218.5
Pre-settlement Top of Subgrade, ft	520.70	518.50	516.52	509.60	538.00
Total Settlement, ft	0.26	0.15	0.00	0.00	1.04
Post-settlement Top of Subgrade, ft	520.44	518.35	516.52	509.60	536.96

Analysis Location	Point A_1 to Point A_2	Point A_2 to Point A_3	Point A_3 to Point A_4	Point A_4 to Point A_5
Pre-settlement Slope, %	1.00	1.00	1.00	-25.82
Post-settlement Slope, %	0.94	0.92	1.00	-24.87
Initial Length, ft	417.22	198.81	691.33	113.61
Final Length, ft	417.22	198.81	691.33	113.35
Strain, % (- values=no tension)	-0.001%	-0.001%	0.000%	-0.225%

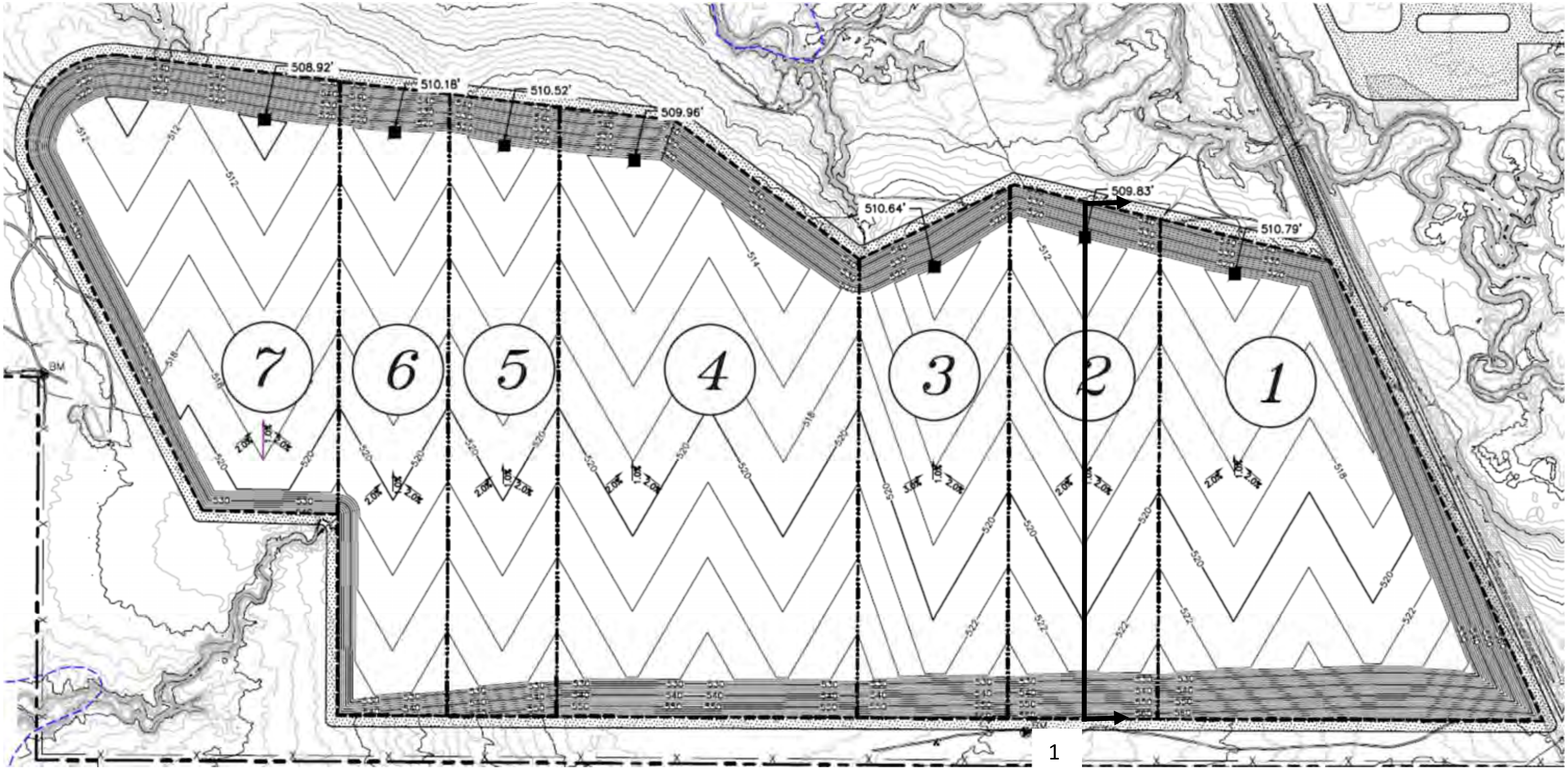

Figure 1. Location of the Analyzed Cross Section 1 on Excavation Grading Plan – East Disposal Area

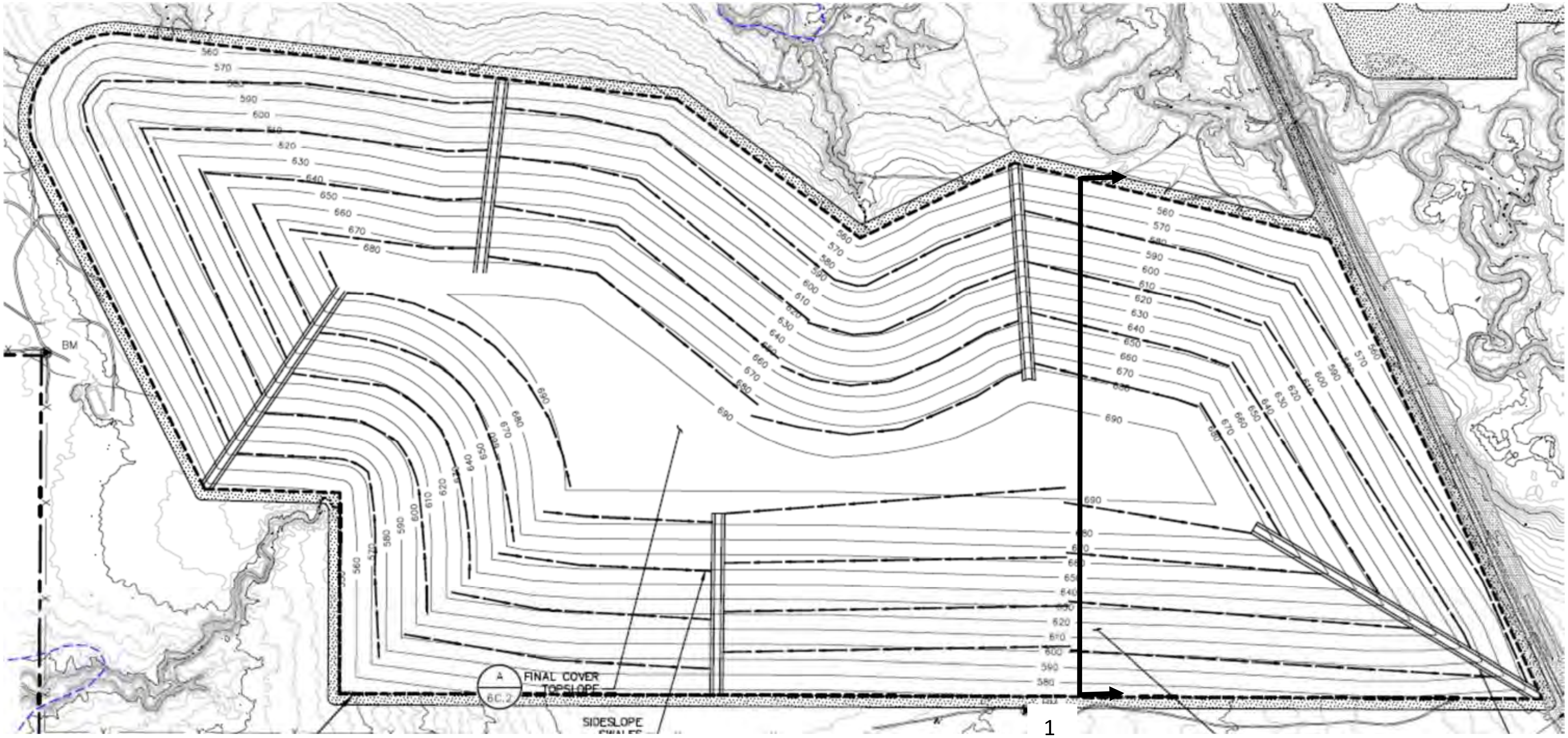

Figure 2. Location of the Analyzed Cross Section 1 on Final Cover Grading Plan – East Disposal Area

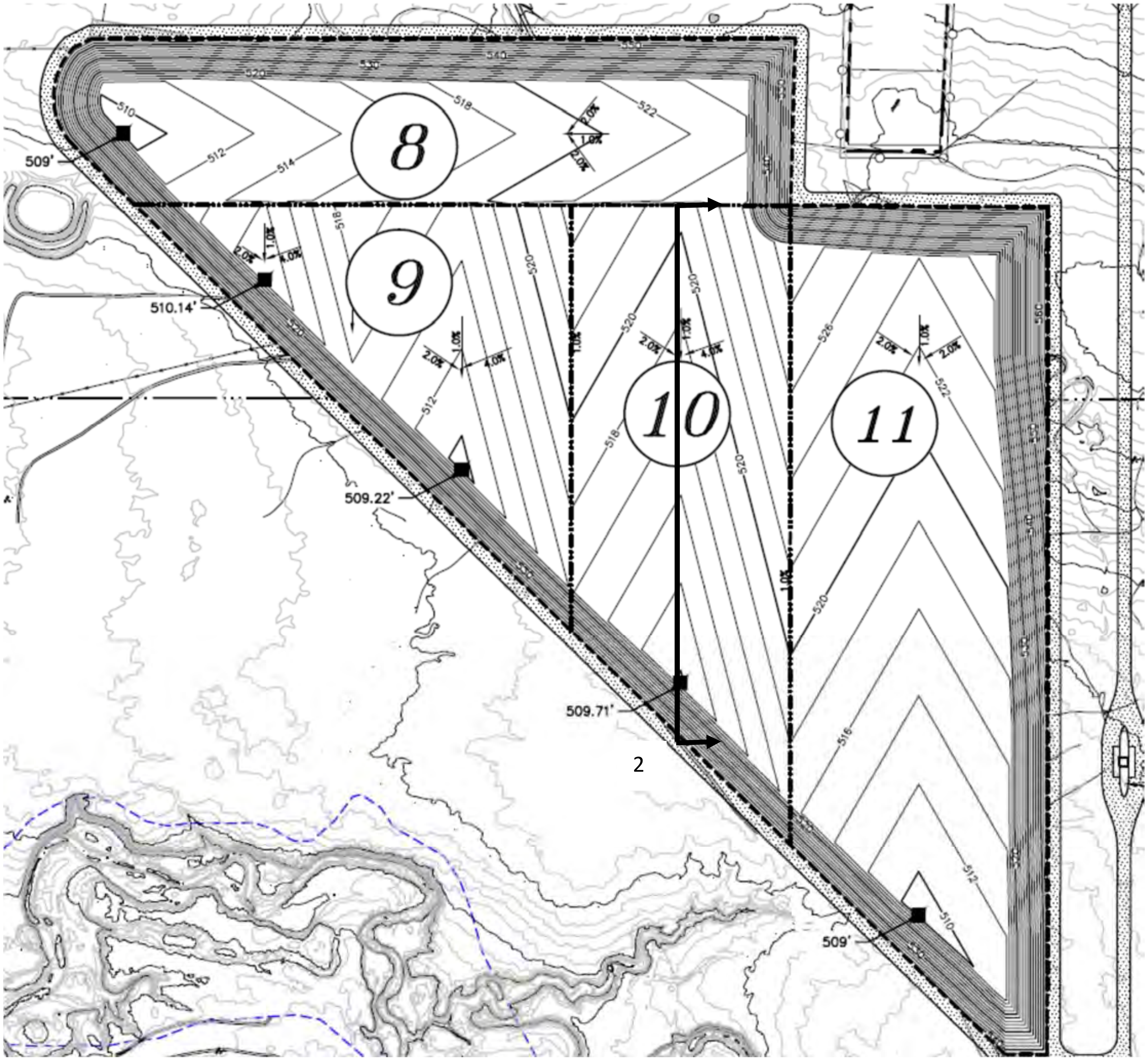

Figure 3. Location of the Analyzed Cross Section 2 on Excavation Grading Plan – West Disposal Area

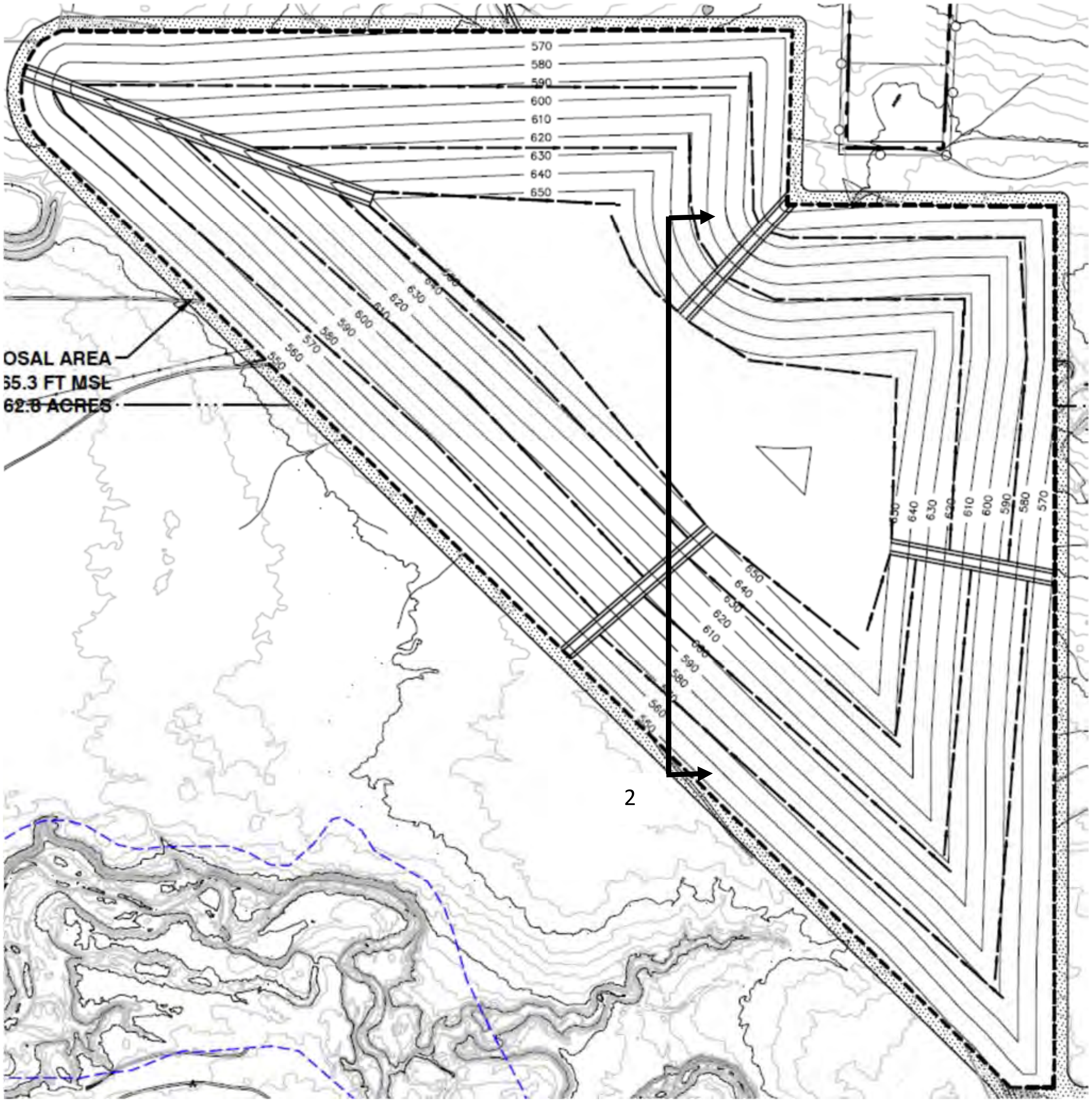

Figure 4. Location of the Analyzed Cross Section 2 on Final Cover Grading Plan – West Disposal Area

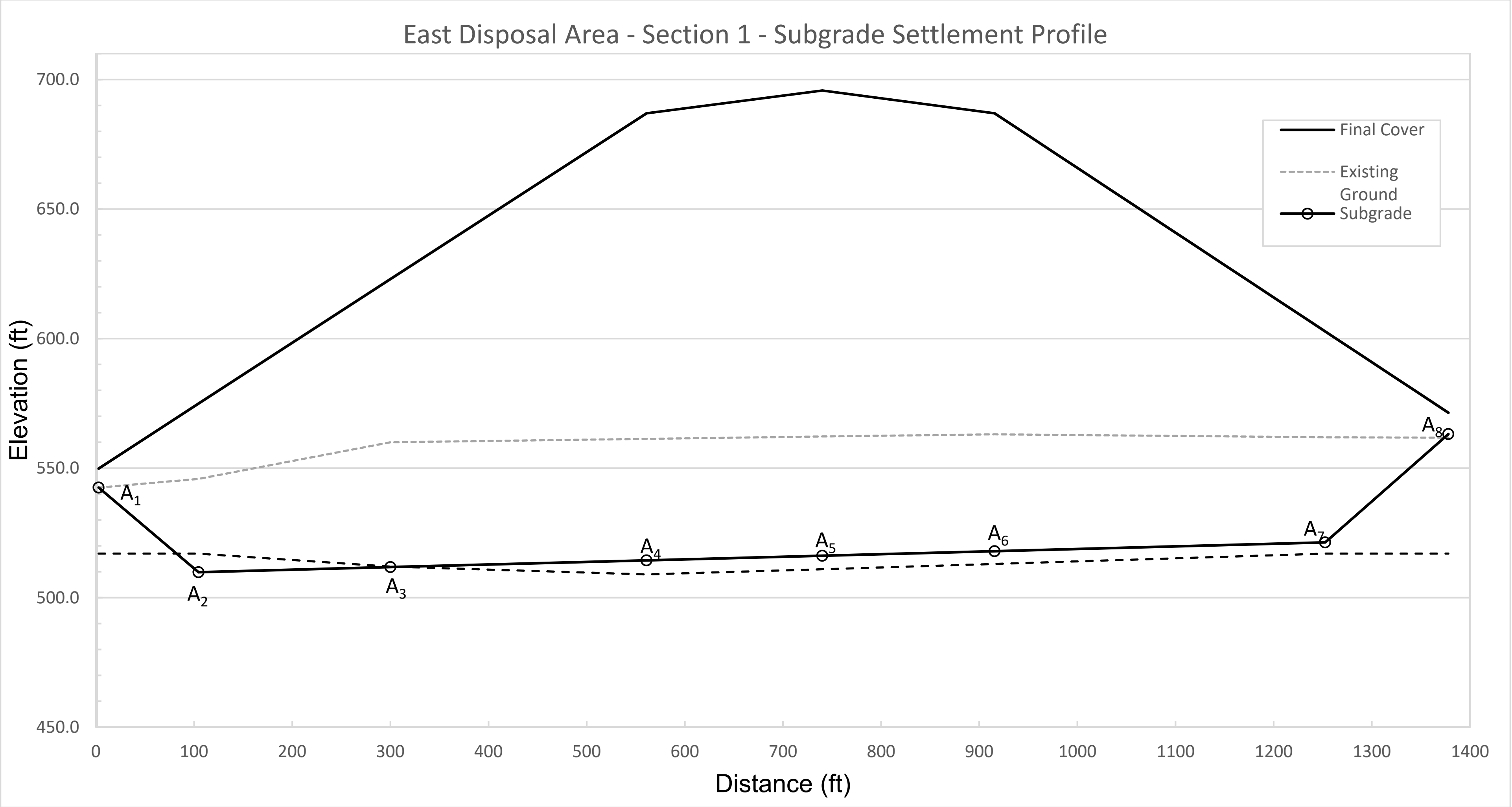

Figure 5. Cross Section 1 Geometry – East Disposal Area

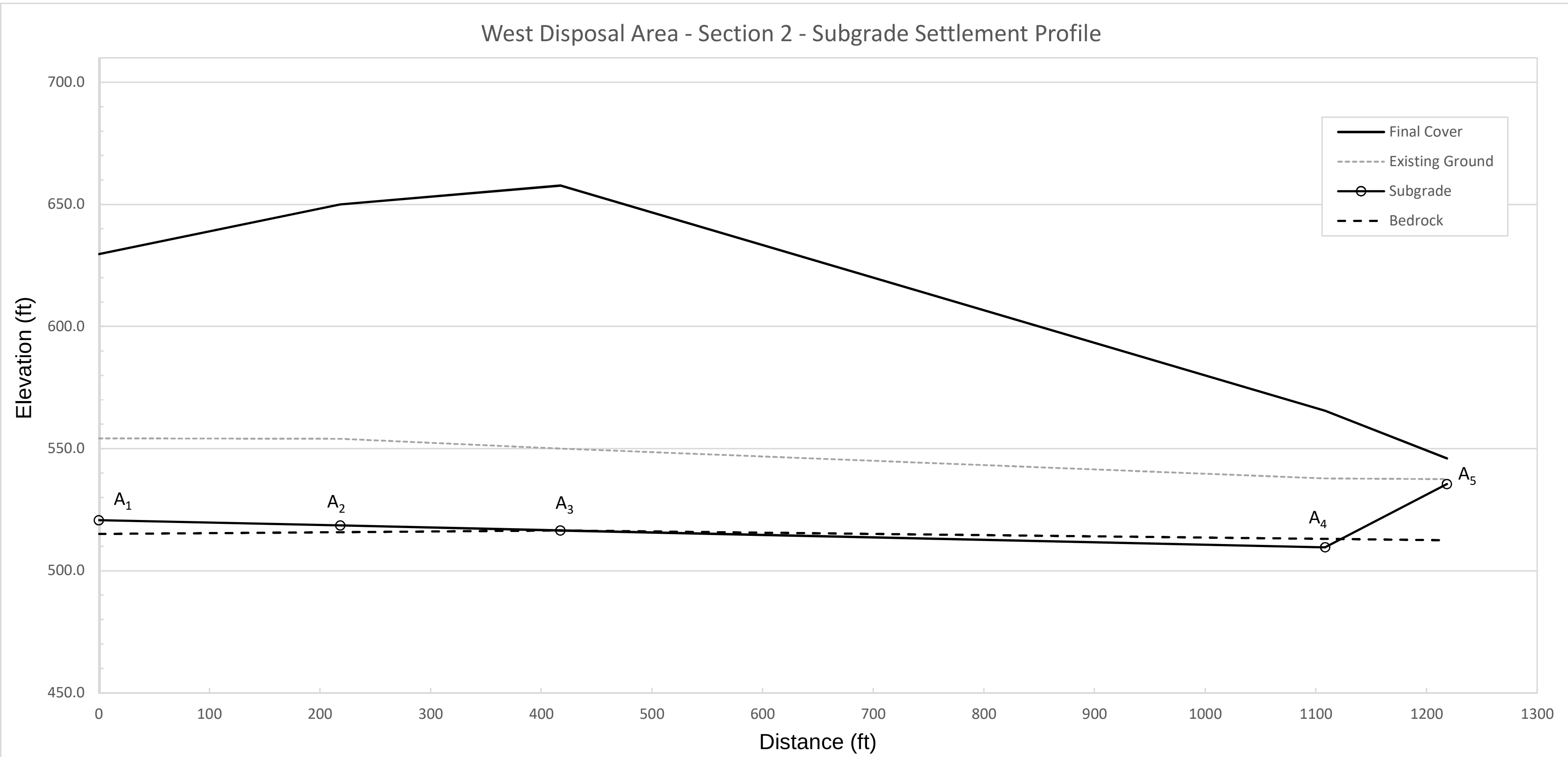

Figure 6. Cross Section 2 Geometry – West Disposal Area

FINAL COVER SYSTEM

SETTLEMENT ANALYSIS

Date: April 22, 2019
Project: City of Waco Landfill, McLennan and Limestone Counties, TX
Project No.: 16216088.00

Spreadsheet to calculate the amount of municipal solid waste consolidation/settlement.

$$S = \underbrace{C_{c\varepsilon} H log\left(\frac{P}{P_0}\right)}_{\text{Primary Consolidation}} + \underbrace{C_\alpha H log\left(\frac{t_2}{t_1}\right)}_{\text{Secondary Compression}}$$

where:

S = total settlement;
$C_{c\varepsilon}$ = modified compression index;
H = initial thickness of compressible layer;
P_0 = initial effective overburden stress;
P = final effective overburden pressure. ($P=P_0 + \Delta P$),
ΔP = final cover thickness x unit weight of final cover soils
C_α = secondary compression index;
t_1 = time when secondary compression is assumed to begin (assumed to be 1 year)
t_2 = time for when secondary settlements are calculated for (assumed to be 30 years)

$$\varepsilon = \frac{L_0 - L_f}{L_0} \times 100\ (percent)$$

where:

ε = strain in the final cover system (+ indicated compression, - indicated tension);
L_f = final length between calculation points based on post-settlement elevations; and
L_i = initial length between calculation points based on pre-settlement elevations.

ASSUMPTIONS:

1. Average unit wt. of liner/fnl cvr, γ_{Fill} (pcf):	120
2. Average unit wt. of MSW, γ_{MSW} (pcf):	60
3. Thickness of Final Cover System (ft):	3.5
4. Surcharge (ΔP) (γ_{fill} x $Thickness_{Fnl\ Cvr}$) (psf):	420
5. t_1 (years):	1
6. t_2 (years):	30
7. $C_{c\varepsilon}$:	0.205
8. C_α:	0.050

Location of Consideration Point	Top of Final Cover	Top of Waste	Top of Protective Soil Layer	Thickness of Waste
	feet	feet	feet	feet
SECTION 1				
A_1 (x= 162.9)	542.7	539.2	538.3	0.9
A_2 (x= 211.4)	554.8	551.3	522.2	29.1
A_3 (x= 741.0)	687.0	683.5	521.1	162.4
A_4 (x= 1643.9)	697.6	694.1	522.2	171.9
A_5 (x= 2285.0)	689.9	686.4	526.4	160.0
A_6 (x= 2795.8)	695.3	691.8	521.9	169.9
A_7 (x= 3089.9)	694.0	690.5	524.0	166.5
A_8 (x= 3230.0)	687.0	683.5	521.4	162.1
A_9 (x=3674.3)	575.7	572.2	519.4	52.8
A_{10} (x=3764.8)	553.0	549.5	549.0	0.5

Settlement of MSW Layer 1

Location of Consideration Point	Top of Final Cover	Top of Waste	Waste El. at Midpoint	Thickness of Waste Layer	$C_{c\varepsilon}$	Surcharge (ΔP)	P'o	P' (P'o + ΔP)	Primary Settlement	Cα	Secondary Settlement	Total Settlement
	feet	feet	feet	feet	-	s psf	psf	psf	ft		ft	ft
SECTION 1												
A_1 (x= 162.9)	542.7	539.2	539.1	0.2	0.205	420.0	4.5	424.5	0.06	0.050	0.01	0.07
A_2 (x= 211.4)	554.8	551.3	548.9	4.8	0.205	420.0	145.5	565.5	0.59	0.050	0.36	0.94
A_3 (x= 741.0)	687.0	683.5	670.0	27.1	0.205	420.0	812.0	1232.0	1.00	0.050	2.00	3.00
A_4 (x= 1643.9)	697.6	694.1	679.8	28.7	0.205	420.0	859.5	1279.5	1.01	0.050	2.12	3.13
A_5 (x= 2285.0)	689.9	686.4	673.1	26.7	0.205	420.0	800.0	1220.0	1.00	0.050	1.97	2.97
A_6 (x= 2795.8)	695.3	691.8	677.6	28.3	0.205	420.0	849.5	1269.5	1.01	0.050	2.09	3.10
A_7 (x= 3089.9)	694.0	690.5	676.6	27.8	0.205	420.0	832.5	1252.5	1.01	0.050	2.05	3.06
A_8 (x= 3230.0)	687.0	683.5	670.0	27.0	0.205	420.0	810.5	1230.5	1.00	0.050	2.00	3.00
A_9 (x=3674.3)	575.7	572.2	567.8	8.8	0.205	420.0	264.0	684.0	0.75	0.050	0.65	1.40
A_{10} (x=3764.8)	553.0	549.5	549.5	0.1	0.205	420.0	2.5	422.5	0.04	0.050	0.01	0.04

Settlement of MSW Layer 2

Location of Consideration Point	Top of Final Cover	Top of Waste	Waste El. at Midpoint	Thickness of Waste Layer	$C_{c\varepsilon}$	Surcharge (ΔP)	P'o	P' (P'o + ΔP)	Primary Settlement	Cα	Secondary Settlement	Total Settlement
	feet	feet	feet	feet	-	s psf	psf	psf	ft		ft	ft
SECTION 1												
A_1 (x= 162.9)	542.7	539.2	539.0	0.2	0.205	420.0	13.5	433.5	0.05	0.050	0.01	0.06
A_2 (x= 211.4)	554.8	551.3	544.0	4.8	0.205	420.0	436.5	856.5	0.29	0.050	0.36	0.65
A_3 (x= 741.0)	687.0	683.5	642.9	27.1	0.205	420.0	2436.0	2856.0	0.38	0.050	2.00	2.38
A_4 (x= 1643.9)	697.6	694.1	651.1	28.7	0.205	420.0	2578.5	2998.5	0.38	0.050	2.12	2.50
A_5 (x= 2285.0)	689.9	686.4	646.4	26.7	0.205	420.0	2400.0	2820.0	0.38	0.050	1.97	2.35
A_6 (x= 2795.8)	695.3	691.8	649.3	28.3	0.205	420.0	2548.5	2968.5	0.38	0.050	2.09	2.48
A_7 (x= 3089.9)	694.0	690.5	648.9	27.8	0.205	420.0	2497.5	2917.5	0.38	0.050	2.05	2.43
A_8 (x= 3230.0)	687.0	683.5	643.0	27.0	0.205	420.0	2431.5	2851.5	0.38	0.050	2.00	2.38
A_9 (x=3674.3)	575.7	572.2	559.0	8.8	0.205	420.0	792.0	1212.0	0.33	0.050	0.65	0.98
A_{10} (x=3764.8)	553.0	549.5	549.4	0.1	0.205	420.0	7.5	427.5	0.03	0.050	0.01	0.04

Settlement of MSW Layer 3

Location of Consideration Point	Top of Final Cover	Top of Waste	Waste El. at Midpoint	Thickness of Waste Layer	$C_{c\varepsilon}$	Surcharge (ΔP)	P'o	P' (P'o + ΔP)	Primary Settlement	Cα	Secondary Settlement	Total Settlement
	feet	feet	feet	feet	-	s psf	psf	psf	ft		ft	ft
SECTION 1												
A_1 (x= 162.9)	542.7	539.2	538.8	0.2	0.205	420.0	22.5	442.5	0.04	0.050	0.01	0.05
A_2 (x= 211.4)	554.8	551.3	539.2	4.8	0.205	420.0	727.5	1147.5	0.20	0.050	0.36	0.55
A_3 (x= 741.0)	687.0	683.5	615.8	27.1	0.205	420.0	4060.0	4480.0	0.24	0.050	2.00	2.24
A_4 (x= 1643.9)	697.6	694.1	622.5	28.7	0.205	420.0	4297.5	4717.5	0.24	0.050	2.12	2.35
A_5 (x= 2285.0)	689.9	686.4	619.7	26.7	0.205	420.0	4000.0	4420.0	0.24	0.050	1.97	2.21
A_6 (x= 2795.8)	695.3	691.8	621.0	28.3	0.205	420.0	4247.5	4667.5	0.24	0.050	2.09	2.33
A_7 (x= 3089.9)	694.0	690.5	621.1	27.8	0.205	420.0	4162.5	4582.5	0.24	0.050	2.05	2.29
A_8 (x= 3230.0)	687.0	683.5	616.0	27.0	0.205	420.0	4052.5	4472.5	0.24	0.050	2.00	2.23
A_9 (x=3674.3)	575.7	572.2	550.2	8.8	0.205	420.0	1320.0	1740.0	0.22	0.050	0.65	0.87
A_{10} (x=3764.8)	553.0	549.5	549.3	0.1	0.205	420.0	12.5	432.5	0.03	0.050	0.01	0.03

Settlement of MSW Layer 4

Location of Consideration Point	Top of Final Cover (feet)	Top of Waste (feet)	Waste El. at Midpoint (feet)	Thickness of Waste Layer (feet)	C_{ce} (-)	Surcharge (ΔP) s (psf)	P'o (psf)	P' (P'o + ΔP) (psf)	Primary Settlement (ft)	Cα	Secondary Settlement (ft)	Total Settlement (ft)
SECTION 1												
A_1 (x= 162.9)	542.7	539.2	538.7	0.2	0.205	420.0	31.5	451.5	0.04	0.050	0.01	0.05
A_2 (x= 211.4)	554.8	551.3	534.3	4.8	0.205	420.0	1018.5	1438.5	0.15	0.050	0.36	0.51
A_3 (x= 741.0)	687.0	683.5	588.8	27.1	0.205	420.0	5684.0	6104.0	0.17	0.050	2.00	2.17
A_4 (x= 1643.9)	697.6	694.1	593.8	28.7	0.205	420.0	6016.5	6436.5	0.17	0.050	2.12	2.29
A_5 (x= 2285.0)	689.9	686.4	593.1	26.7	0.205	420.0	5600.0	6020.0	0.17	0.050	1.97	2.14
A_6 (x= 2795.8)	695.3	691.8	592.7	28.3	0.205	420.0	5946.5	6366.5	0.17	0.050	2.09	2.26
A_7 (x= 3089.9)	694.0	690.5	593.4	27.8	0.205	420.0	5827.5	6247.5	0.17	0.050	2.05	2.22
A_8 (x= 3230.0)	687.0	683.5	588.9	27.0	0.205	420.0	5673.5	6093.5	0.17	0.050	2.00	2.17
A_9 (x=3674.3)	575.7	572.2	541.4	8.8	0.205	420.0	1848.0	2268.0	0.16	0.050	0.65	0.81
A_{10} (x=3764.8)	553.0	549.5	549.2	0.1	0.205	420.0	17.5	437.5	0.02	0.050	0.01	0.03

Settlement of MSW Layer 5

Location of Consideration Point	Top of Final Cover (feet)	Top of Waste (feet)	Waste El. at Midpoint (feet)	Thickness of Waste Layer (feet)	C_{ce} (-)	Surcharge (ΔP) s (psf)	P'o (psf)	P' (P'o + ΔP) (psf)	Primary Settlement (ft)	Cα	Secondary Settlement (ft)	Total Settlement (ft)
SECTION 1												
A_1 (x= 162.9)	542.7	539.2	538.5	0.2	0.205	420.0	40.5	460.5	0.03	0.050	0.01	0.04
A_2 (x= 211.4)	554.8	551.3	529.5	4.8	0.205	420.0	1309.5	1729.5	0.12	0.050	0.36	0.48
A_3 (x= 741.0)	687.0	683.5	561.7	27.1	0.205	420.0	7308.0	7728.0	0.13	0.050	2.00	2.13
A_4 (x= 1643.9)	697.6	694.1	565.2	28.7	0.205	420.0	7735.5	8155.5	0.13	0.050	2.12	2.25
A_5 (x= 2285.0)	689.9	686.4	566.4	26.7	0.205	420.0	7200.0	7620.0	0.13	0.050	1.97	2.10
A_6 (x= 2795.8)	695.3	691.8	564.4	28.3	0.205	420.0	7645.5	8065.5	0.13	0.050	2.09	2.23
A_7 (x= 3089.9)	694.0	690.5	565.6	27.8	0.205	420.0	7492.5	7912.5	0.13	0.050	2.05	2.18
A_8 (x= 3230.0)	687.0	683.5	561.9	27.0	0.205	420.0	7294.5	7714.5	0.13	0.050	2.00	2.13
A_9 (x=3674.3)	575.7	572.2	532.6	8.8	0.205	420.0	2376.0	2796.0	0.13	0.050	0.65	0.78
A_{10} (x=3764.8)	553.0	549.5	549.1	0.1	0.205	420.0	22.5	442.5	0.02	0.050	0.01	0.03

Settlement of MSW Layer 6

Location of Consideration Point	Top of Final Cover (feet)	Top of Waste (feet)	Waste El. at Midpoint (feet)	Thickness of Waste Layer (feet)	C_ce (-)	Surcharge (ΔP) s (psf)	P'o (psf)	P' (P'o + ΔP) (psf)	Primary Settlement (ft)	Cα	Secondary Settlement (ft)	Total Settlement (ft)
SECTION 1												
A_1 (x= 162.9)	542.7	539.2	538.4	0.2	0.205	420.0	49.5	469.5	0.03	0.050	0.01	0.04
A_2 (x= 211.4)	554.8	551.3	524.6	4.8	0.205	420.0	1600.5	2020.5	0.10	0.050	0.36	0.46
A_3 (x= 741.0)	687.0	683.5	534.6	27.1	0.205	420.0	8932.0	9352.0	0.11	0.050	2.00	2.11
A_4 (x= 1643.9)	697.6	694.1	536.5	28.7	0.205	420.0	9454.5	9874.5	0.11	0.050	2.12	2.23
A_5 (x= 2285.0)	689.9	686.4	539.7	26.7	0.205	420.0	8800.0	9220.0	0.11	0.050	1.97	2.08
A_6 (x= 2795.8)	695.3	691.8	536.1	28.3	0.205	420.0	9344.5	9764.5	0.11	0.050	2.09	2.20
A_7 (x= 3089.9)	694.0	690.5	537.9	27.8	0.205	420.0	9157.5	9577.5	0.11	0.050	2.05	2.16
A_8 (x= 3230.0)	687.0	683.5	534.9	27.0	0.205	420.0	8915.5	9335.5	0.11	0.050	2.00	2.11
A_9 (x=3674.3)	575.7	572.2	523.8	8.8	0.205	420.0	2904.0	3324.0	0.11	0.050	0.65	0.76
A_{10} (x=3764.8)	553.0	549.5	549.0	0.1	0.205	420.0	27.5	447.5	0.02	0.050	0.01	0.03

Point Number	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
X Coordinate	162.9	211.4	741.0	1643.9	2285.0	2795.8	3089.9	3230.0	3674.3	3764.8
Layer 1 -Total Settlement (ft)	0.07	0.94	3.00	3.13	2.97	3.10	3.06	3.00	1.40	0.04
Layer 2 -Total Settlement (ft)	0.06	0.65	2.38	2.50	2.35	2.48	2.43	2.38	0.98	0.04
Layer 3 -Total Settlement (ft)	0.05	0.55	2.24	2.35	2.21	2.33	2.29	2.23	0.87	0.03
Layer 4 -Total Settlement (ft)	0.05	0.51	0.51	2.29	2.14	2.26	2.22	2.17	0.81	0.03
Layer 5 -Total Settlement (ft)	0.00	0.48	2.13	2.25	2.10	2.23	2.18	2.13	0.78	0.03
Layer 6 -TotalSettlement (ft)	0.04	0.46	2.11	2.23	2.08	2.20	2.16	2.11	0.76	0.03
Total Settlement at Point (ft)	0.27	3.59	12.37	14.75	13.86	14.60	14.35	14.01	5.59	0.20

X Coordinate	162.9	211.4	741.0	1643.9	2285.0	2795.8	3089.9	3230.0	3674.3	3764.8
Pre-settlement Top of Final Cover, ft	542.7	554.8	687.0	697.6	689.9	695.3	694.0	687.0	575.7	553.0
Total Settlement, ft	0.27	3.59	12.37	14.75	13.86	14.60	14.35	14.01	5.59	0.20
Post-settlement Top of Final Cover, ft	542.43	551.21	674.6	682.8	676.0	680.7	679.7	673.0	570.1	552.8

Analysis Location	Point A_1 to Point A_2	Point A_2 to Point A_3	Point A_3 to Point A_4	Point A_4 to Point A_5	Point A_5 to Point A_6	Point A_6 to Point A_7	Point A_7 to Point A_8	Point A_8 to Point A_9	Point A_9 to Point A_{10}
Presettlement Final Cover Top Slope, %	-24.95	-24.96	-1.17	1.20	-1.06	0.44	5.00	25.05	25.08
Postsettlement Final Cover Top Slope, %	-18.09	-23.30	-0.91	1.06	-0.91	0.36	4.76	23.15	19.13
Initial Length, ft	49.99	545.85	902.96	641.15	510.83	294.10	140.27	458.03	93.30
Final Length, ft	49.29	543.79	902.94	641.14	510.82	294.10	140.26	456.05	92.14
Strain, % (Tensile Negative)	1.399%	0.377%	0.003%	0.002%	0.001%	0.000%	0.012%	0.431%	1.247%

CITY OF WACO LANDFILL
TCEQ PERMIT NO. MSW-2400
McLENNAN AND LIMESTONE COUNTIES, TEXAS

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 6A
SURFACE WATER DRAINAGE PLAN

Prepared for:

CITY OF WACO

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STATE OF TEXAS
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73860
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

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Revision 0 – April 2020
SCS Project No. 16216088.00

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SCS Engineers
TBPE Reg. # F-3407

(Drawings 6A-E.1 through 6A-E.5 are provided in Appendix 6A-E)

Appendices

STATE OF TEXAS
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5/13/2020

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TBPE Reg. # F-3407

1 INTRODUCTION

This Surface Water Drainage Plan has been prepared as a part of the permit application for the City of Waco Landfill (landfill). This plan has been prepared consistent with the requirements outlined in 30 TAC Chapter 330, Subchapter G. This plan addresses the surface water drainage design, and erosion and offsite sedimentation controls that will be implemented and maintained during all phases of landfill operation.

Consistent with 30 TAC §330.303(a) and 330.305(b) and (c), the drainage features are designed to convey post-development run-on and runoff from a 25-year, 24-hour storm event. Attachment 6A also includes a surface water drainage demonstration pursuant to §330.305(a), which verifies that the proposed landfill development will not adversely alter existing drainage patterns surrounding the landfill. This surface water drainage demonstration was prepared consistent with TCEQ guidance document, "Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill", revised May 2018. Permit-level plans and details for the proposed surface water and erosion control features are presented in this attachment.

A demonstration of compliance with the floodplain location restriction [§330.63(c)(2) and 330.307] is included in Part III, Attachment 6B – Floodplain Evaluation.

Groundwater protection measures for the landfill (e.g., bottom liner system, leachate collection system, and final cover system) are described in Part III, Attachment 6C – Groundwater Protection Plan.

2 METHODOLOGY

2.1 HYDROLOGIC ANALYSIS METHODS

This subsection describes the hydrologic methodology used for the surface water drainage demonstration. The demonstration provided herein includes an analysis of the impacts to existing drainage patterns (pre-development conditions) as a result of the proposed landfill development (post-development conditions) in accordance with §330.63(c)(1)(C). Pre-development conditions are depicted on Drawings 6A.1A and 6A.1B, while post-development conditions, which are representative of the landfill at final grade, are shown on Drawing 6A.2. To evaluate impacts to existing drainage patterns, pre- and post-development peak flow rates and total discharge volumes were compared at offsite discharge locations referred to as points-of-demonstration (POD). A POD is defined as a location where one or more contributing drainage areas, channels, or detention basins discharge offsite. Based on review of pre-development conditions, surface water is discharged from the property at eleven locations or PODs. Pre- and post-development conditions are described in Sections 3 and 4 of this attachment, respectively. The comparison of pre- and post-development discharge rates at these eleven PODs is further described in Subsection 5.4 of this attachment.

In accordance with §330.63(c)(1)(D), the pre- and post-development hydrologic conditions were modeled for a 25-year, 24-hour storm event using the U.S. Army Corp of Engineers', Hydrologic Engineering Center's - Hydrologic Modeling System, Version 4.0 computer software (referred to as HEC-HMS). HEC-HMS was used to develop hydrographs for both the pre-development and post-development conditions for computation of the peak flow rates and total discharge volumes, as described in the following subsections.

Peak flow rates and total discharge volumes were compared between the pre- and post-development conditions to evaluate potential impacts to existing drainage patterns, as described in Section 5. Additionally, the peak flow rates modeled using HEC-HMS were used in the design of the major surface water drainage features proposed for the landfill property (i.e., perimeter drainage channels, detention basins, and outlet structures), as described in Section 4.

2.1.1 Description of HEC-HMS Computer Program

HEC-HMS is a Windows-based program incorporating analytical methods to simulate the surface runoff response of a watershed subjected to a design storm event. The HEC-HMS model represents a watershed as a network of hydrologic and hydraulic components. The modeling process results in the computation of hydrographs for surface water runoff, channel-flow, and detention basin storage within the watershed. HEC-HMS then combines and routes the hydrographs through user-defined up- and down-gradient drainage features to defined watershed outlets (i.e., PODs).

Input parameters for the HEC-HMS model are described below. The input parameters assumed for the HEC-HMS modeling are summarized in tables included in Appendix 6A-A. The tables include parameters for both the pre-development subbasins, as well as post-development subbasins, channels, and detention basins.

2.1.1.1 Watershed Subbasins

Subbasins are generally assumed to be drainage areas that share similar run-on and runoff characteristics, surface features, and typically discharge to a single reach (i.e., channel), detention basin, or off-site discharge location, such as a POD. The on-site and off-site watershed subbasins and surrounding drainage features modeled using HEC-HMS are presented on Drawings 6A.1A and 6A.1B (pre-development conditions) and Drawing 6A.2 (post-development conditions).

2.1.1.2 Time Step

The time step, or the program computation interval, and model duration are used to develop the hydrographs. The time step interval determines the resolution of the model results computed during a model run. A time interval of one minute was used for the computations, resulting in 1440 hydrograph ordinates per 24-hour period. The model duration was set at 48 hours. This duration allowed precipitation from the design storm to exit the landfill property, with the exception of any stormwater retained in the basin sediment storage. This duration was also long enough that the hydrograph peak had clearly passed and that flows had decreased to a level at which a longer time period would yield no usable information.

2.1.1.3 Hypothetical Precipitation Distribution

The hypothetical precipitation distribution was derived from the National Weather Service, Technical Paper No. 40 (TP-40). A Type III storm event with a return period of 25 years and duration of 24 hours was used for the hydrologic modeling. This storm event is associated with approximately 7.75 inches of precipitation, which was assumed to be evenly distributed across the entire watershed for the return period. A figure presenting the source of the precipitation data used in the model is included in Appendix 6A-A.

2.1.1.4 Precipitation Losses

Precipitation losses (the precipitation that does not contribute to runoff) were estimated in the HEC-HMS model by the Soil Conservation Service (SCS) Curve Number (CN) method. This method relates the hydrologic soil group to the CN as a function of soil type, land use, and antecedent moisture conditions. Input values for the method typically include the CN value, the initial abstraction, and the percent impervious area for each subbasin.

Initial abstraction (IA) represents the precipitation loss that occurs at the beginning of a storm event, prior to runoff beginning. The model allows either IA values to be input, or to be calculated by the model. For this analysis, the model calculated the IA values as a function of the CN method.

CN values for pre-development were selected based on the cover type. A CN value of 85 was used for post-development conditions, which is a conservative assumption. Reference tables for these CN values are provided in Appendix 6A-A. Based on Soil Survey Maps and subsurface explorations conducted as part of this permit application, on-site soils are predominantly clayey soils. Therefore, Soil group D was used for curve number determination since on-site soils are generally clays.

2.1.1.5 Routing and Hydrograph Methods

Numerous routing and hydrograph methods are available within the HEC-HMS model. The routing and hydrograph method represents the methodology used by the model to develop hydrographs for each subbasin, channel, and detention basin, which are then combined by the program to represent the watershed being analyzed. The specific routing and hydrograph methods used for the analysis are discussed in subsequent subsections. HEC-HMS routing and hydrograph methods were used to predict the peak flow rates (peak of hydrograph), as well as the total discharge volume (area under the hydrograph) associated with pre- and post-development conditions.

Discharge hydrographs for each POD for both pre- and post-development conditions are presented in Appendix 6A-D of this attachment.

2.1.1.6 Subbasin Transform

SCS Unit Hydrograph Transform Method - The SCS Unit Hydrograph (UH) method was used for developing a hydrograph that develops surface runoff calculations for pre-development subbasins, post-development areas that are not within the limit of waste, and small post-development subbasins that do not have main channels, which are required when using the Kinematic Wave Method. These post-development areas include the areas occupied by detention basins and landfill sideslope areas that discharge to perimeter channels.

The UH method generalizes the surface water flow of a drainage area into a dimensionless unit hydrograph, based on the ratio of discharge to UH peak discharge and the ratio of time to UH time to peak. The UH time to peak is dependent on the drainage area lag time, which is defined as the length of time between the centroid of precipitation mass and the peak flow of the resulting hydrograph. The input parameter for this method is the lag time, which is typically approximated by taking 60 percent of the time-of-concentration for these areas. Time of concentrations for these areas were estimated using the Velocity Method. As introduced in the USDA Part 630 Hydrology National Engineering Handbook Chapter 15 (May, 2010), the velocity method assumes that time of concentration is the sum of travel times for segments along the hydraulically most distant flow path. The segments used in the Velocity Method may be of three types: sheet flow, shallow concentrated flow, and open channel flow. Time of concentration is calculated for each segment and total time of concertation is used for lag time calculation. Equations used for sheet flow, shallow concentrated flow, and open channel flow are presented in the pre-development summary tables in Appendix 6A-A along with the input parameters.

Kinematic Wave Transform Method - The Kinematic Wave method is designed principally for representing urban areas. It is a model that includes one or two representative planes. Typically, one plane is used for pervious surfaces and one for impervious. The same meteorological boundary conditions are applied to each plane. However, separate loss rate information is required for each plane. The Kinematic Wave Transform methodology was used to develop surface runoff calculations for developed post-development subbasins located within the limits of waste of the landfill or areas outside the waste limit boundary, such as detention basins and other disturbed areas.

Various input parameters for the Kinematic Wave Transform method components are summarized below:

- **Flow Plane**: Requires the input of average flow plane length, slope, and surface roughness (N, representative of land-use and ground cover). Parameters were determined from review of design final grades for post-development conditions.

- **Collector:** Requires the input of average collector length, average slope, Manning's "n", channel geometry, and average contributing area. The average contributing area within the subbasin (drainage area) discharges into a single collector (drainage swale). The subbasin area is divided by this average contributing area to estimate the number of collectors within each subbasin. Parameters for collectors are based on the landfill completion design for post-development conditions.

- **Main Channel:** Requires input of channel length, average slope, Manning's "n", and channel geometry. Parameters were determined from review of design final grades for post-development conditions.

The post-development condition (landfill completion) was separated into subbasins that are representative of either landfill topslopes, landfill sideslopes, or areas outside the waste limit boundary, such as detention basins and other disturbed areas. The flow planes, collectors, and main channels for landfill topslopes and sideslopes are represented as follows:

- Landfill Topslopes: Flow planes are related to the topslope area above the upper-most drainage swale, which represent the main channel within each respective topslope subbasin.

- Landfill Sideslopes: Flow planes are represented by the area between drainage swales proposed for the sideslopes, which discharge into collectors that are represented by the drainage swales. The collectors or drainage swales discharge into a main channel, which is represented by a downchute located in each sideslope subbasin. It should be noted that the perimeter channels, into which the sideslope drainage features discharge, were evaluated using the Muskingum-Cunge method as discussed in Subsection 2.1.1.8.

The input parameters, as described above, for overland flow planes, collectors, and main channels for each post-development subbasin are summarized in Appendix 6A-A.

2.1.1.7 Detention Basin Routing

Detention basins are used in the design to reduce the combined peak flow rates from the post-development subbasins to a level that will not adversely impact down-gradient properties, when compared to the pre-development conditions. Additionally, detention basins will provide off-site sedimentation control, as described in Subsection 4.2 of this attachment.

HEC-HMS is capable of modeling the effects of detention basins based on the inflow hydrographs using the Modified Puls method of storage routing. The program assumes level-pool routing, such that inflow into the detention basin is assumed to affect the entire basin immediately. Input parameters consist of elevation-area and elevation-discharge relationships for each detention basin. Elevation-area-discharge relationships are presented in Appendix 6A-A.

2.1.1.8 Perimeter Channel Routing

Perimeter channel routing in the HEC-HMS model was performed using the Muskingum-Cunge method. The Muskingum-Cunge method was selected based upon its ability to account for hydrograph attenuation inherent in the physical properties of the channel and the inflow hydrograph. The input parameters for the model are based on the length, channel geometry, and surface roughness of the channel. Input parameters for post-development drainage channels are summarized in Appendix 6A-A and depicted on channel profile drawings in this attachment.

Channel capacity, velocity, and peak flow depths for input onto the channel profile drawings were estimated using Manning's equation, as described in Subsection 2.2 of this attachment.

2.2 HYDRAULIC ANALYSIS METHODS

This section describes the methodology used for evaluating hydraulic parameters, including geometry and peak flow velocities, for the stormwater conveyance structures, such as drainage swales and downchutes, perimeter drainage channels, culverts, and detention basin outlet structures that will be constructed at the landfill. It should be noted that the hydraulic analysis for drainage swales and downchutes pertains to both intermediate and final cover phases of landfill operation. This section also describes the methodology for evaluating the overland flow velocity on the topslope and sideslope of intermediate and final cover.

2.2.1 Permissible Non-Erosive Velocities

The peak flow velocities calculated using the methodologies described herein were compared to the permissible non-erosive velocity for vegetated landfill slopes or drainage features. Landfill cover or drainage features experiencing erosive velocities (i.e., in excess of the defined non-erosive velocity) will be armored or protected using structural controls, as described in Section 6 of this attachment.

In accordance with published literature, as provided with calculations in Appendix 6A-E, and TCEQ guidance, permissible non-erosive velocities are defined as velocities less than or equal to the following:

- 5 feet per second (fps) for vegetated perimeter channels, drainage swales, and final cover slopes; and

- 3 fps for intermediate cover slopes with vegetation in fair condition (i.e., 60 percent coverage).

These velocities are considered appropriate for the surface slopes and vegetative cover described herein and the predominantly clay soil present at the landfill property.

2.2.2 Analysis of Drainage Swales and Downchutes

Drainage swales, including topslope and sideslope swales, and downchutes are structural controls used to convey runoff from the landfill cover to the perimeter drainage system and to reduce cover erosion by limiting uninterrupted flow lengths. These structures will be installed on both intermediate and final cover at the frequencies specified. These structures will be utilized on topslopes and external embankment sideslopes (as defined in Subsection 6.1) to convey runoff to the installed perimeter drainage system and for control of erosion and offsite sedimentation. Erosion and sedimentation controls that will be implemented at the landfill are described in Section 6 of this attachment.

Drainage swales will be installed following construction and placement of intermediate and final cover to the representative grades coinciding with the elevations and/or maximum spacing between swales, as described below:

- Intermediate Cover – Maximum horizontal spacing between swales of 400 horizontal feet or 100 vertical feet on a 4H:1V slope. An example of this approach is shown on Drawings 6A-E.3 and 6A.E4 provided in Appendix 6A-E.

- Final Cover – Maximum horizontal spacing between swales of 130 horizontal feet or 32.5 vertical feet on a 4H:1V slope. Drainage swales and downchutes on final cover will be installed at the locations depicted on Drawing 6A.3.

The installation schedule or frequency of drainage swales is based on overland flow velocity and potential soil loss from intermediate and final cover, as described in Subsections 2.2.5 and 2.3, respectively. Drainage swales will be installed to drain runoff to downchutes installed on intermediate or final cover. The methodology for sizing drainage swales and downchutes is described below. Additionally, specifications for installing drainage swales and downchutes are described in Subsection 6.2 of this attachment. Drainage swale and downchute details are depicted on Drawings 6A.12 and 6A.13, respectively.

2.2.2.1 Rational Method

The Rational Method was used to estimate peak runoff from typical contributing areas for design of the drainage swales and downchutes installed on both intermediate and final cover. The Rational Method estimates the peak rate of runoff at any location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time-of-concentration (the time required for water to flow from the most remote point of the drainage area to the location being analyzed).

The Rational Method is expressed as the following:

$$Q = CIA$$

Where, Q = maximum rate of runoff, cfs
C = runoff coefficient representing a ratio of runoff to rainfall

I = average rainfall intensity for a duration equal to the time-of-concentration, inches per hour
A = drainage area contributing to the discharge location, acres

The runoff coefficient (C) used for the drainage swale and downchute analysis is described in the calculations provided in Appendix 6A-E. The 25-year rainfall intensity (I) was determined for Limestone County from Technical Paper 40 (TP-40), assuming a minimum time-of-concentration (tc) of 10 minutes for sizing landfill drainage swales and downchutes. Description of the contributing areas used for the analysis of (1) topslope and sideslope swales and (2) downchutes are provided on drawings provided in Appendix 6A-E. Drawings 6A-E.1 and 6A-E.2 depict the contributing areas for drainage swales and downchutes installed on final cover, respectively. Drawings 6A-E.3, 6A-E.4 and 6A-E.5 depict the contributing areas for drainage swales and downchutes installed on intermediate cover, respectively.

2.2.2.2 Manning's Equation for Uniform Flow

Hydraulic analysis of the drainage swale and downchute geometry was performed using Manning's uniform flow equation. The uniform flow assumption used by Manning's equation is applicable to long prismatic channels of uniform slope, such as those proposed for the drainage swales or downchutes.

The general form of Manning's equation is:

$$V = \frac{1.49R^{0.667}S^{0.5}}{n}$$

Where, V = Velocity of flow, fps
n = Manning's "n"
R = Hydraulic Radius, ft, or

$$R = \frac{A}{P}$$

S = Friction slope for non-uniform flow or channel slope for uniform flow, ft/ft
A = Area of water perpendicular to direction of flow, sf
P = Wetted perimeter, ft

Using the relationship Q = VA, Manning's equation can be written as:

$$Q = \frac{1.49AR^{0.667}S^{0.5}}{n}$$

The uniform flow assumption equates the slope of the structure to the friction slope. Therefore, the slope of the channel can be used for "S" in Manning's equation for computation of uniform flow. Using the peak flow rate for a 25-year storm event calculated using the Rational Method (described above), the velocity and peak flow depth within drainage swales and downchutes was calculated using Manning's equation.

The following assumptions were used when evaluating the peak velocity with drainage swales and downchutes:

- Drainage swales will be grass-lined for velocities less than or equal to 5 fps. These structures were designed assuming a Manning's "n" of 0.027.
- When velocities exceed 5 fps, typically downchutes or drainage swales installed on intermediate cover, the structure will be lined with armoring materials, as described below.
- Armoring materials will include: rip rap or turf reinforcement mats (TRM) for intermediate cover drainage swales; gabions, rip rap, TRM, or flexible membrane liner for intermediate cover downchutes; and gabions for final cover downchutes. In any case, these structures were designed assuming a Manning's "n" of 0.033, as this surface roughness provides the greatest flow depth within the respective structure for the referenced armoring materials.
- Energy dissipation in the form of gabions, rip rap, or dissipation blocks will be installed at the confluence of downchutes and the landfill toe of slope and/or perimeter drainage channels.

Both the drainage swale and downchute cross-sections will be designed with a minimum 1-foot freeboard and will be capable of retaining the peak flow rate, as calculated using the rational method described above. A peak flow analysis was performed for drainage swales and downchutes installed on both intermediate and final cover. Calculations using Manning's equation for the hydraulic properties of the drainage swales and downchutes were performed using the Dodson's HydroCalc Hydraulics program (Version 2.0.1). This flow analysis and the HydroCalc output summary sheets for these calculations are presented in Appendix 6A-E.

2.2.3 Flow Capacity of Perimeter Drainage Channels

Perimeter drainage channels were designed to convey runoff from the developed landfill property to down-gradient detention basins or offsite discharge locations. The peak flow rates obtained from HEC-HMS for contributing subbasins were used to evaluate the flow capacity of the perimeter drainage channels. HydroCalc was used to confirm that the designed channel geometry, depth, and invert slope will provide sufficient capacity to discharge the 25-year, 24-hour storm event. The following assumptions were incorporated into the channel modeling:

- Manning's coefficient values of 0.027 for grass-lined channels or 0.033 for rip rap or TRM-lined channels was used for the analysis.
- Channels were designed with trapezoidal cross-sections with 3H:1V sideslopes.
- Each channel was analyzed for peak flow for the 25-year, 24-hour storm event, and then a minimum 1-foot of freeboard above the flow depth associated with the peak flow rate was added to the channel design.

Information derived from the HydroCalc output files includes channel flow depth and peak velocity at the peak flow conditions. This information, channel flow lines and peak velocities, were incorporated onto the channel profiles, as shown on Drawings 6A.4 through 6A.8. The respective HydroCalc output files for each of the perimeter channels are included in Appendix 6A-E.

2.2.4 Reservoir 19 Structure

The elevation-area storage for Reservoir 19 was evaluated beginning at the principle spillway elevation, 520.69 ft. MSL, to an elevation 536 ft. MSL with the use of a topographic map. The Reservoir 19 basin structure is comprised of a culvert, principle spillway, and emergency spillway at elevation 532.74 ft. MSL. The culvert discharge flow rate was calculated using Hydrocalc. The principle spillway, discharges through a concrete weir, flow rates were calculated using the standard orifice and weir equations. The emergency spillway discharge flow rates were calculated using the ogee weir equation. Then the minimum discharge between the principle spillway and culvert discharge flow rate was selected and added to the emergency spillway discharge flow rate to develop a single elevation-discharge relationship.

This elevation-area-discharge relationship was input into the HEC-HMS to model the Reservoir 19 structure, for both Pre and Post Development. The discharge relationship for Reservoir 19 is provided in Appendix 6A-A of this attachment.

2.2.5 Detention Basin Outlet Structures

Three detention basins are proposed. Two detention basins are proposed for the East Disposal Area (EDA), EDA East Basin and EDA West Basin. A single detention basin is proposed for the West Disposal Area (WDA), WDA Basin. The EDA East Basin and EDA West Basin each have concrete weir outlet structures. WDA Basin discharges through a series of culverts. For basins with a concrete weir, the weir crest was designed above the basin floor, thereby providing at least 2 feet of sediment storage. Water is released from below the weir invert through 4-inch diameter weep-holes located at the basin floor. The discharge flow rates through the weep-holes and weir invert were calculated using the standard orifice and weir equations, respectively, then added together to develop a single area-elevation-discharge relationship. For the WDA Basin's series of culverts, the discharge flow rate of a single culvert was calculated using Hydrocalc, then multiplied by the number of culverts to create a single elevation-area-discharge relationship.
Elevation-area-discharge relationships were developed for each detention basin based on varying hydraulic heads on each specific outlet structure configuration. These elevation-area-discharge relationships were input into the HEC-HMS model for routing runoff through the detention basins and ultimately to offsite discharge locations or PODs. The discharge relationships for each detention basin are provided in Appendix 6A-A of this attachment. Drawing 6A.14 depicts the detention basin outlet structures, including each outlet elevation and dimensions. This information is also summarized in Section 4 of this attachment.

2.2.6 Overland Flow Velocity

An analysis was performed to evaluate overland flow velocities on intermediate and final cover topslopes and sideslopes. Overland flow is defined as the combination of sheet flow and shallow concentrated flow conditions. Calculated overland flow velocities were compared to the permissible non-erosive flow velocities, as defined in Subsection 2.2.1 of this attachment.

In accordance with Technical Release 55 (TR-55), developed by the Natural Resources Conservation Service (formerly the Soil Conservation Service), sheet flow occurs on slopes at lengths less than 100 feet, whereas shallow concentrated flow begins at lengths greater than 100 feet. The time-of-concentration for sheet flow on the landfill slopes was analyzed using Kinematic Wave procedures, which are referenced from TR-55. Sheet flow velocity is defined as the ratio of the sheet flow length to the sheet flow time of concentration.

The shallow concentrated flow velocity was analyzed by calculating the shallow concentrated flow depth, which was derived using Manning's Equation. Based on the shallow concentrated flow depth, the peak flow rate and velocity were calculated using the Rational Method and the Continuity Equation (Q=VA) assuming a unit width of flow (w = 1-foot).

These methods were performed to demonstrate that the overland flow velocity on intermediate and final cover slopes will be below 3 fps and 5 fps, respectively, at the set swale spacing. The greatest potential slopes and flow lengths for both intermediate and final cover topslopes and sideslopes, as shown in Table 6A-2-1, were evaluated. The flow lengths provided in Table 6A-2-1 were selected to maintain velocities less than permissible non-erosive velocities and maintain soil loss less than the permissible soil loss limits (see Subsection 2.3 of this attachment). Drainage swales will be installed to maintain these maximum flow lengths on both intermediate and final cover.

Sample calculations for overland flow velocity on typical intermediate and final topslope and sideslope areas are presented in Appendix 6A-E. As presented in the calculations, flow velocities will be maintained at less than the maximum permissible non-erosive velocities for the respective vegetated cover. Sheet flow length was conservatively assumed to be 100 ft for the overland flow velocity calculations.

2.3 SOIL LOSS ANALYSIS METHODS

The Universal Soil Loss Equation (USLE)/Revised Universal Soil Loss Equation (RUSLE) was used to calculate the soil loss resulting from precipitation contacting the intermediate and final cover. The estimated soil loss was compared to the permissible soil loss for intermediate and final cover, as defined by the TCEQ. Consistent with TCEQ guidelines ("Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill", TCEQ, Revised May 2018), the soil loss demonstration should pertain to the top dome surfaces and external embankment sideslopes for both intermediate and final cover phases of landfill operation.

The USLE/RUSLE is an empirical equation which estimates soil losses from rainfall and runoff. The USLE was developed by statistical analysis of many plot-years of rainfall, runoff, and sediment loss data from many small plots located around the country. The USLE is supported by the National Resource Conservation Service (NRCS).

The Universal Soil Loss Equation is:

A=RKLSCP

Where A = average annual soil loss (tons/acre/ year)
R = rainfall and runoff erosivity index for a given location
K = soil erodibility factor

L = slope length factor
S = slope steepness factor
C = cover and management factor
P = erosion control practice factor

The input parameters into the USLE/RUSLE and soil loss calculations for both intermediate and final cover are presented in Appendix 6A-F of this attachment.

2.3.1 Intermediate Cover Soil Loss

The purpose of calculating the soil loss from intermediate cover is to evaluate the frequency (i.e., spacing between drainage swales) at which drainage swales will be installed to maintain soil loss less than or equal to 50 tons/acre/year (permissible soil loss recommended by the TCEQ for intermediate cover slopes).

Soil loss for intermediate cover was calculated for the worst-case topslope and external sideslope conditions. These conditions include the slopes and flow lengths described in Table 6A-2-1 and depicted on Drawing 6A-E.3 (see Appendix 6A-E). Soil loss calculations for intermediate cover were based on the assumptions that vegetation will be established following application of intermediate cover, and that the vegetation will provide approximately 60 percent ground coverage. Drainage swales on intermediate cover will be installed to provide a maximum spacing of 400 horizontal feet or 100 vertical feet, assuming a 4H:1V sideslope.

Based on the calculated results, the maximum erosion potential was estimated to be 5.5 tons/acre/year and 43.0 tons/acre/year for the topslope and sideslope segments, respectively. Therefore, the soil loss potential is less than the maximum permissible soil loss of 50 tons/acre/year for intermediate cover slopes.

2.3.2 Final Cover Soil Loss

The purpose of calculating the soil loss from final cover is to evaluate the frequency (i.e., spacing between drainage swales) at which the drainage swales must be installed to maintain soil loss at less than or equal to 3 tons/acre/year (maximum permissible soil loss recommended by the TCEQ for final cover slopes). Soil loss on final cover was calculated for the slopes and flow lengths provided in Table 6A-2-1. The analysis for the topslope is based on the greatest flow length on the 5 percent topslope. Drainage swales on final cover sideslopes will be installed at a maximum spacing of 130 horizontal feet or 32.5 vertical feet, assuming a 4H:1V sideslope. Soil loss calculations for final cover were based on the assumption that vegetation would be established following application of final cover, and that the vegetation would provide approximately 90 percent ground coverage.

Based on the results, the maximum erosion potential of the final cover was estimated to be 0.45 tons/acre/year and 2.7 tons/acre/year on the topslope and sideslope, respectively.

Table 6A-2-1. Slopes and Flow Lengths [1]

Cover Phase	Topslope		Sideslope	
	Slope	**Flow Length**	**Slope**	**Flow Length**
Intermediate Cover	5 percent	650 feet	25 percent	400 feet
Final Cover	5 Percent	250 feet	25 percent	130 feet

1. Flow lengths are the maximum distances between drainage swales for both intermediate and final cover.

3 PRE-DEVELOPMENT CONDITIONS

As previously mentioned, pre-development conditions are defined as existing drainage patterns associated with the permit property prior to construction of the landfill and upstream drainage areas of adjacent properties that contribute run-on to the permit property. The overall permit property is approximately 502.2 acres in size and located approximately a half mile southeast of the intersection of Farm-to-Market 939 (FM-939) and State Highway 31 in Limestone County, Texas. This property is currently undeveloped agricultural land located within the Tehuacana Creek watershed. The property is vegetated with pastured grassland and brush. There are no structures or maintained roads on the property with the exception of one residential housing unit. The property is bounded by: (1) FM-939 and Reservoir 19 dam to the west; (2) undeveloped land to the north; (3) undeveloped land to the east; and (4) Reservoir 19 and undeveloped land to the south. Land-use within one-mile of the property is primarily undeveloped, ranchland, and agricultural land, as shown on Drawing I/II-5 - Land-Use Map.

Surface water flows into Horse Creek, which flows from north to south across the property, and across the property's south and southeast property boundaries towards Packwood Creek and Reservoir 19. Both Horse Creek and Packwood Creek discharge into Reservoir 19, adjacent to the property. Reservoir 19 is part of Williams Creek, a tributary of the Brazos River. The Elevation-Area-Discharge relationship for Reservoir 19 is provided in Appendix 6A-A. Surface water is discharged from the property at eleven offsite discharge locations, POD-1 through POD-11. The permit property and adjacent properties include on-site drainage areas, PRE-1 through PRE-9B, and off-site drainage areas, OS-1 through OS-5. These off-site areas were evaluated in this demonstration due to the following: (1) OS-1, OS-2, and OS-3 discharge into Horse Creek and directly impacts POD-8 (2) OS-4 discharges on-site, which impacts POD-8 (3) OS-5 discharges on-site, which impacts POD-1.

Although other off-site drainage areas, other than OS-1 through OS-5, contribute runoff into Packwood Creek that encroaches upon the southeast permit boundary, respectively, these off-site areas were not included in this demonstration. Stormwater runoff from these other off-site areas discharge directly into Packwood Creek or the unnamed tributary without contributing sheet flow or shallow concentrated flow across the property boundary.

Several stock ponds are located on-site, which were not modeled in HEC-HMS due to the small size of the ponds. These stock ponds were conservatively considered to be wet ponds, which do not account for surface water storage, as inflow into the pond equals the resulting outflow. Additionally, three drainage areas existing on-site, referred to as PRE-10A, PRE-10B, and PRE-11, do not contribute a net runoff volume to a POD associated with Reservoir 19.

Specifically, the following conclusion can be made from review of Drawings 6A.1.A and 6A.2 related to PRE-10A, PRE-10B, and PRE-11:

- PRE-10A and PRE-10B will convey stormwater in a southwesterly direction parallel to T. K. Parkway, prior to discharging off-site, downstream of the Reservoir 19 dam.

- PRE-11 will convey stormwater in a southwesterly direction towards T. K. Parkway, prior to discharging off-site.

Pre-development conditions, including on- and off-site drainage areas and subsequent POD locations are depicted on Drawings 6A.1A and 6A.1B. Pre-development PODs and contributing drainage areas are summarized below:

East PODs (POD-1 through POD-4):

The following drainage areas convey runoff in a southeasterly direction from the northeastern portion of the property across the east and southeast permit boundaries at the respective PODs:

- PRE-1, PRE-2, PRE-3, and PRE-4 discharge runoff at POD-1, POD-2, POD-3, and POD-4, respectively.

Surface water discharged across the east and southeast property boundaries flow into Packwood Creek, which then discharges into Reservoir 19.

South PODs (POD-5 through POD-9):

The following drainage areas convey runoff in a southerly direction from the approximate center of the property across the southern permit boundaries at the respective PODs:

- PRE-5, PRE-6, and PRE-7 discharge at POD-5, POD-6, and POD-7, respectively.
- PRE-8A, PRE-8B, PRE-8C, OS-1 and OS-2 contribute runoff to and discharge at POD-8.
- PRE-9A contributes runoff onto OS-3, which flows back on-site to PRE-9B and discharges at POD-9.

All surface water runoff discharged across the southern property boundaries ultimately flows into Horse Creek, or directly into Reservoir 19.

West PODs (POD-10 and POD-11):

The following drainage areas convey runoff in a southwest direction from the southwestern portion of the property across the southwest permit boundaries at the respective PODs:

- PRE-10A and PRE-10B contribute runoff to and discharge runoff at POD-10.
- PRE-11 discharges at POD-11.

Surface water discharged across the southwest property boundaries flow downstream of the Reservoir 19 dam.

4 POST-DEVELOPMENT CONDITIONS

Post-development conditions with delineated drainage areas and direction of surface water flow to each detention basin and POD are depicted on Drawing 6A.2. Additionally, a general layout of the post-development drainage system, including perimeter drainage channels and detention basins, is presented on Drawing 6A.3. As shown, rainfall contacting the landfill topslope and sideslopes will be collected as runoff in drainage swales located near the landfill's upper grade break and at intervals on the 4H:1V sideslopes. Runoff will flow within the drainage swales, roughly parallel to the slope, into gabion-lined downchutes. Once in the downchutes, runoff will be conveyed to the toe of the landfill and into the perimeter drainage channels or discharge directly into detention basins. The perimeter drainage channels discharge into one of three detention basins. Surface water collected in the detention basins discharges through the basin outlet structures towards PODs, where it discharges offsite. The Elevation-Area-Discharge relationship for Reservoir 19 is provided in Appendix 6A-A.

4.1 PERIMETER CHANNEL DESIGN

The perimeter drainage channels will be constructed as filling proceeds sequentially across the property. This will allow the detention basins to be used for sediment control during landfilling operations. The channels were designed to have peak flow velocities of less than 5 feet per second where only vegetation is proposed for the channel lining. For velocities greater than approximately 5 feet per second, the channels were designed with either rip rap lining, gabions, or TRM.

The hydraulic analysis of the perimeter drainage channels is described in Subsection 2.2.3. As described in this subsection, the peak flow rates in the channels were determined from the HEC-HMS output for the respective contributing drainage areas. The peak velocity and flow depth within each channel were calculated using HydroCalc, based on the proposed channel geometry. A summary of the channel design parameters, which were incorporated into HEC-HMS and HydroCalc, are included in Appendix 6A-A. Additionally, the HydroCalc output files for each channel are included in Appendix 6A-E. Channel profiles, including channel inverts, surface water flowlines, and velocities under peak flow conditions are shown on Drawings 6A.4 through 6A.12. In addition, these drawings show a typical cross-section for each channel.

4.2 DETENTION BASIN DESIGN

Three detention basins (East Disposal Area (EDA) East, East Disposal Area (EDA) West, and West Disposal Area (WDA) Basins) have been designed for the landfill based on the post-development runoff characteristics modeled in HEC-HMS, as described in Section 2 of this attachment. The EDA East Basin has been designed as a dry basin (i.e., water will not pond in the basin for extended periods), while the remaining basins have been designed as wet basins (i.e., water will pond in the basins).

The outlet structures for EDA East Basin and EDA West Basin are comprised of concrete weirs. The EDA East Basin weir crest will be constructed 1.5 feet above the basin floor; and the EDA West Basin weir crest will be constructed 4.5 feet above the basin floor, thereby providing offsite sedimentation control through an extended residence time within the basin. This sediment storage will slowly drain through 4-inch diameter weep holes in the concrete weirs located at the basin floor. The WDA Basin was modeled using culverts, in HEC-HMS as a wet basin, assuming the basins were over excavated to either contain water, sediment, or a combination of both. Sediment will be removed from the detention basins on a regular basis during inspection and maintenance, as described in Subsection 6.7. The outlet structure of the WDA Basin will be comprised of two 21-inch diameter concrete culverts discharging to POD-8. Additionally, each detention basin has been designed with a minimum 1-foot of freeboard to prevent overtopping during the design storm event.

Elevation-area-discharge relationships for the basins are presented in Appendix 6A-A. HEC-HMS output for the detention basins, including the peak discharge, storage, and pool depth associated with the 25-year, 24-hour storm event is presented in Appendix 6A-C. This information also has been summarized in Table 6A-4-1. Detention basin layout plans are depicted on Drawings 6A.13 through 6A.18.

4.3 BASIN OUTLET STRUCTURE DESIGN

Peak discharge rates were calculated for each detention basin outlet structure, as described in Subsection 2.2.4 of this attachment. As described in this section, the standard orifice and weir equations were used for calculation of discharge rates through weep holes and concrete weirs. As previously described, the peak discharge rates were incorporated into the elevation-area-discharge relationships used in the HEC-HMS model, as provided in Appendix 6A-A. Design details for the culvert and concrete weir configurations are shown on Drawing 6A.14. Additionally, Table 6A-4-2 and Table 6A-4-3 describes the respective weir and culvert outlet dimensions/elevations.

Table 6A-4-1. Detention Basin Peak Storage and Discharge

Detention Basin	Discharge Points	Peak Storage (acre-feet)	Peak Pool Depth (ft msl)	Peak Discharge (cfs)
EDA East Basin	POD-1	4.7	537.7	106.3
EDA West Basin	POD-8	36.6	535.9	41.8
WDA Basin	POD-8	31.5	536.6	22.5

Table 6A-4-2. Detention Basin Peak Storage and Discharge

Detention Basin	Discharge Points	Basin Invert Elevation (ft msl)	Number of Weep Holes	Weir Elevation (ft msl)	Weir Length (ft)
EDA East Basin	POD-1	534.0	5	535.5	10.0
EDA West Basin	POD-8	530.0	3	534.5	7.0

Table 6A-4-3. Culvert Outlet Configuration Summary

Detention Basin	Discharge Points	Basin Invert Elevation (ft msl)	Diameter of Pipe (inches)	Number of Culverts	Culvert Elevation (ft msl)	Culvert Length (ft)
WDA Basin	POD-8	531.0	21	2	534.5	25.0

5 IMPACT TO EXISTING DRAINAGE PATTERNS POINT OF DEMONSTRATION

5.1 POINT OF DEMONSTRATION

As discussed in Section 2, PODs were established as shown on Drawing 6A.1A. Pre- and post-development HEC-HMS models were developed with the PODs as the points where “impacts to existing drainage patterns” were evaluated by comparing the pre- and post-development conditions, as required by 30 TAC §§330.63(c)(1)(C).

5.2 PRE-DEVELOPMENT CONDITIONS

The pre-development subbasins, as described in Section 3, are presented on Drawings 6A.1A and 6A.1B. Input parameters for the HEC-HMS modeling performed for pre-development conditions are presented in tables included in Appendix 6A-A.

The results of HEC-HMS modeling of the pre-development conditions are included in Appendix 6A-B.

5.3 POST-DEVELOPMENT CONDITIONS

Post-development conditions are represented by the fully developed landfill, with final closure having been completed, and all drainage features in-place and operational, as described in Section 4 and presented on Drawing 6A.2. The post-development discharge conditions were analyzed at the same PODs as pre-development conditions. Input parameters for the HEC-HMS modeling performed for post-development conditions are presented in tables included in Appendix 6A-A.

The results of HEC-HMS modeling of the post-development conditions are included in Appendix 6A-C.

5.4 COMPARISON OF PRE- AND POST-DEVELOPMENT DISCHARGE RATES

The pre- and post-development peak discharge rates and total discharge volumes are summarized in Tables 6A-5-1 and 6A-5-2.

As shown in these tables, the landfill development will not result in significant increases in peak discharge rates at the PODs as demonstrated by comparison of the pre- and post-development conditions. Although there is a one minor increase and decrease in the peak discharge at the eleven PODs, (less than 2 percent increase at POD-8) and (56.5 percent decrease at POD-2) this increase is not significant and, as such, will not impact existing drainage patterns. The magnitude of change between the post-development peak discharge rates [no change or below (i.e., < 10 percent), with the exception of POD-2] and the pre-development rates will not adversely impact downstream receiving drainage features. As presented in Table 6A-5-2, the overall post-development discharge rate from PODs discharging to Reservoir 19 was almost same as the overall pre-development discharge rate. Therefore, no adverse impact to existing drainage patterns will result from the proposed landfill development.

Regarding the discharge volumes, as shown in Tables 6A-5-1 and 6A-5-2, the post-development discharge volume is below the pre-development discharge volume for all PODs. Therefore, it is concluded that there will be no adverse impact to existing drainage patterns related to the total volume of discharge to downstream water receiving rights and uses.

Furthermore, regarding the time of peak discharge, all off-site discharge during post-development occurs within 30 minutes of the corresponding pre-development peak during the first twenty-four hours following the design storm event. Hydrographs of the pre- and post-development conditions at each of the PODs are included in Appendix 6A-D. These hydrographs depict the respective peak discharge rates and discharge volumes (area under the hydrograph).

Discharge velocities from the property will be below the 5 feet per second threshold, which typically is considered the threshold for erosion damage. This will be accomplished by dissipating discharge velocities at the basin outlet structures prior to off-site discharge. Velocity dissipation from the outlet structures will be provided by either rip rap blankets, dissipation blocks or stilling basins installed at the outlet of each structure.

SCS concludes from the information presented herein, as summarized in Tables 6A-5-1 and 6A-5-2, that existing drainage patterns, as represented by the pre-development conditions, will not be adversely altered as a result of the landfill development, as required by 30 TAC §330.305(a).

**Table 6A-5-1. Comparison of Pre- and Post-Development Conditions
Peak Discharge Rate and Volume**

Location: POD-1

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	153.9	12:50	31.0
Post-development	150.9	12:20	25.2
Percent Change	-1.9	N/A	-18.7

Location: POD-2

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	37.5	12:30	6.2
Post-development	16.3	12:20	2.2
Percent Change	-56.5	N/A	-64.5

Location: POD-3

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	34.2	12:40	5.9
Post-development	32.6	12:30	5.2
Percent Change	-4.7	N/A	-11.9

Location: POD-4

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	11.2	12:20	1.4
Post-development	10.9	12:20	1.4
Percent Change	-2.7	N/A	0.0

Location: POD-5

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	55.0	12:40	10.6
Post-development	53.2	12:30	8.9
Percent Change	-3.3	N/A	-16.0

Location: POD-6

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	6.9	12:30	1.1
Post-development	6.9	12:30	1.1
Percent Change	0.0	N/A	0.0

Location: POD-7

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	33.9	12:40	5.9
Post-development	33.0	12:30	5.6
Percent Change	-2.7	N/A	-5.1

Location: POD-8

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	2030.2	13:40	619.7
Post-development	2060.3	13:20	621.8
Percent Change	1.5	N/A	0.3

Location: POD-9

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	4.1	12:40	0.7
Post-development	4.1	12:40	0.7
Percent Change	0.0	N/A	0.0

Location: POD-10

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	36.9	12:30	6.5
Post-development	7.8	12:40	1.3
Percent Change	-78.9	N/A	-80.0

Location: POD-11

Condition	Peak Discharge Rate (cfs)	Time of Peak Discharge (hours)	Discharge Volume (ac-ft)
Pre-development	21.9	12:20	3.1
Post-development	21.0	12:40	3.0
Percent Change	-4.1	N/A	-3.2

Notes

1. Values obtained from HEC-HMS output files (Appendices 6A-B and 6A-C).
2. Time of Peak Discharge in hours from beginning of 24-hour storm period.

Table 6A-5-2. Comparison of Reservoir 19 Pre- and Post-Development Conditions Peak Discharge Rate and Volume

Location: Reservoir 19

Condition	Peak Discharge Rate (cfs)	Discharge Volume (ac-ft)
Pre-development	2366.9	682.5
Post-development	2368.2	672.1
Percent Change	0.1	-1.5

6 EROSION AND SEDIMENTATION CONTROL PLAN

6.1 INTRODUCTION

In accordance with §330.305(d), the landfill design will provide effective erosional stability to top dome surfaces and embankment sideslopes on all cover phases during landfill operation, including the closure and post-closure care period. This Erosion and Sedimentation Control Plan has been prepared consistent with TCEQ guidance document, "Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill", dated May, 2018. Part 2 of this document covers demonstrating erosional stability during all phases of landfill operation. Consistent with this guidance document, the landfill cover phases are defined as daily cover, intermediate cover, and final cover. Top dome surfaces and external embankment sideslopes are defined by the following criteria:

- Above-grade slopes that directly drain to the landfill's perimeter drainage system, such as perimeter channels or detention basins.
- Areas of the landfill that have: (1) received intermediate or final cover; (2) reached their permitted fill elevation; or (3) require intermediate cover due to being inactive for longer than 180 days.

The following areas are not considered top dome surfaces or external sideslopes:

- Slopes which drain to areas where ongoing waste placement is occurring.
- Pre-excavated areas.
- Areas that have received only daily cover or areas under construction which have not received waste.

Erosional stability of landfill surfaces will be accomplished by implementing and maintaining best management practices on the landfill cover, including non-structural and structural controls, as described in Subsection 6.2. These controls specifically pertain to areas that receive runoff from top dome surfaces or external embankment slopes, as defined above. Landfill management will control erosion and offsite sedimentation by implementing interim controls, as specified in §330.305(e)(2). The frequency of installing erosion control measures on areas with intermediate and final cover are described in this subsection. These controls will be installed consistent with the overland flow velocity and soil loss analyses presented in Subsection 2.2 and Subsection 2.3, respectively. Additionally, Subsection 2.2 describes the methodologies for sizing drainage swales and downchutes installed on the intermediate and final cover. Furthermore, based on inspections of the landfill property, including top dome surfaces and external embankment sideslopes, for erosion and offsite sedimentation, additional controls will be implemented, as described herein. The following aspects are discussed in this Subsection, as they relate to erosion and offsite sedimentation controls:

- Typical non-structural and structural controls or best management practices (BMPs);
- Specifications for typical structural BMPs;

- Erosion control practices for soil stockpiles and daily cover, intermediate cover, and final cover;

- Sequence of development of the perimeter drainage system in conjunction with landfill development; and

- Inspection, maintenance, and recordkeeping requirements.

6.2 GENERAL EROSION AND SEDIMENTATION CONTROLS

This section describes general non-structural controls, general structural controls, and specifications for installing typical structural BMPs that will be implemented at the landfill to control erosion and offsite sedimentation. These controls will be installed as-needed based on the following: as required to maintain both surface velocities and potential soil loss below permissible limits; cover inspections for erosion and adequate vegetation; and inspection of offsite discharge locations for sediment.

Additionally, the non-structural and structural controls described in this subsection will be used independently or in combination to protect on-site and offsite water bodies from erosion and sedimentation associated with landfill operations. Offsite water bodies include tributaries of Horse Creek, which flows from north to south across the property

6.2.1 General Non-Structural Controls

Non-structural controls are defined as activities or practices performed at the landfill that will minimize the area and time that soil or landfill cover is exposed to erosion. Landfill and earthwork practices, such as excavations, stockpiling, and other land disturbances will be conducted to minimize erosion of existing and constructed features. These practices will also be conducted to minimize the sedimentation effects to tributaries of Horse Creek and stormwater control features, e.g., intermediate and final cover, hydraulic structures installed on the landfill cover, perimeter drainage channels, and detention basins. This will be accomplished by implementing the following procedures:

- Minimize the disruption of existing vegetation (i.e., grasses, brush, and trees), especially at the perimeter of the property, as long as practical to provide a vegetative buffer to offsite sedimentation.

- Phased development of the perimeter drainage system, including channels and detention basins, and waste disposal phases.

- Minimize the size of bare soil areas that discharge runoff to the perimeter drainage system. In the event this is not practical, structural controls or BMPs will be installed to reduce erosion of these surfaces or reduce offsite sedimentation.

Stabilize exposed soil or cover in a timely manner. This will be accomplished by stabilizing the soil with vegetation (structural control) consistent with the requirements described in Subsections 6.4 and 6.5.

6.2.2 Structural Controls

Structural controls are defined as installed measures or structures for the purpose of controlling erosion or offsite sedimentation. Structural controls discussed herein are related to materials or features installed to reduce erosion and sedimentation effects prior to discharge into the perimeter drainage system or offsite discharge locations. Examples of structural controls include swales/berms, vegetation, erosion control mats, energy dissipation devices, sediment trapping devices, and other structural BMPs specified in Subsection 6.2.3. Structural controls will be installed for the following situations:

- Where flow velocities are greater than 3 fps on intermediate cover or 5 fps on final cover;
- Where flow velocities are greater than 5 fps in drainage swales and perimeter channels;
- Where the erosion potential is greater than 50 tons/acre/year for intermediate cover or 3 tons/acre/year for final cover;
- Where non-structural controls are not effective; or
- Areas identified during cover inspections (see Subsection 6.7).

Erosion will be controlled by vegetation on landfill slopes and in drainage structures (drainage swales, perimeter drainage channels, and detention basins) with flow velocities less than or equal to approximately 5 fps. For drainage structures with flow velocities greater than 5 fps (primarily the downchutes, perimeter drainage channels, and basin outlets), suitable materials (see below) will be used to armor the drainage structures or to reduce erosive velocities.

Suitable materials for control of erosive velocities in drainage channels include, but are not limited to, TRMs, rip rap, or rock ditch checks, as appropriate. For perimeter channels, downchutes, or basins with high exit velocities (i.e., greater than 5 feet per second for the design peak discharge), gabions, rip rap, or dissipation blocks will be installed at channel transitions, toe of landfill slope, or downstream of the basin outlet structure, which will dissipate the velocity prior to the confluence with other drainage features or discharging onto adjacent properties.

6.2.3 Specifications for Typical Structural BMPs

During site development, BMPs will be employed to control erosion. BMPs to be deployed at the landfill, depending on the area of installation, include drainage swales and downchutes, temporary rock rip rap, silt fences, hay bales, check dams, temporary and permanent seeding and sodding, surface roughening, erosion control mats, sediment traps, and surface wetting for dust control. The following describes specifications for several BMPs that will be used:

1. **Drainage Swales and Downchutes:** Drainage swales will convey runoff to downchutes, which will discharge directly into perimeter drainage channels or detention basins. The spacing or installation frequency and sizing criteria for drainage swales and downchutes for intermediate cover and final cover, is described in Subsection 2.2. Drainage swales will be installed on the topslope at a minimum half percent slope. Drainage swales will be installed on the sideslope at a minimum one percent slope. Swales will be constructed to

flow in the direction of the respective downchute, which will convey the stormwater to the perimeter drainage system. Survey control will be used in the construction of the drainage swales and downchutes to provide the necessary minimum design slope to avoid ponding of water on the intermediate or final cover. Typically, these swales will be lined with vegetation, as velocities will be less than 5 fps. However, if velocities are greater than 5 fps or inspections indicate concerns with erosion, rip rap, rolled erosion control mats, or TRM will be installed. Downchutes installed on intermediate cover will be lined with gabions, rip rap, TRM, or flexible membrane liner (thickness > 40-mil). However, downchutes installed on final cover will be lined with gabions. The discharge points of downchutes will be lined with energy dissipation blocks or rip rap to reduce erosive velocities at the confluence with perimeter drainage channels.

Calculations for sizing sideslope swales and downchutes installed on intermediate and final cover, including peak velocities and flow depths are provided in Appendix 6A-E. Note, the actual contributing drainage areas to sideslope swales and downchutes installed on intermediate cover may vary at the time of installation due to the continuously evolving land form as waste is disposed. Therefore, the following criteria will be used for installing sideslope swales and downchutes on intermediate cover:

a. Topslopes with contributing drainage areas less than or equal to 17 acres: Drainage swales will be installed as grass-lined v-ditch channels with a minimum 2-foot depth, invert slope of 0.5 percent, 2H:1V and 5 percent (landfill side) sideslopes.

b. Sideslopes with contributing drainage areas less than or equal to 7.3 acres: Drainage swales will be installed as grass-lined v-ditch channels with a minimum 2.4-foot depth, invert slope of 1.0 percent, 2H:1V and 4H:1V percent (landfill side) sideslopes.

c. Sideslopes with contributing drainage areas greater than 7.3 acres but less than or equal to 10 acres: Drainage swales will be installed as v-ditch channels with a minimum 2.7-foot depth, invert slope of 1 percent, and 4H:1V sideslopes. However, these swales will be lined with rip rap or TRM, as velocities may exceed 5 fps.

d. Downchutes with contributing drainage areas less than or equal to 35 acres: Downchutes will be installed as trapezoidal channels with a minimum 2-foot depth, 2H:1V sideslopes and 10-foot bottom lined with gabions, rip rap, TRM, or flexible membrane liner (thickness > 40-mil).

e. Sideslope swales and downchutes that vary from the above dimensions or with contributing drainages greater than that specified above, will be designed by a Texas Registered Professional Engineer prior to constructing these structures on intermediate cover. These designs will be signed and sealed by the engineer and maintained in the Site Operating Record.

Drawings 6A-E.3, 6A-E.4, and 6A-E.5 (see Appendix 6A-E) depicts the contributing areas and conceptual locations for drainage swales and downchutes installed on intermediate cover. Drawings 6A-E.1 and 6A-E.2 depict the contributing areas for drainage swales and downchutes installed on final cover. Drawing 6A.3 depicts the location of drainage swales and downchutes installed on final cover. Typical details of sideslope swales and downchutes installed on intermediate or final cover are provided on Drawings 6A.12 and 6A.13, respectively.

2. **Seeding and Sodding:** As specified in the SOP, intermediate cover and final cover will be seeded or sodded following application of the cover. This vegetation will be established on the top dome surfaces and the external embankment side slopes. At a minimum 60 percent and 90 percent vegetative cover will be maintained on areas with the intermediate and final cover for erosion control, respectively. Timeframes for establishing vegetation on the respective covers are described in Subsections 6.4 and 6.5.

3. **Check Dams:** Check dams constructed using gravel, rock, gabions, compost socks, hay bales, or sand bags may be installed within perimeter channels to reduce flow velocities and erosion. Check dams will be installed within perimeter channels that may experience erosive conditions or if, during cover inspections, it is determined that the vegetation is not adequately controlling erosion. The landfill manager will install check dams using the design criteria shown on Drawing 6A.23.

4. **Silt Fences and Hay Bales:** Silt fences or hay bales can be used to trap sediment suspended in runoff. The maximum drainage area to the silt fence will not exceed the manufacturer's specification, but in no case should the drainage area be greater than 0.5 acre per 100 feet of fence. Silt fences or hay bales are recommended for temporary or short term control, at which point they will be replaced and more permanent controls installed (i.e., stabilized vegetation, diversion berms, perimeter drainage system, etc.). These controls will be installed, as needed, at the toe of the landfill, toe of soil stockpiles, near property lines, and natural drainage features.

Drawing No. 6A.15 includes installation guidelines for silt fences and hay bales. When installing and anchoring silt fences and hay bales, landfill personnel will make sure that the anchoring posts are adequately secured. Landfill personnel will routinely inspect silt fence and hay bale anchoring posts and sediment accumulation behind silt fences and hay bales during inspections of BMPs, as described in Subsection 6.7. As a result of these inspections, accumulated sediment will be removed from these structures; or the silt fence or hay bale will be repaired or replaced (if damaged).

5. **Sediment Traps:** Sediment traps will be installed up-gradient of offsite discharge locations to control offsite sedimentation. Sediment traps will only be installed if other on-site erosion control practices are not adequately controlling offsite sedimentation, as determined during inspection for cover erosion and sedimentation at offsite discharge locations. The purpose of sediment traps is to allow runoff to pool in man-made surface depressions (not located on waste) to allow sediment to settle out of runoff prior to discharging from the landfill property. The Landfill Manager will install sediment traps using the design criteria specified on Drawing 6A.16.

6. **Compost/Straw Filter Berms or Socks:** Compost filter berms or mesh socks filled with compost or straw material, measuring at least 1 foot high x 2 feet wide, may be installed at the toe of the landfill or soil stockpile slopes. These berms or mesh socks will be replaced

in the event they become clogged with sediment, as indicated by pooling water behind the berms or socks.

7. **Vegetative Buffers or Filter Strips:** Vegetative buffers will be maintained near the perimeter of the property or natural stream to trap sediment, as appropriate.

The above specifications provide guidance to the Landfill Manager for selection of BMPs to control erosion and offsite sedimentation. At a minimum, drainage swales and downchutes will be installed on intermediate and final cover, as described in Subsections 6.4 and 6.5, respectively. The above referenced BMPs may be used separately or in combination with each other to control erosion and offsite sedimentation at the landfill. The following provides general guidelines on how the erosion control features will minimize erosion or sediment discharge from the site:

- The installation of erosion controls will be performed in conjunction with placement of intermediate cover and final cover. Final cover will be placed as areas of the landfill reach design final grades, followed by (1) placement of permanent erosion controls and (2) construction of drainage control structures, such as drainage swales and downchutes, vegetation, perimeter channels and detention ponds. The sequence of installing the perimeter drainage system is discussed in Subsection 6.6.

- Vegetation will be established on above-grade areas with intermediate cover and final cover following application of cover. The vegetative cover will substantially reduce erosion potential.

- Drainage swales and downchutes will be installed on intermediate and final cover at the frequency specified in Subsection 6.4 and Subsection 6.5, respectively. Other BMPs will be installed on an as-needed basis, as a result of cover inspections.

- Uncontaminated stormwater runoff from the landfill will be conveyed to the perimeter channels or detention basins by drainage swales/downchutes or overland flow before being discharged from the site. Sediment that collects in these drainage structures will be removed consistent with the stormwater system maintenance plan presented in Subsection 6.7.

- Site management will maintain coverage under the TPDES general stormwater permit, and will keep an updated version of the Storm Water Pollution Prevention Plan (SWP3) on-site.

- Runoff from the working face will be contained within the landfill by temporary containment and/or diversion berms, as described in Attachment 15 of this application.

6.3 SOIL STOCKPILES AND DAILY COVER EROSION CONTROL PRACTICES

Soil stockpiles and areas with daily cover are typically not vegetated, as these areas remain active for long periods of time. However, BMPs will be installed to reduce erosion and offsite sedimentation from these areas. At a minimum, BMPs will be installed down-gradient of daily cover areas and at the toe of soil stockpiles that have the potential to drain to the perimeter drainage system or landfill property boundary. Any of the BMPs described in Subsection 6.2.3 may be installed to reduce erosion and offsite sedimentation. The effectiveness of the selected BMP will be evaluated during cover and BMP inspections, as described in Subsection 6.7.

6.4 INTERMEDIATE COVER EROSION CONTROL PRACTICES

All areas that receive waste and then become inactive for longer than 180 days will be covered with intermediate cover. Vegetation will be established on intermediate cover within 180 days following application of the intermediate cover. Vegetation will provide a minimum 60 percent ground coverage. When vegetation is being established, landfill personnel will perform cover inspections, as described in Subsection 6.7, and will continue to place temporary seed or sod until vegetation is established.

An overland flow velocity and soil loss demonstration for intermediate cover are included in Appendices 6A-E and 6A-F, respectively. These demonstrations are discussed in Subsections 2.2 and 2.3 of this attachment. As presented in the soil loss analysis, the maximum soil loss from the intermediate cover topslope and sideslope is estimated to be approximately 5.5 tons/acre/year and 43.0 tons/acre/year, respectively. The overland flow velocity demonstration indicates that velocities on intermediate cover topslopes and sideslopes will be less than 3 fps.

To maintain soil loss and overland flow velocities below the permissible limits, drainage swales will be installed on intermediate cover slopes every 400 horizontal feet or 100 vertical feet on a 4H:1V sideslope. Drainage swales will drain surface water to installed downchutes that discharge into the perimeter drainage system. Drainage swales and downchutes will be installed on intermediate cover within 180 days of the application of intermediate cover, assuming the external embankment sideslopes have been constructed to at least 100-feet above natural grade. An example of drainage swales and downchutes installed on intermediate cover is shown on Drawing 6A-E.3 and 6A-E.4. Other BMPs will be installed, as needed, as a result of cover and BMP inspections. BMPs will also be evaluated for effectiveness during the inspections. Installation specifications for structural BMPs are provided in Subsection 6.2.3.

6.5 FINAL COVER EROSION CONTROL PRACTICES

Final cover will be installed consistent with Attachment 12 - Final Closure Plan. The top 6 inches of the final cover will be capable of sustaining native vegetation. Areas that receive final cover will be vegetated immediately following completion of final cover placement. Vegetation will provide a minimum 90 percent ground coverage. When vegetation is being established, landfill personnel will perform cover inspection, as described in Subsection 6.7, and will continue to place seed or sod until 90 percent vegetated coverage is established.

An overland flow velocity demonstration and a soil loss demonstration for final cover are included in Appendices 6A-E and 6A-F, respectively. These demonstrations are discussed in Subsections 2.2 and 2.3. As presented in the soil loss analysis, the maximum soil loss from the final cover topslopes and sideslopes is estimated to be approximately 0.45 tons/acre/year and 2.70 tons/acre/year, respectively. The overland flow velocity demonstration indicates that velocities on final cover topslopes and sideslopes will be less than 5 fps.

Consistent with the proposed drainage design, drainage swales will be installed on final cover every 130 horizontal feet or 32.5 vertical feet on a 4H:1V sideslope. Drainage swales and downchutes will be installed on final cover during placement of final cover. Drainage swales and downchutes will be installed on final cover at the locations shown on Drawing 6A.3.

Potential soil loss from final cover will be mitigated by (1) periodic cover inspections and maintenance consistent with the Subsection 6.7, and (2) constructing the perimeter drainage system as described in Subsection 6.6, and (3) implementing BMPs upstream of the drainage features, within the drainage features, or at the offsite discharge outlets, as appropriate, to prevent offsite sedimentation. Prior to placement of final cover, temporary structural controls will be removed followed by the installation of the permanent structural controls. These BMPs will be removed in such a manner so as to minimize disturbance of the vegetative layer in place at the time of removal.

6.6 SEQUENCE OF DEVELOPMENT - PERIMETER DRAINAGE SYSTEM

During ongoing landfill development, drainage features, as described in Section 4 and depicted on Drawing 6A.3, including perimeter drainage channels and detention basins, will be constructed and maintained. The drainage features will be installed concurrent with the construction of up-gradient landfill disposal cells, such that when the cell grades are above existing grade, down-gradient drainage features are in-place. The sector fill layout, which depicts the sequence of sector development and direction of fill, is provided on Drawing 1.4 (see Attachment 1). Additionally, to control offsite sedimentation and reduce erosive velocities in the perimeter drainage system, vegetation or other approved structural controls (as described in Subsections 6.3 through 6.5 for the phases of landfill operation) will be installed for controlling erosion and offsite sedimentation.

During ongoing landfill development, prior to vegetation on the top dome surface and external embankment sideslopes (intermediate or final cover), BMPs described in Subsection 6.2.3 will be installed, as appropriate, to reduce sedimentation up-gradient of offsite discharge outlets. Landfill cover, BMP, and perimeter drainage system inspections will be performed, as described in Subsection 6.7.

6.7 STORMWATER SYSTEM INSPECTION AND MAINTENANCE PLAN

In accordance with 30 TAC §330.305(e)(1), constructed stormwater systems such as channels, drainage swales, downchutes, and detention basins will be restored and repaired in the event of washout, failure, or erosion damage. In addition, other installed BMPs will be replaced or repaired, consistent with this inspection and maintenance plan.

Excessive sediment deposited during the landfill operations will be removed from the drainage features, as needed, so that the features will function as designed. Site inspections by landfill personnel will be performed daily for active daily cover areas, weekly for inactive daily cover and intermediate cover areas, monthly for final cover areas, or within 24 hours of significant rainfall events (a significant rainfall event being 0.5 inches or greater over a 24-hour period). Site inspections will include both inspection of the landfill cover and in-place BMPs. Cover and BMP inspections and maintenance will be documented in the Site Operating Record (as specified in the SOP). Daily inspections will be noted in the cover application log, and weekly and monthly inspections will be noted on the form or similar form provided in Appendix 6A-G - Erosion and Sedimentation Control Inspection and Maintenance Form.

The following items will be evaluated during the inspections:

- Erosion of daily, intermediate, and final cover areas; downchutes; drainage swales; detention basins; and other temporary and permanent drainage features.
- Adequate vegetation coverage for intermediate cover (60 percent minimum) and final cover (90 percent minimum).
- Silt and sediment build-up, or obstructions in temporary and permanent drainage features.
- Presence of erosion or sediment discharge at offsite discharge locations.
- Presence of sediment discharges along the site boundary in areas which have been disturbed by site activities.

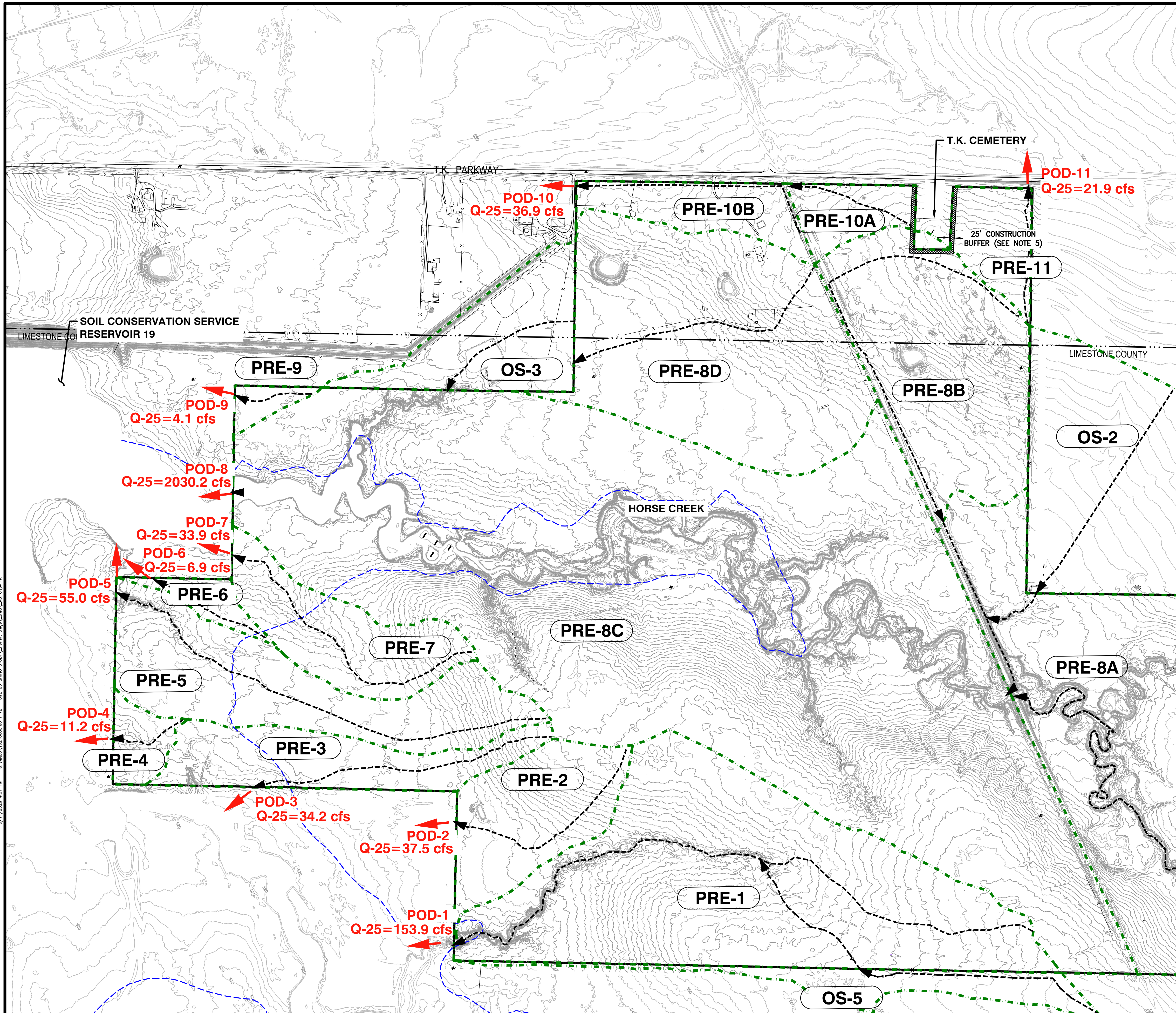
Maintenance activities will be performed to correct damaged or deficient items noted during the cover and BMP inspections. These activities will be performed within 5 days of the inspection or detection of the damaged or deficiency, as described in the SOP. However, the timeframe for correction of damaged or deficient BMPs or erosion control structures may vary based on weather, ground conditions, and other site-specific conditions. Erosion of intermediate or final cover will be repaired by restoring the cover material, grading, compacting, and/or seeding or sodding, as described in the SOP.

Maintenance activities will include, but are not limited to, the following as needed:

- Placement of additional temporary or permanent vegetation in eroded areas or areas which have not achieved the required vegetative coverage.
- Placement of additional soils in eroded areas or areas which have settled. This will require re-grading and/or stabilization of soils in the eroded areas.
- Placement of additional rip rap, erosion control mats or TRMs, or other BMPs, as described in Subsection 6.2.3, in eroded areas or in area which have settled.
- Removal of obstructions, such as debris, silt, and sediment build-up from drainage features, including swales downchutes, perimeter channels, and detention basins.
- Replacement or repair of rip rap or other structural lining.
- Replacement or repair of permanent erosion mats or fabrics.
- Repairs to existing erosion and sedimentation controls.

DRAWINGS

6A.1A through 6A.16



0 300 600
SCALE IN FEET

LEGEND

— — —	PERMIT BOUNDARY
—560—	EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
— · · —	COUNTY LINE
- - - -	100-YEAR FLOOD PLAIN (SEE NOTE 2)
— x —	EXISTING FENCE (SCREENED)
- · - ·	DRAINAGE AREA BOUNDARY
→	POINT-OF-DEMONSTRATION (POD)
- - - ▶	ASSUMED CHANNEL LENGTH
PRE-1	PRE-DEVELOPMENT DRAINAGE AREA

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 3, 2018.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48293C0125C, DATED 09/16/11.
3. USGS MAP AXTELL, TEXAS (1956) IS SHOWN ON THIS EXHIBIT.
4. DRAINAGE AREAS OS-1 ARE SHOWN ON DRAWING 6A.1B.
5. IN ACCORDANCE WITH "AN INTENSIVE CULTURAL RESOURCES SURVEY OF THE CITY OF WACO'S PROPOSED SITE 50 LANDFILL PROJECT," PREPARED BY HORIZON ENVIRONMENTAL SERVICES, INC., DATED NOVEMBER 2018 (SEE APPENDIX I/IIA), A 25-FOOT CONSTRUCTION BUFFER WILL BE MAINTAINED AROUND TK CEMETERY TO PROTECT ANY POTENTIAL UNMARKED GRAVES OUTSIDE THE PRESENT MODERN DAY CEMETERY BOUNDARIES AND FENCING.

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
PRE-DEVELOPMENT CONDITIONS (ON-SITE)

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DWN. BY: NR | Q/A RVW BY: RRK
DSN. BY: BG/RRK | CHK. BY: BJD | APP. BY: RRK

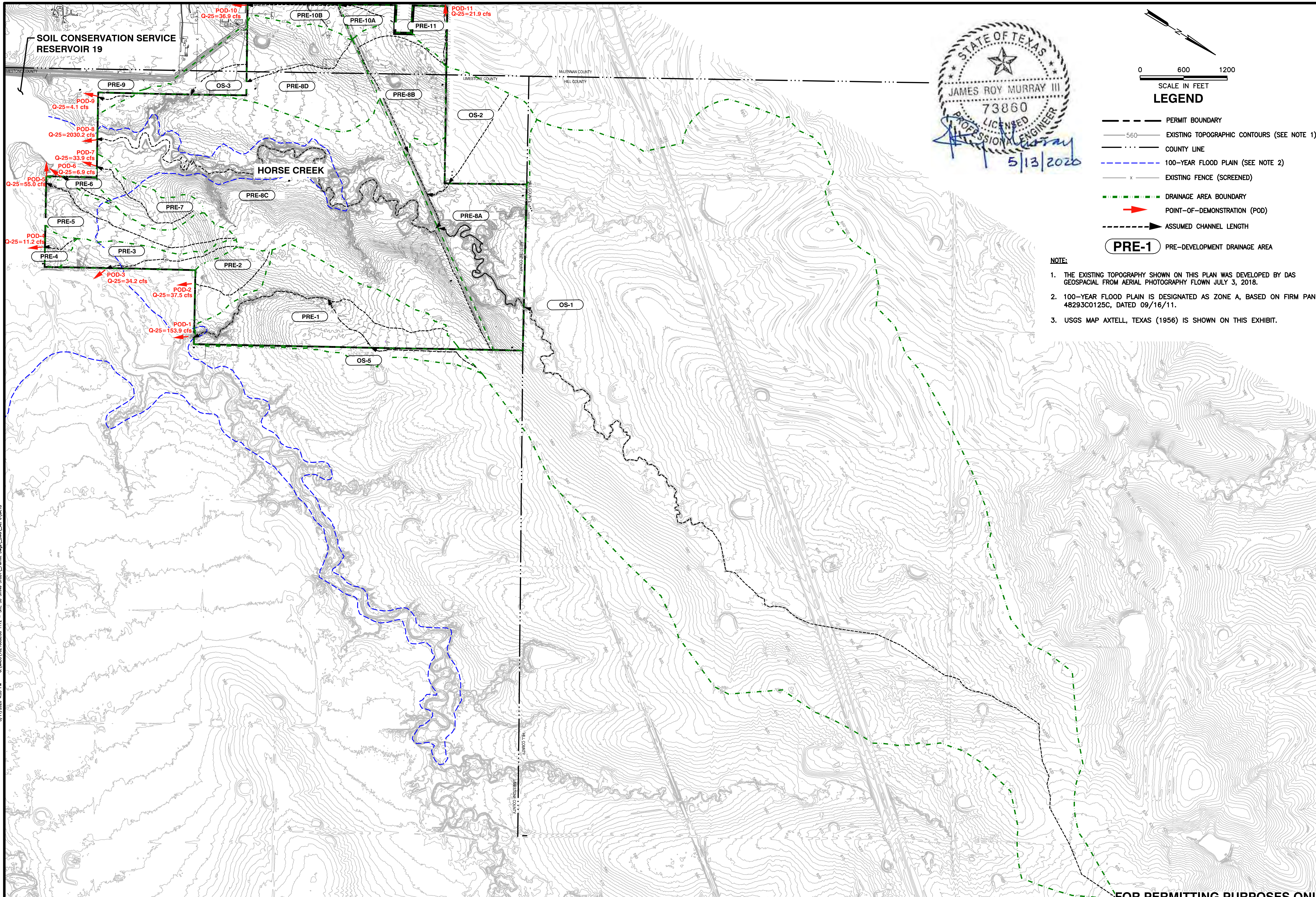
CADD FILE: 6A.1A

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.1A

5/11/2020 4:51 PM



FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: PRE-DEVELOPMENT CONDITIONS (OFF-SITE)

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

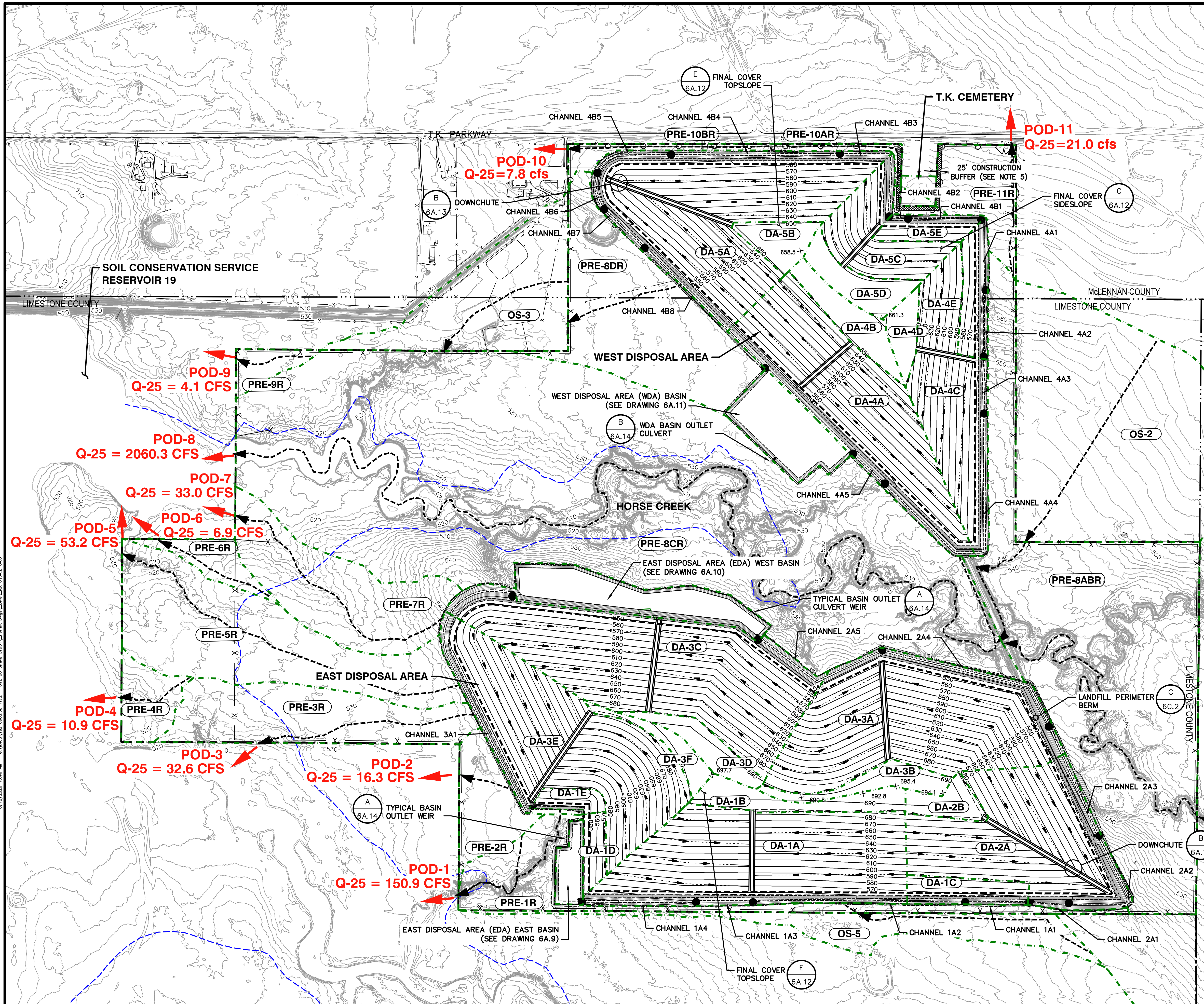
PROJ. NO.: 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A.1B

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.1B



SCALE IN FEET
0 300 600

LEGEND

- 560 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- PERMIT BOUNDARY
- LIMITS OF WASTE
- SECTOR BOUNDARY
- COUNTY LINE
- 100-YEAR FLOOD PLAIN (SEE NOTE 2)
- EXISTING FENCE (SCREENED)
- 650 FINAL COVER CONTOURS (SEE NOTE 3)
- PROPOSED/EXISTING PERIMETER FENCE (CHAIN LINK OR BARBED WIRE)
- PROPOSED 8' PRIVACY FENCE
- DRAINAGE SWALES
- DOWNCHUTES
- CHANNEL SECTION
- DRAINAGE AREA BOUNDARY
- POINT-OF-DEMONSTRATION (POD)
- ASSUMED CHANNEL LENGTH
- DA-9B POST-DEVELOPMENT DRAINAGE AREA

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48293C0125C, DATED SEPTEMBER 16, 2011.
3. ELEVATIONS SHOWN ON THIS DRAWING ARE TOP OF FINAL COVER ELEVATIONS IN FEET MEAN SEA LEVEL (FT MSL).
4. USGS MAP AXTELL, TEXAS (1956) IS SHOWN ON THIS EXHIBIT.
5. IN ACCORDANCE WITH "AN INTENSIVE CULTURAL RESOURCES SURVEY OF THE CITY OF WACO'S PROPOSED SITE 50 LANDFILL PROJECT," PREPARED BY HORIZON ENVIRONMENTAL SERVICES, INC. DATED NOVEMBER 2018 (SEE APPENDIX I/IIA), A 25-FOOT CONSTRUCTION BUFFER WILL BE MAINTAINED AROUND TK CEMETERY TO PROTECT ANY POTENTIAL UNMARKED GRAVES OUTSIDE THE PRESENT MODERN DAY CEMETERY BOUNDARIES AND FENCING.

JAMES ROY MURRAY III
73860
LICENSED PROFESSIONAL ENGINEER
STATE OF TEXAS
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV. DATE DESCRIPTION BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: POST-DEVELOPMENT CONDITIONS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A.2-6A.3

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.2

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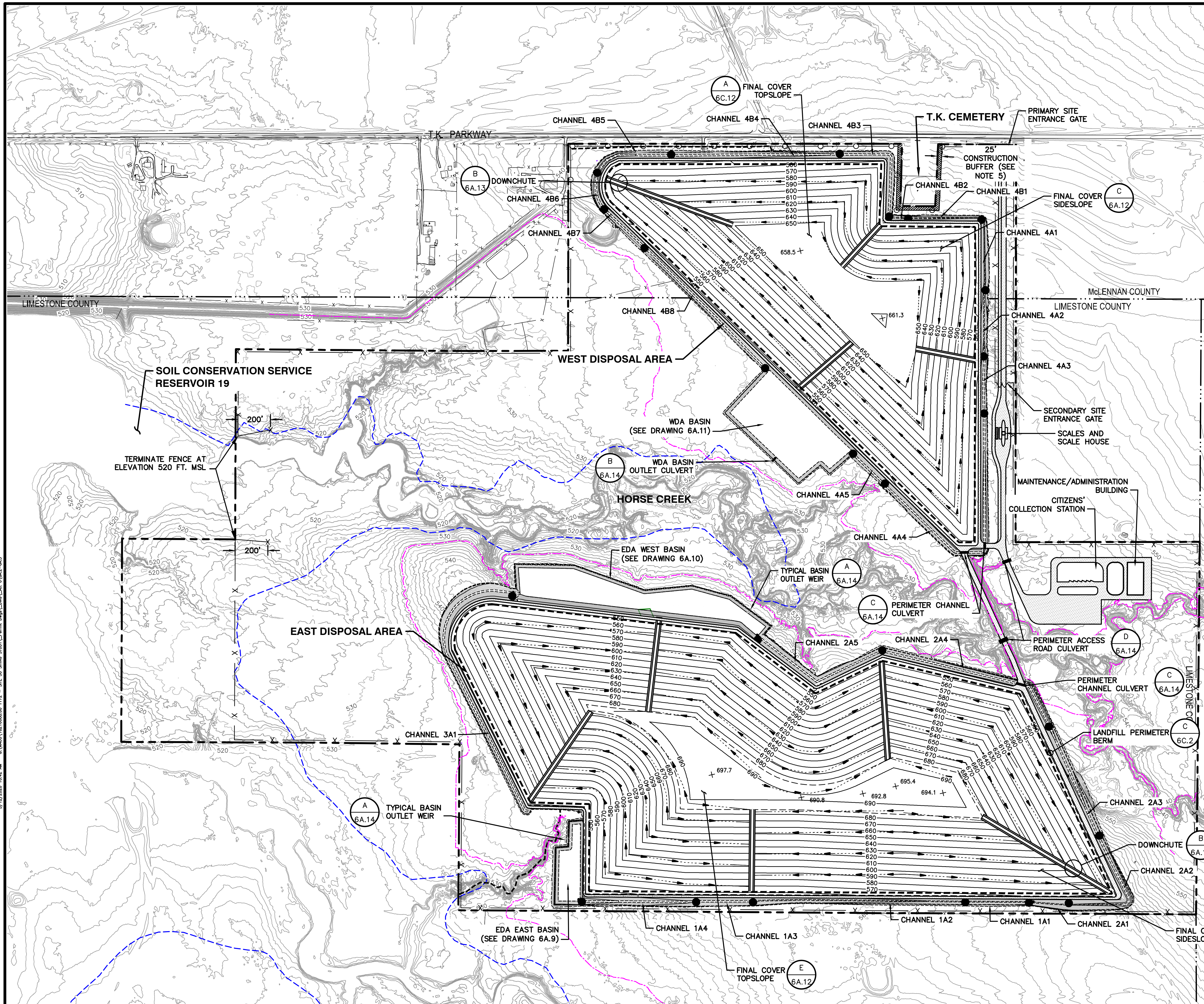


5/12/2020 10:42 AM G:\WACO\16216088.00 T172 – SITE 50 SITING STUDY_Permit Dwgs_DWG_AH 6\6A.2–6A.3

LEGEND

- EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- PERMIT BOUNDARY
- LIMITS OF WASTE
- SECTOR BOUNDARY
- COUNTY LINE
- EXISTING FENCE (SCREENED)
- 100-YEAR FLOOD PLAIN (SEE NOTE 2)
- 100-YEAR STORM EVENT WATER SURFACE (SEE NOTE 6)
- FINAL COVER TOPOGRAPHIC CONTOURS (SEE NOTE 3)
- PROPOSED/EXISTING PERIMETER FENCE (CHAIN LINK OR BARBED WIRE)
- PROPOSED 8' PRIVACY FENCE
- DRAINAGE SWALES
- DOWNCHUTES
- CHANNEL SECTION

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48293C0125C, DATED SEPTEMBER 16, 2011.
3. ELEVATIONS SHOWN ON THIS DRAWING ARE TOP OF FINAL COVER ELEVATIONS IN FEET MEAN SEA LEVEL (FT MSL).
4. USGS MAP AXTELL, TEXAS (1956) IS SHOWN ON THIS EXHIBIT.
5. IN ACCORDANCE WITH "AN INTENSIVE CULTURAL RESOURCES SURVEY OF THE CITY OF WACO'S PROPOSED SITE 50 LANDFILL PROJECT," PREPARED BY HORIZON ENVIRONMENTAL SERVICES, INC., DATED NOVEMBER 2018 (SEE APPENDIX I/IIA), A 25-FOOT CONSTRUCTION BUFFER WILL BE MAINTAINED AROUND TK CEMETERY TO PROTECT ANY POTENTIAL UNMARKED GRAVES OUTSIDE THE PRESENT MODERN DAY CEMETERY BOUNDARIES AND FENCING.
6. 100-YEAR STORM EVENT WATER SURFACE WAS ESTIMATED USING HEC-HMS AND HEC-RAS MODELING AS DISCUSSED IN ATTACHMENT 6B OF THIS PERMIT APPLICATION.

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: LANDFILL COMPLETION PLAN

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

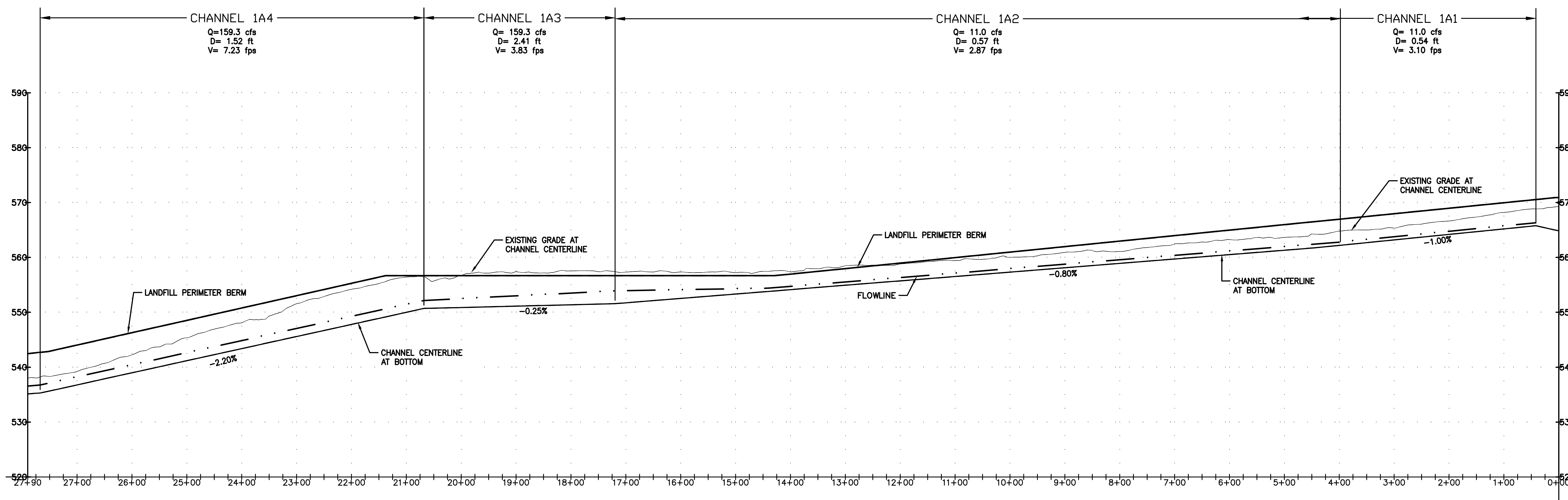
PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

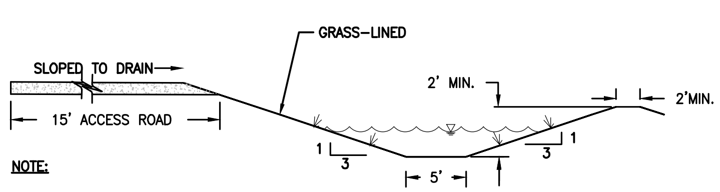
CADD FILE: 6A.2-6A.3

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. **6A.3**

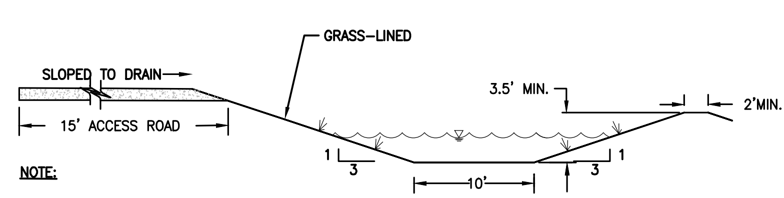




NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

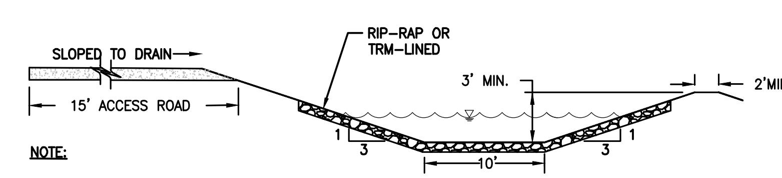
CHANNEL 1A1-1A2
TYPICAL CROSS-SECTION
NOT TO SCALE



NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 1A3
TYPICAL CROSS-SECTION
NOT TO SCALE



NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 1A3
TYPICAL CROSS-SECTION
NOT TO SCALE

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: CHANNEL PROFILE CHANNEL 1A1 TO 1A4

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A.4 - CHANNEL PROFILES

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.4

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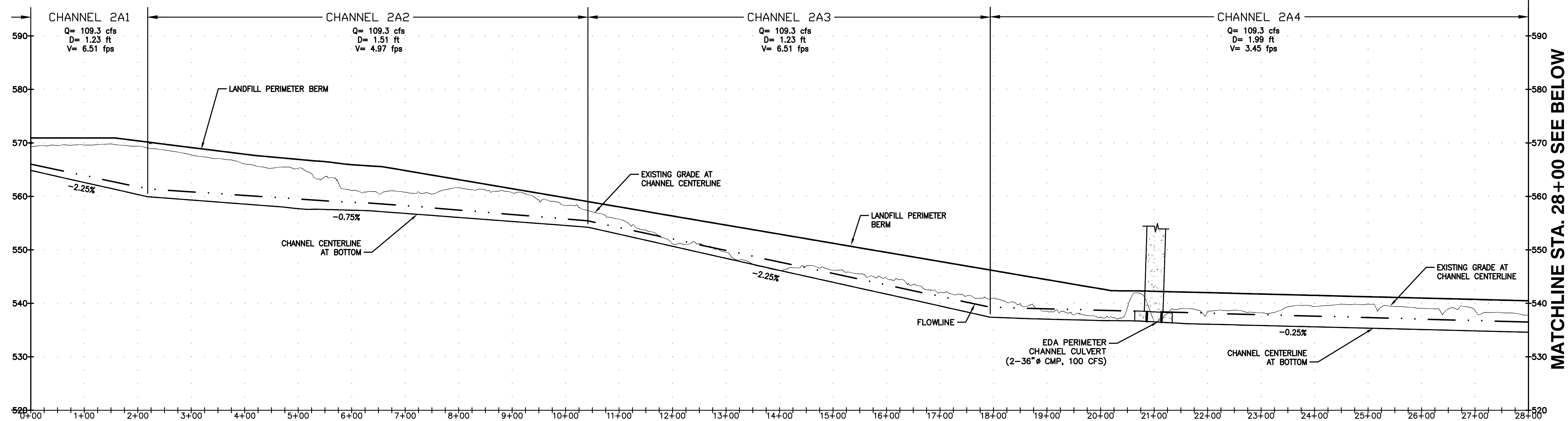
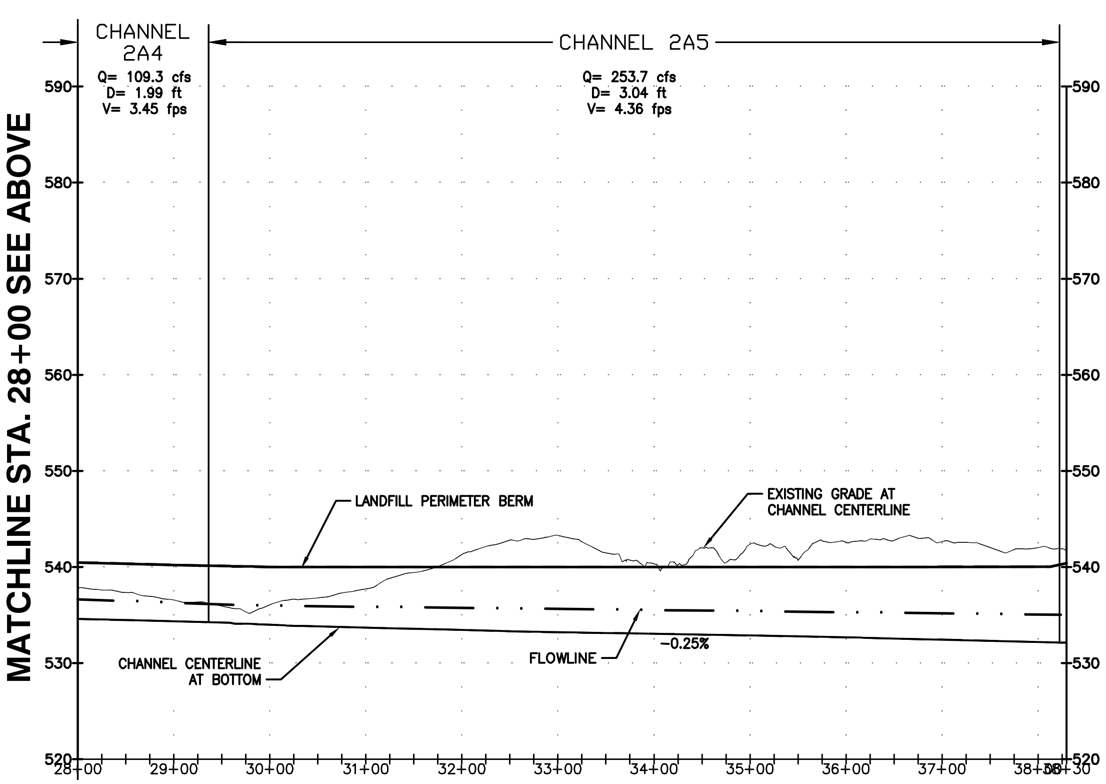
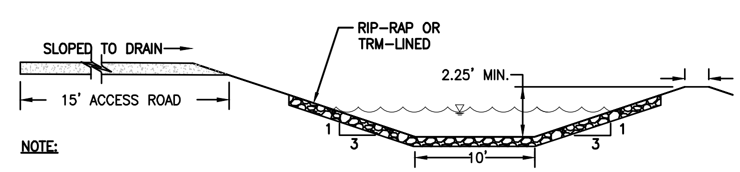


0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

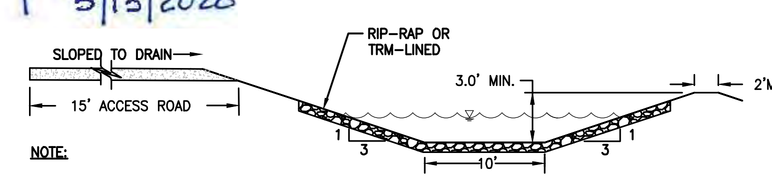
JAMES ROY MURRAY III
73860
LICENSED PROFESSIONAL ENGINEER
STATE OF TEXAS
5/13/2020





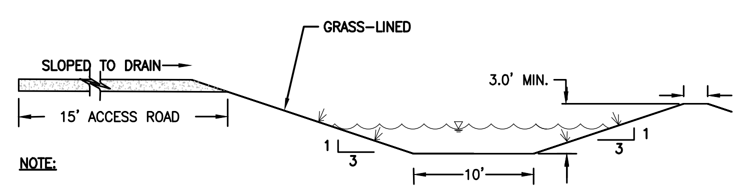
NOTE:
DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 2A1
TYPICAL CROSS-SECTION
NOT TO SCALE



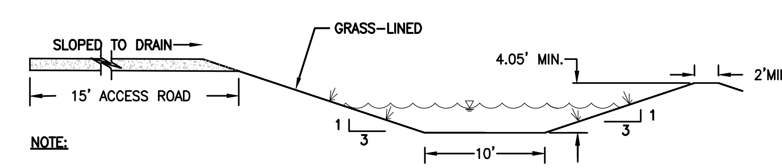
NOTE:
DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 2A3
TYPICAL CROSS-SECTION
NOT TO SCALE



NOTE:
DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 2A2, AND 2A4
TYPICAL CROSS-SECTION
NOT TO SCALE



NOTE:
DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 2A5
TYPICAL CROSS-SECTION
NOT TO SCALE

FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CHANNEL PROFILE
CHANNEL 2A1 TO CHANNEL 2A5

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

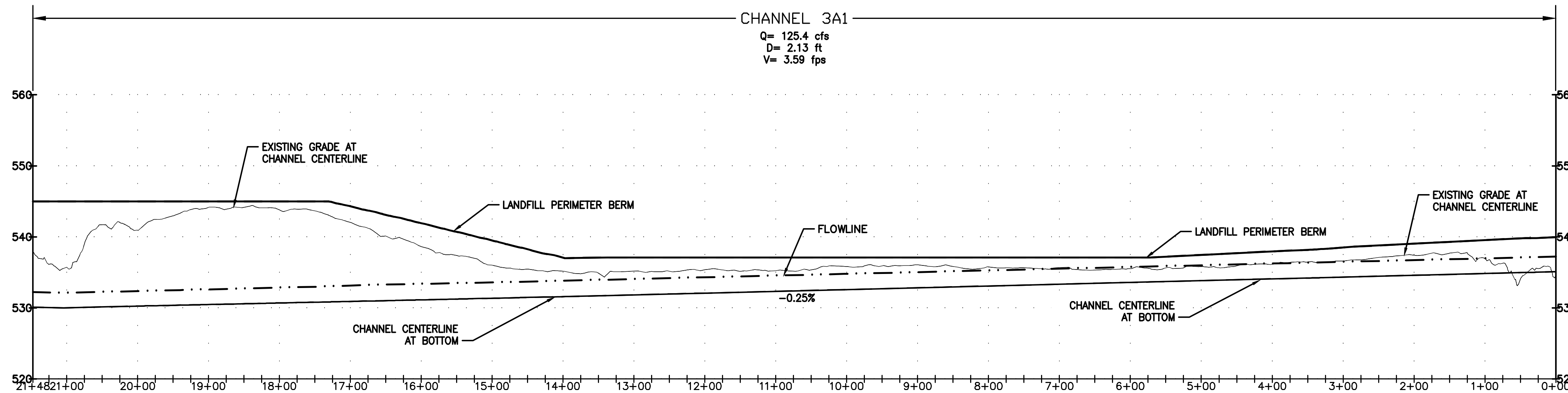
PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A.A4 - CHANNEL PROFILES

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.
6A.5



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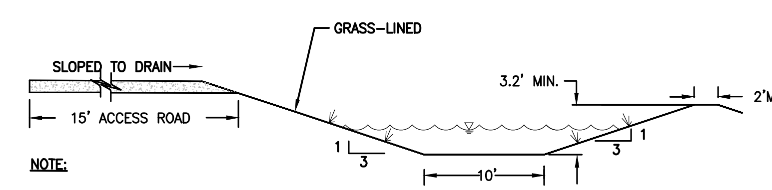
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET



NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 3A1
TYPICAL CROSS-SECTION
NOT TO SCALE

5/11/2020 6:12 PM G:\WACO\16216088.00 T172 - SITE 50 SITING STUDY_Permit Dwgs_DWG_Att 6\6A.A4 - CHANNEL PROFILES

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CHANNEL PROFILE
CHANELL 3A1

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

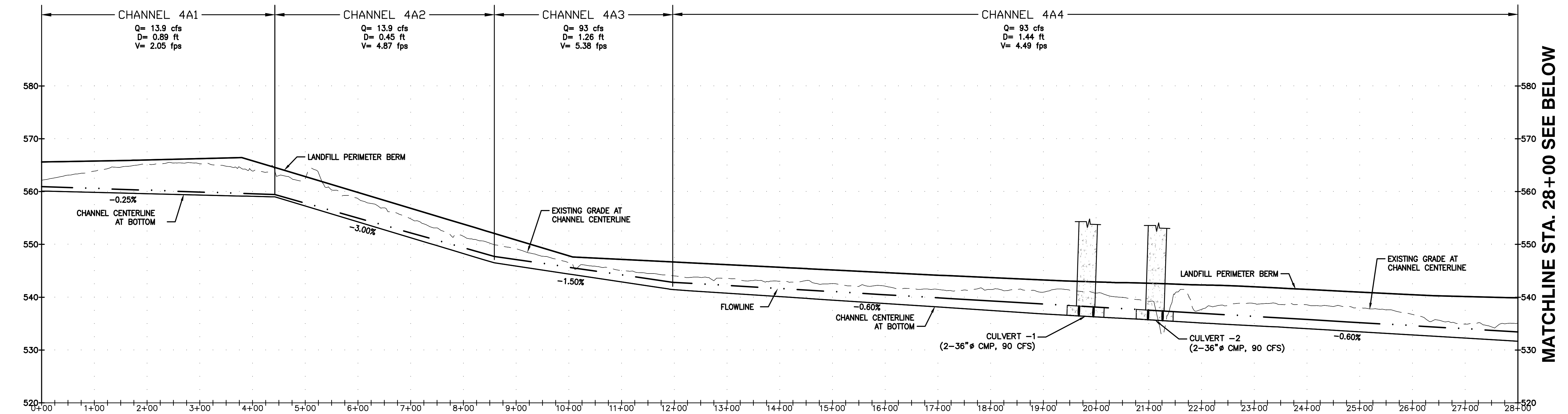
CADD FILE: 6A.A4 - CHANNEL PROFILES

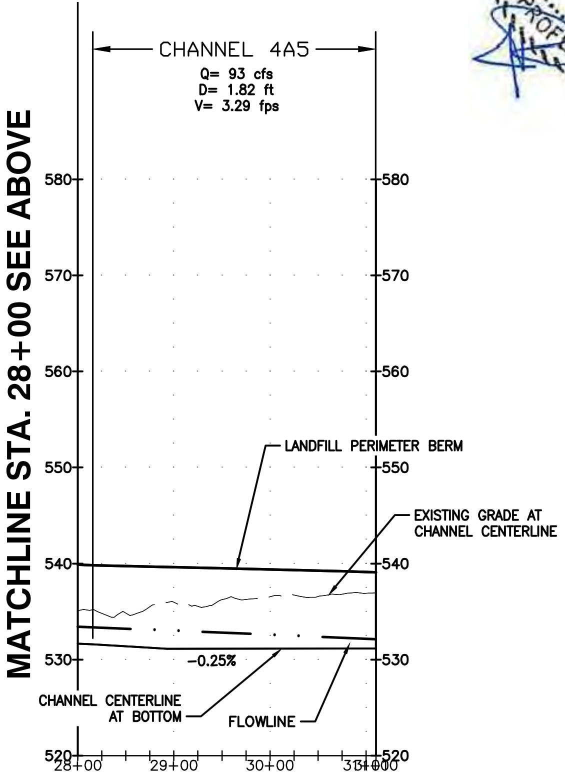
DATE: 04/2020

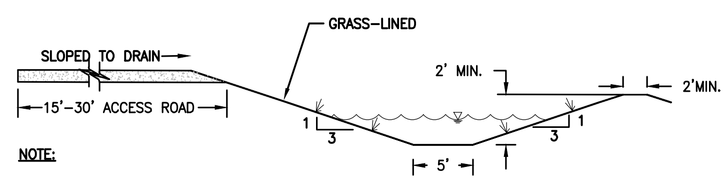
SCALE: AS SHOWN

DRAWING NO.
6A.6

FOR PERMITTING PURPOSES ONLY



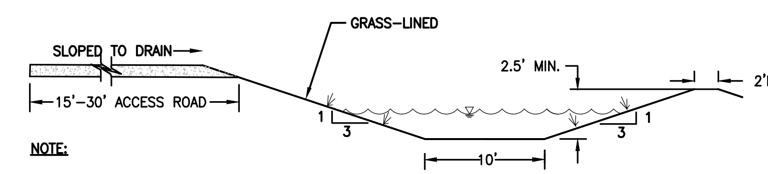




NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 4A-1 - 4A-2
TYPICAL CROSS-SECTION
NOT TO SCALE

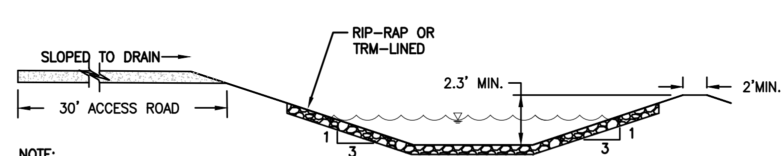


NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

MINIMUM CHANNEL DEPTH AT CULVERT LOCATIONS 6-FEET

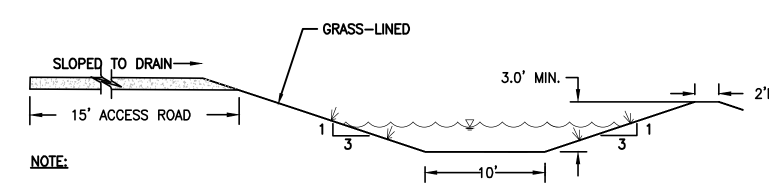
CHANNEL 4A4
TYPICAL CROSS-SECTION
NOT TO SCALE



NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 4A3
TYPICAL CROSS-SECTION
NOT TO SCALE



NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

MINIMUM CHANNEL DEPTH AT CULVERT LOCATIONS 6-FEET

CHANNEL 4A5
TYPICAL CROSS-SECTION
NOT TO SCALE

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: CHANNEL PROFILE CHANNEL 4A1 TO CHANNEL 4A5

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 4A.4 - CHANNEL PROFILES

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.7

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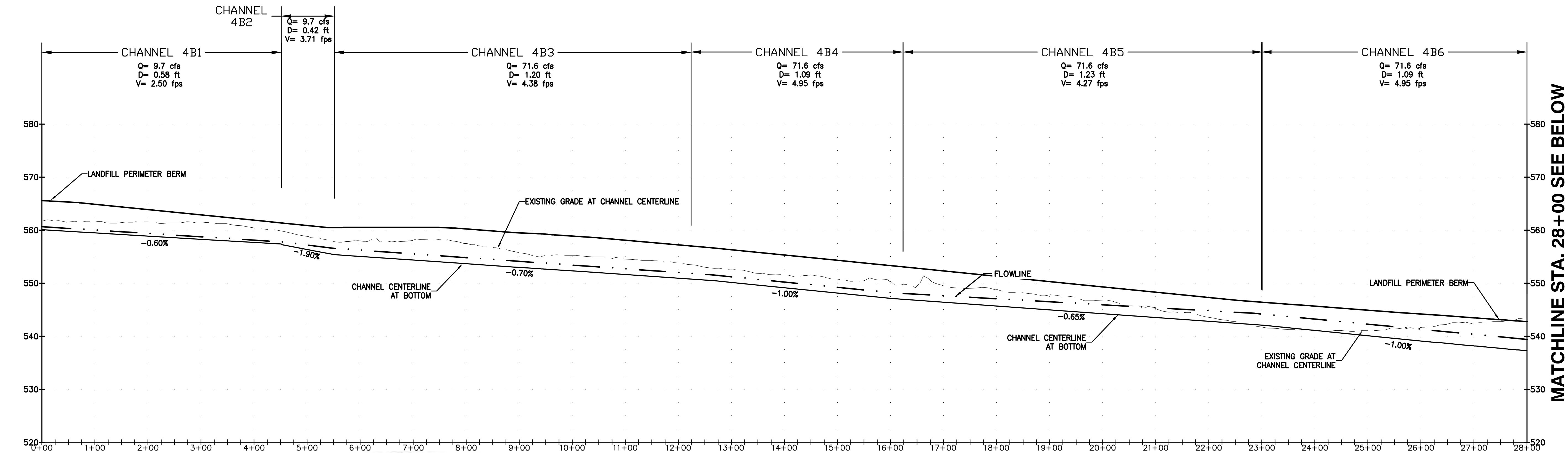
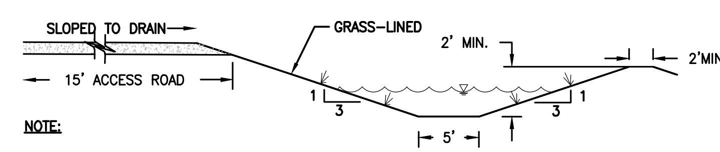


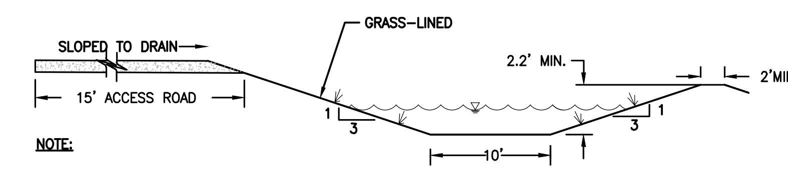
STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
5/13/2020



NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

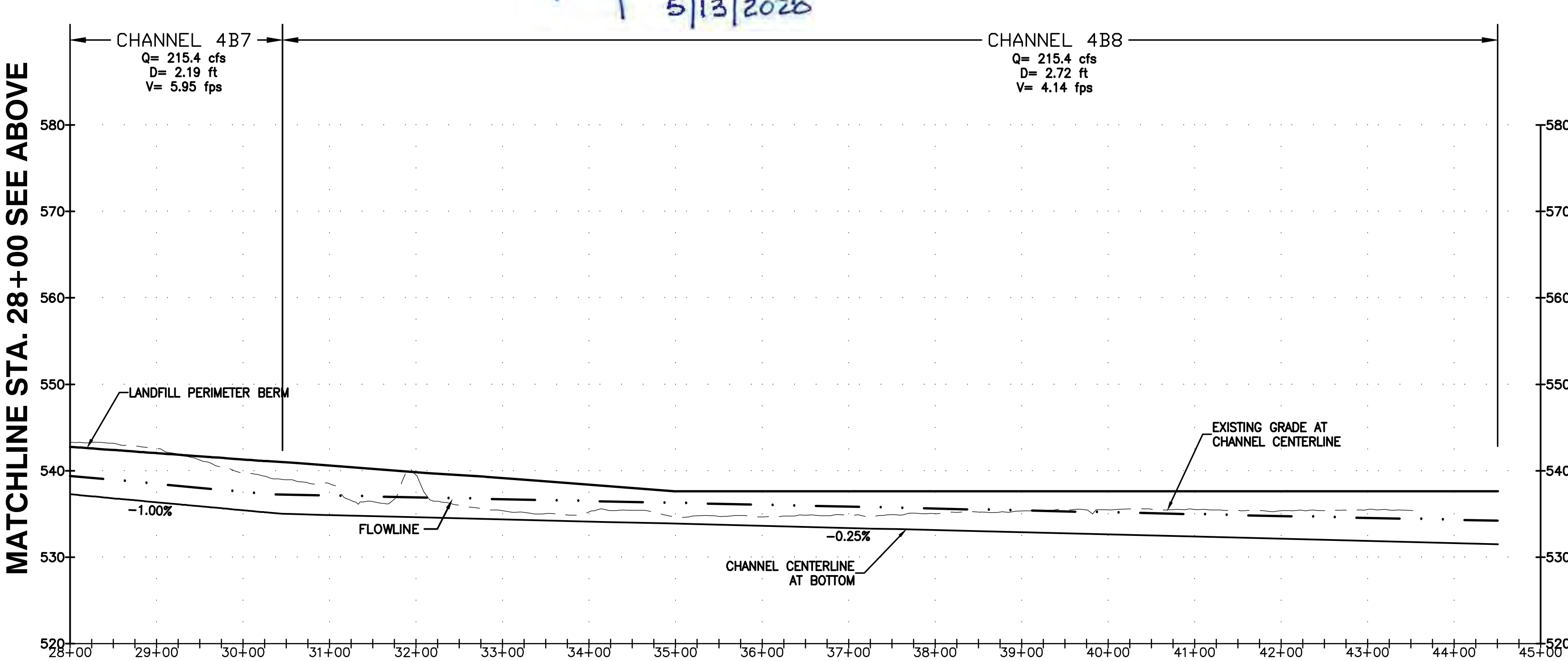
CHANNEL 4B1-4B2
TYPICAL CROSS-SECTION
NOT TO SCALE

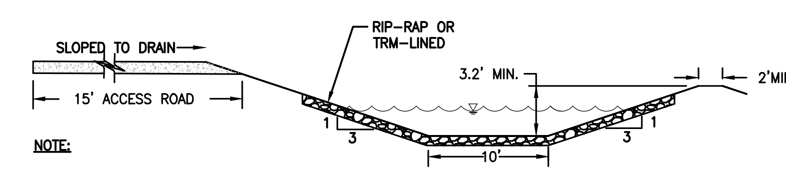


NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 4B3-4B6
TYPICAL CROSS-SECTION
NOT TO SCALE

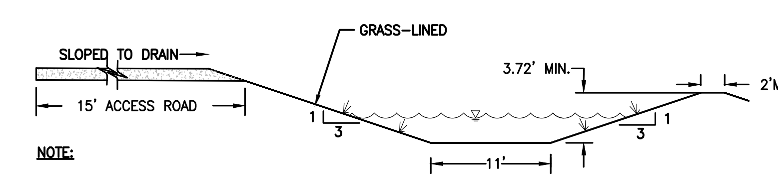




NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 4B7
TYPICAL CROSS-SECTION
NOT TO SCALE



NOTE:

DESIGN DEPTH WILL INCLUDE MIN. 0.4-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24-HOUR STORM EVENT).

CHANNEL 4B8
TYPICAL CROSS-SECTION
NOT TO SCALE

FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: CHANNEL PROFILE CHANNEL 4B1 TO CHANNEL 4B7

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

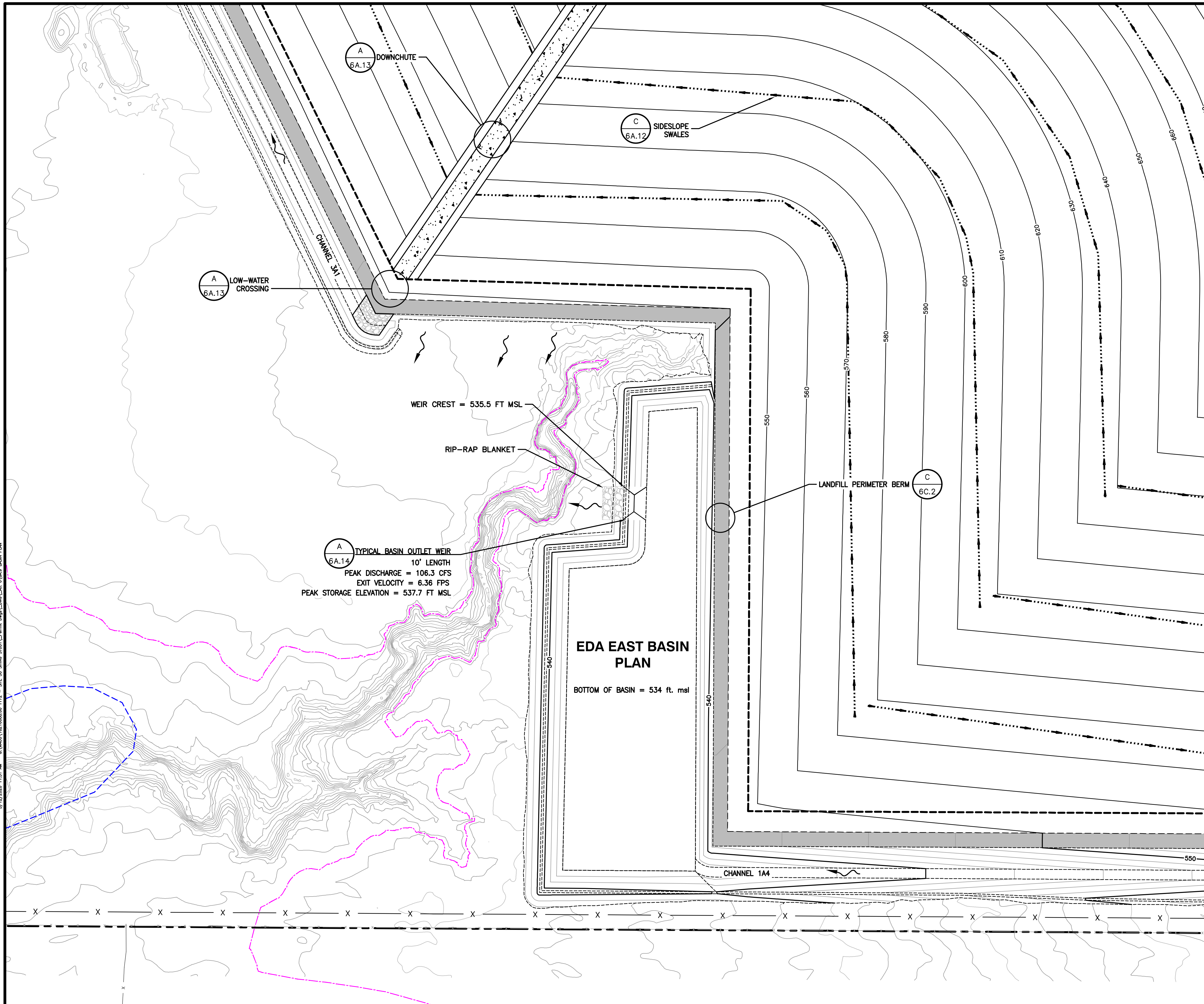
PROJ. NO. 16216088.00 | DWN. BY: NR | Q/A RVW BY: RRK
DSN. BY: BC/RRK | CHK. BY: BJD | APP. BY: RRK

CADD FILE: 6A.A4 - CHANNEL PROFILES

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.8



0 50 100
SCALE IN FEET

LEGEND

LEGEND

- 560 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- PERMIT BOUNDARY
- LIMITS OF WASTE
- 100-YEAR FLOOD PLAIN (SEE NOTE 2)
- 100-YEAR STORM EVENT WATER SURFACE (SEE NOTE 3)
- 650 FINAL COVER TOPOGRAPHIC CONTOURS (SEE NOTE 4)
- X PROPOSED/EXISTING PERIMETER FENCE (BARBED WIRE)
- DRAINAGE SWALES
- DOWNCHUTES
- PERIMETER CHANNEL AND SURFACE FLOW DIRECTION

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48293C0125C, DATED SEPTEMBER 16, 2011.
3. 100-YEAR STORM EVENT WATER SURFACE WAS ESTIMATED USING HEC-HMS AND HEC-RAS MODELING AS DISCUSSED IN ATTACHMENT 6B OF THIS PERMIT APPLICATION.
4. ELEVATIONS SHOWN ON THIS DRAWING ARE TOP OF FINAL COVER ELEVATIONS IN FEET MEAN SEA LEVEL (FT MSL).

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: EDA EAST BASIN PLAN

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
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PH (817) 571-2288 FAX NO. (817) 571-2188

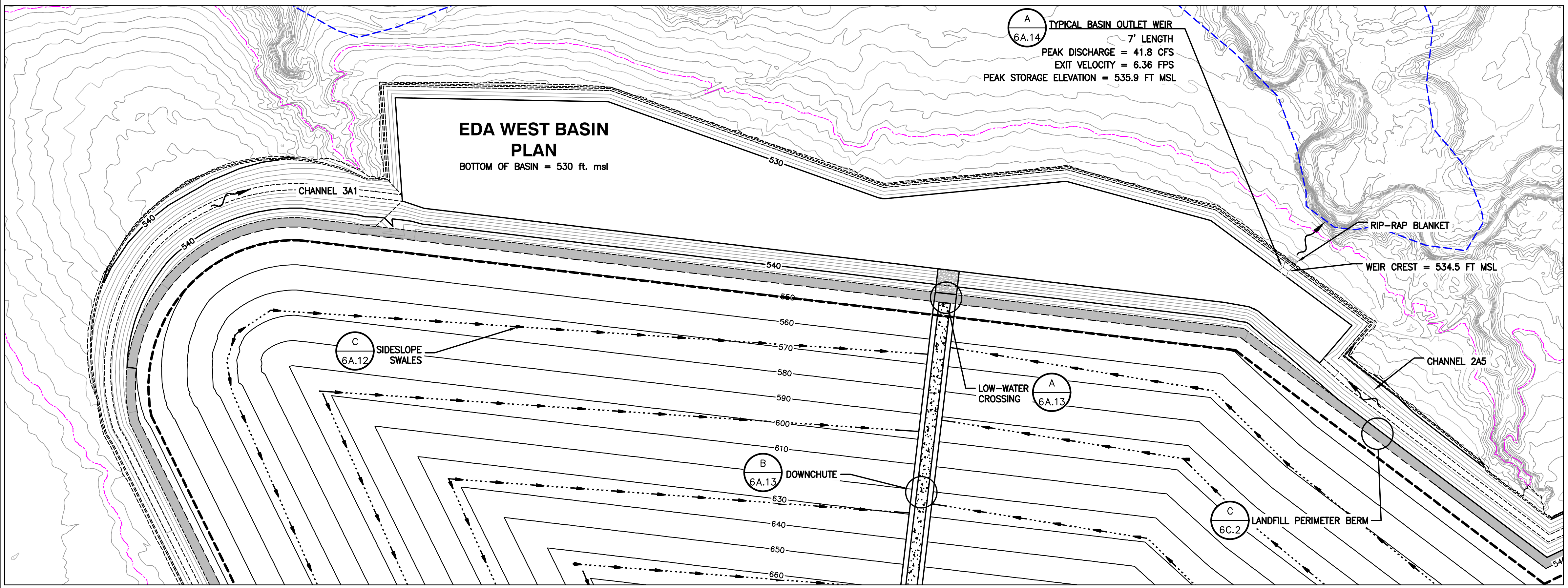
PROJ. NO. 16216088.00
DSN. BY: BC/RRK
DWN. BY: NR
CHK. BY: BJD
Q/A RVW BY: RRK
APP. BY: RRK

CADD FILE: 6A.9 BASIN PLAN

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.9



0 100 200
SCALE IN FEET

LEGEND

560 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)

LIMITS OF WASTE

100-YEAR FLOOD PLAIN (SEE NOTE 2)

100-YEAR STORM EVENT WATER SURFACE (SEE NOTE 3)

650 FINAL COVER TOPOGRAPHIC CONTOURS (SEE NOTE 4)

DRAINAGE SWALES

DOWNCHUTES

PERIMETER CHANNEL AND SURFACE FLOW DIRECTION

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48293C0125C, DATED SEPTEMBER 16, 2011.
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4. ELEVATIONS SHOWN ON THIS DRAWING ARE TOP OF FINAL COVER ELEVATIONS IN FEET MEAN SEA LEVEL (FT MSL).

STATE OF TEXAS
JAMES ROY MURRAY III
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LICENSED
PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: EDA WEST BASIN PLAN

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A.9 BASIN PLAN

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.10

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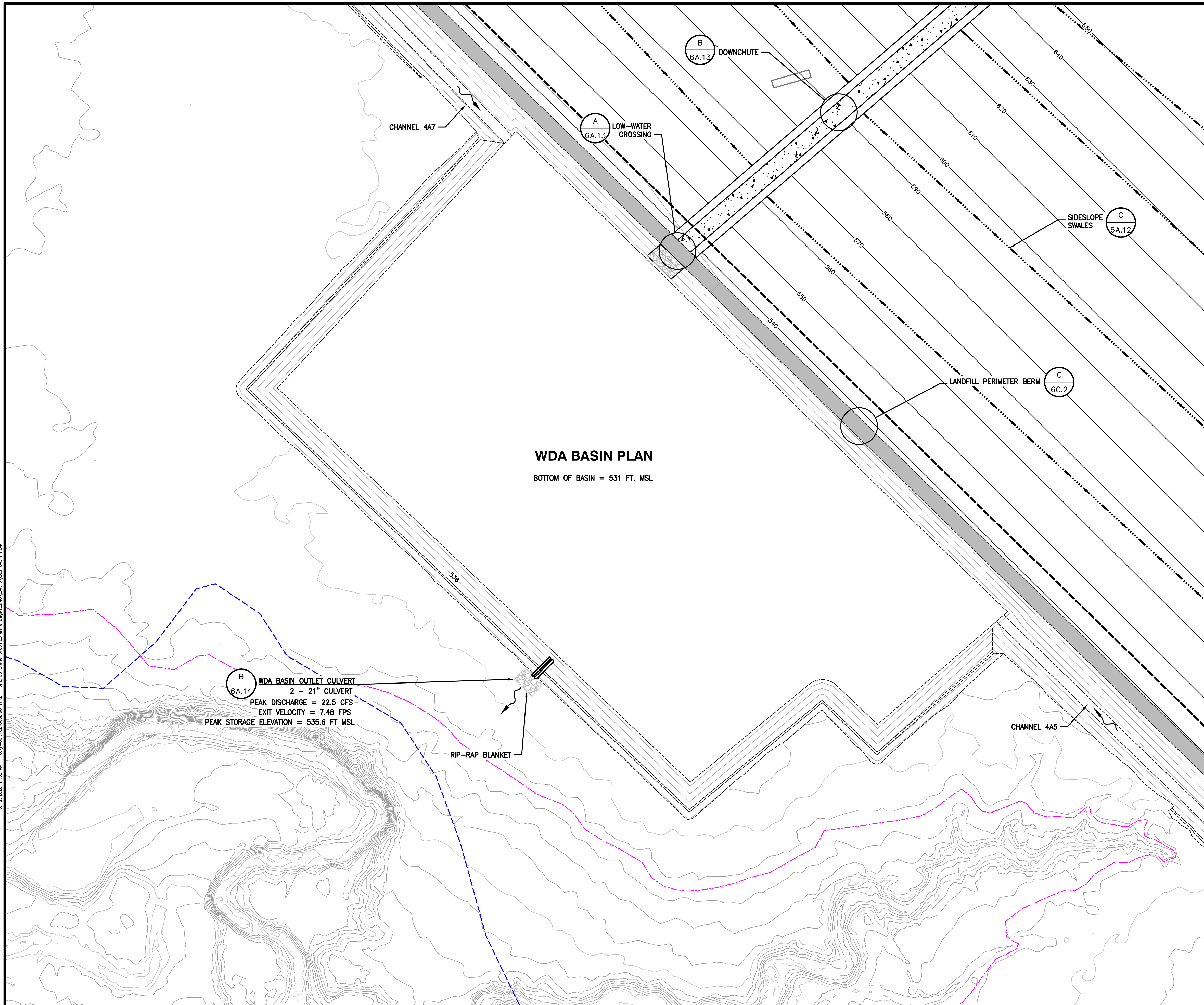

0 50 100
SCALE IN FEET

LEGEND

- 560 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- PERMIT BOUNDARY
- LIMITS OF WASTE
- 100-YEAR FLOOD PLAIN (SEE NOTE 2)
- 100-YEAR STORM EVENT WATER SURFACE (SEE NOTE 3)
- 650 FINAL COVER TOPOGRAPHIC CONTOURS (SEE NOTE 4)
- DRAINAGE SWALES
- DOWNCHUTES
- PERIMETER CHANNEL AND SURFACE FLOW DIRECTION

NOTE:

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STATE OF TEXAS
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PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: WDA BASIN PLAN

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
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PH (817) 571-2288 FAX NO. (817) 571-2188

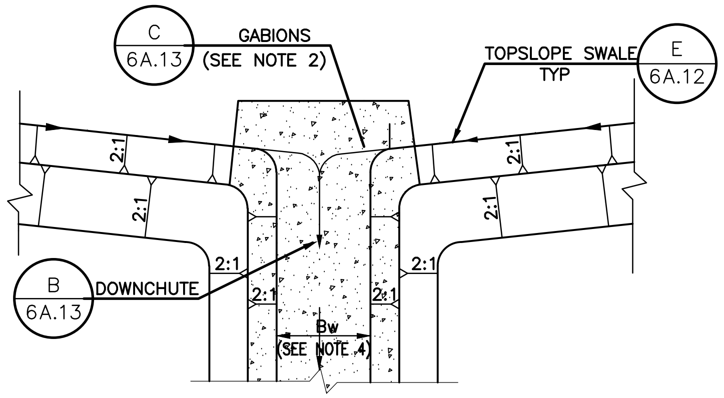
PROJ. NO. 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A.9 BASIN PLAN

DATE: 04/2020

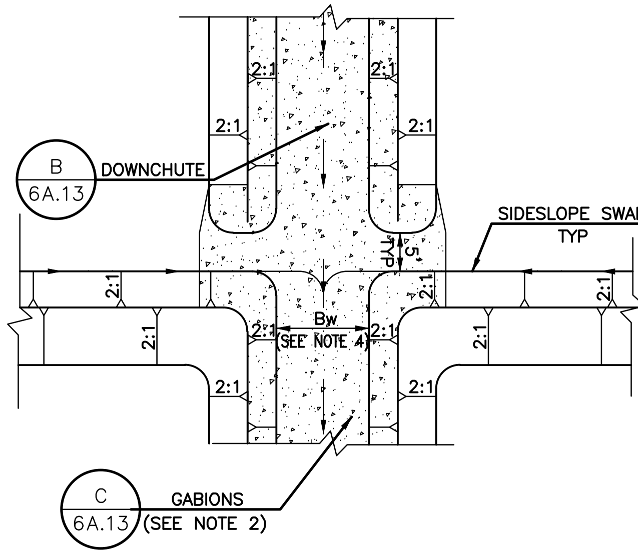
SCALE: AS SHOWN

DRAWING NO. 6A.11



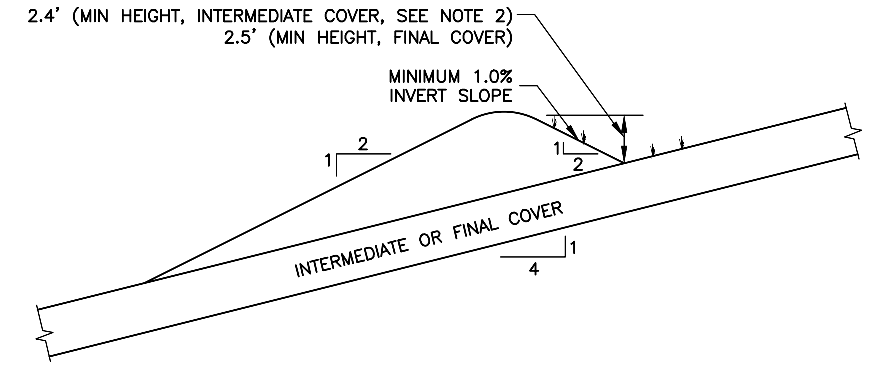
SWALE/DOWNCHUTE CONFLUENCE (A / 6A.12)

NTS



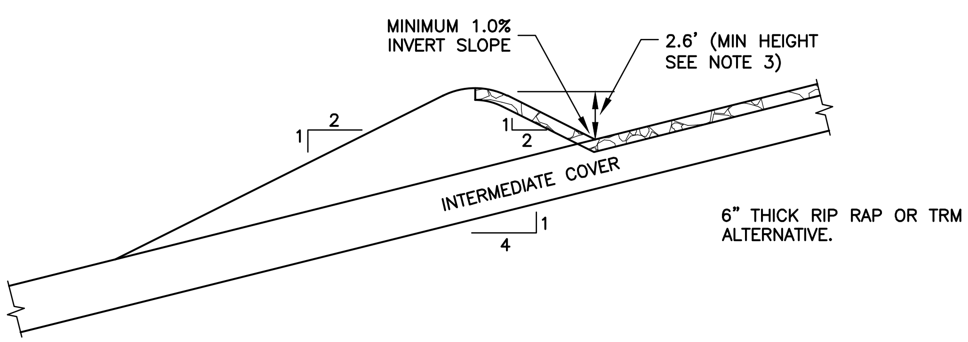
SWALE/DOWNCHUTE CONFLUENCE (B / 6A.12)

NTS



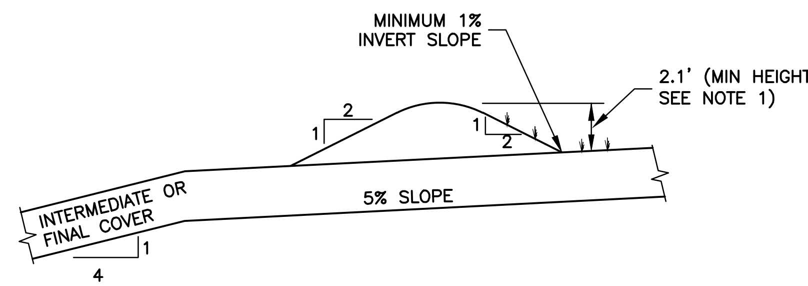
INTERMEDIATE OR FINAL COVER – SIDESLOPE SWALE (C / 6A.12)

NTS



INTERMEDIATE COVER – SIDESLOPE SWALE (D / 6A.12)

NTS



INTERMEDIATE OR FINAL COVER – TOPSLOPE SWALE (E / 6A.12)

NTS

NOTES:

1. TOPSLOPE SWALES INSTALLED ON INTERMEDIATE COVER WILL BE CONSTRUCTED WITH A MINIMUM HEIGHT OF 2.0 FEET, PROVIDED THE CONTRIBUTING AREA IS LESS THAN OR EQUAL TO 17 ACRES. ALL TOPSLOPE SWALES ON FINAL COVER AREAS WILL HAVE A MINIMUM HEIGHT OF 2 FEET.
2. GRASS–LINED SIDESLOPE SWALES INSTALLED ON INTERMEDIATE COVER WILL BE CONSTRUCTED WITH A MINIMUM HEIGHT 2.4 FEET, PROVIDED THE CONTRIBUTING AREA IS LESS THAN OR EQUAL TO 7.3 ACRES.
3. SIDESLOPE SWALES WITH CONTRIBUTING AREAS GREATER THAN 7.3 ACRES BUT LESS THAN 10 ACRES WILL BE RIP RAP OR TRM–LINED AND CONSTRUCTED WITH A MINIMUM HEIGHT OF 2.6 FEET.
4. DESIGN OF DOWNCHUTES ARE PRESENTED IN APPENDIX 6A–E ANALYSIS. DOWNCHUTES WILL BE CONSTRUCTED WITH A MINIMUM BOTTOM WIDTH, Bw, OF 10' OR 15' INTERMEDIATE AND FINAL COVER RESPECTIVELY.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: DRAINAGE SWALE DETAILS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

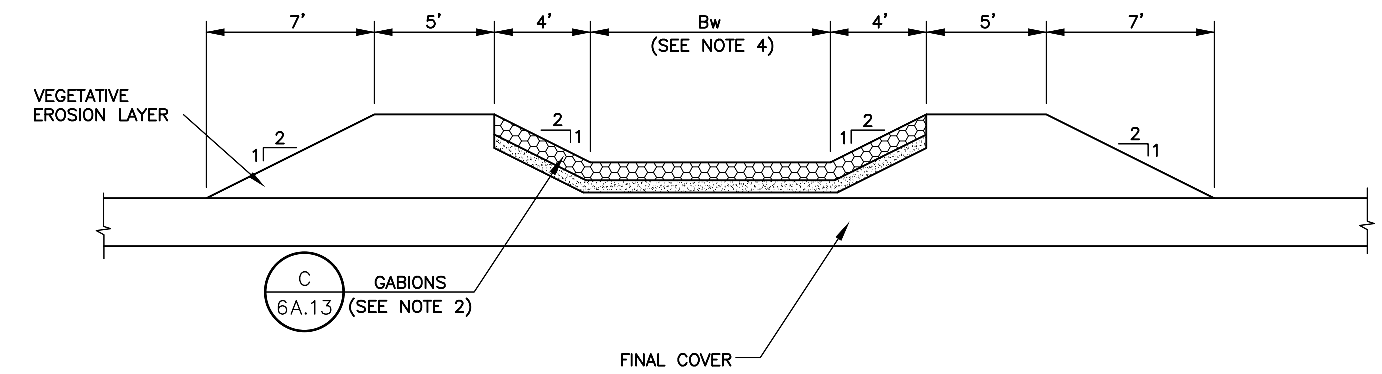
PROJ. NO.: 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

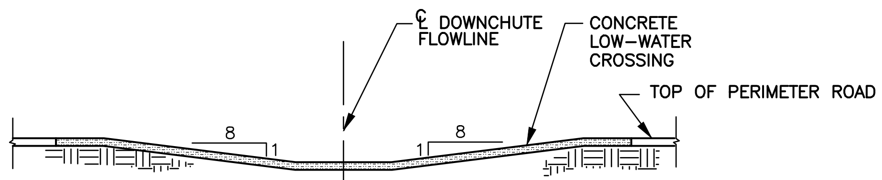
CADD FILE: 6A-12

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.: **6A.12**





LOW-WATER CROSSING SECTION A-A'

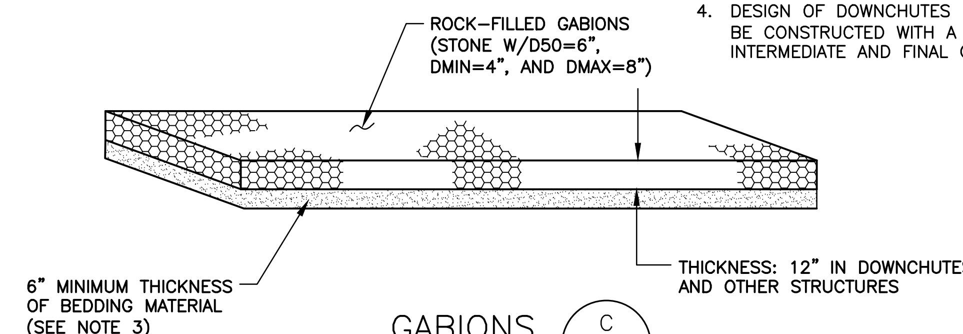
NTS

DOWNCHUTE B 6A.13

NTS

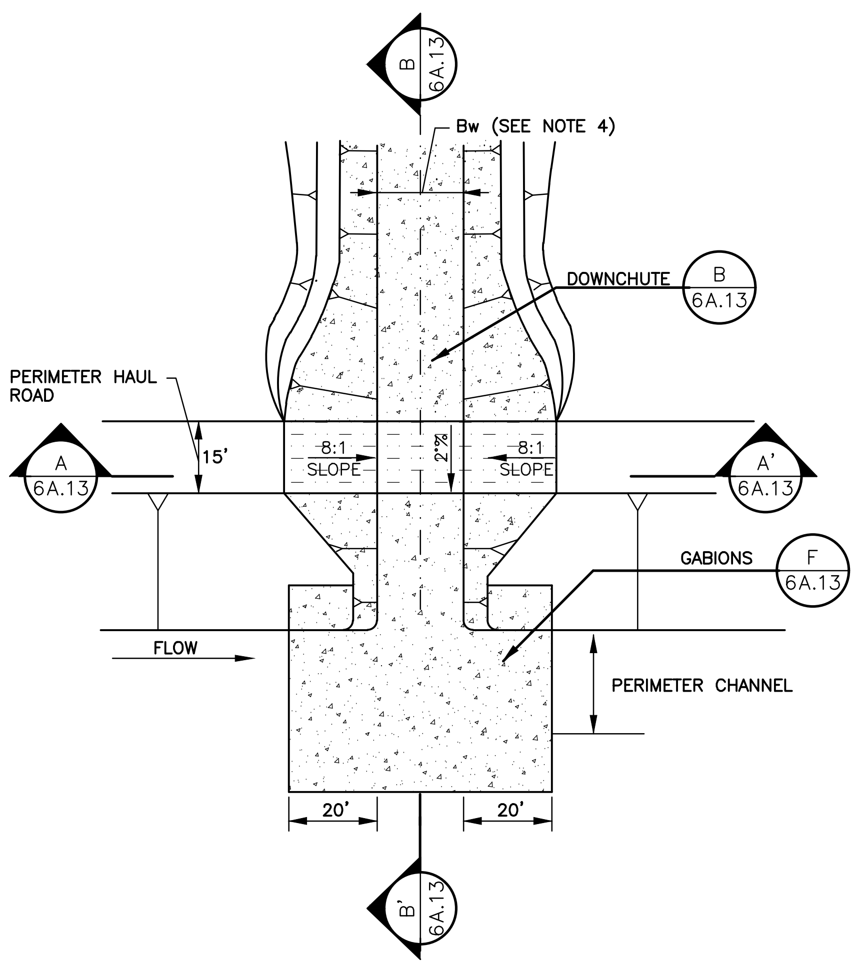
NOTES:

1. TYPICAL DOWNCHUTE DEPTH IS 2 FEET FOR INDIVIDUAL DOWNCHUTES. FINAL DEPTHS TO BE DETERMINED DURING CLOSURE DESIGN.
2. DOWNCHUTES INSTALLED ON INTERMEDIATE COVER WILL BE LINED WITH GABIONS, RIP RAP, TRM OR FLEXIBLE MEMBRANE LINER; DOWNCHUTES INSTALLED ON FINAL COVER WILL BE LINED WITH GABIONS.
3. BEDDING MATERIAL WILL CONSIST OF A COARSE SAND OR FINE CRUSHED STONE.
4. DESIGN OF DOWNCHUTES IS PRESENTED IN APPENDIX 6A-E, DOWNCHUTES WILL BE CONSTRUCTED WITH A MINIMUM BOTTOM WIDTH, Bw, OF 10' OR 15' FOR INTERMEDIATE AND FINAL COVER RESPECTIVELY.



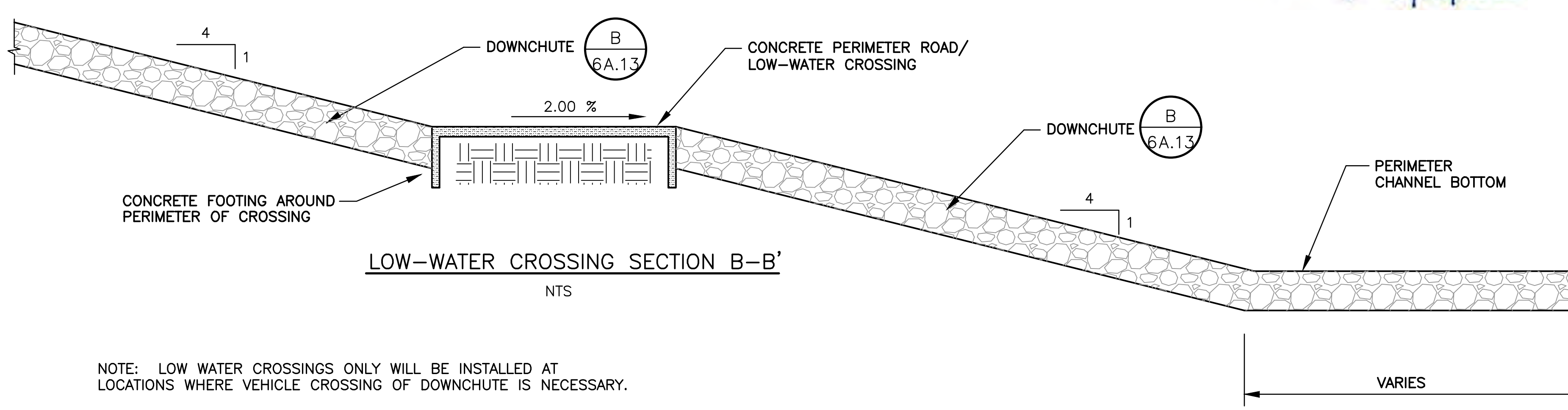
GABIONS C 6A.13

NTS



LOW-WATER CROSSING A 6A.13

NTS



LOW-WATER CROSSING SECTION B-B'

NTS

NOTE: LOW WATER CROSSINGS ONLY WILL BE INSTALLED AT LOCATIONS WHERE VEHICLE CROSSING OF DOWNCHUTE IS NECESSARY.

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: DOWNCHUTE DETAILS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A-13

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A.13

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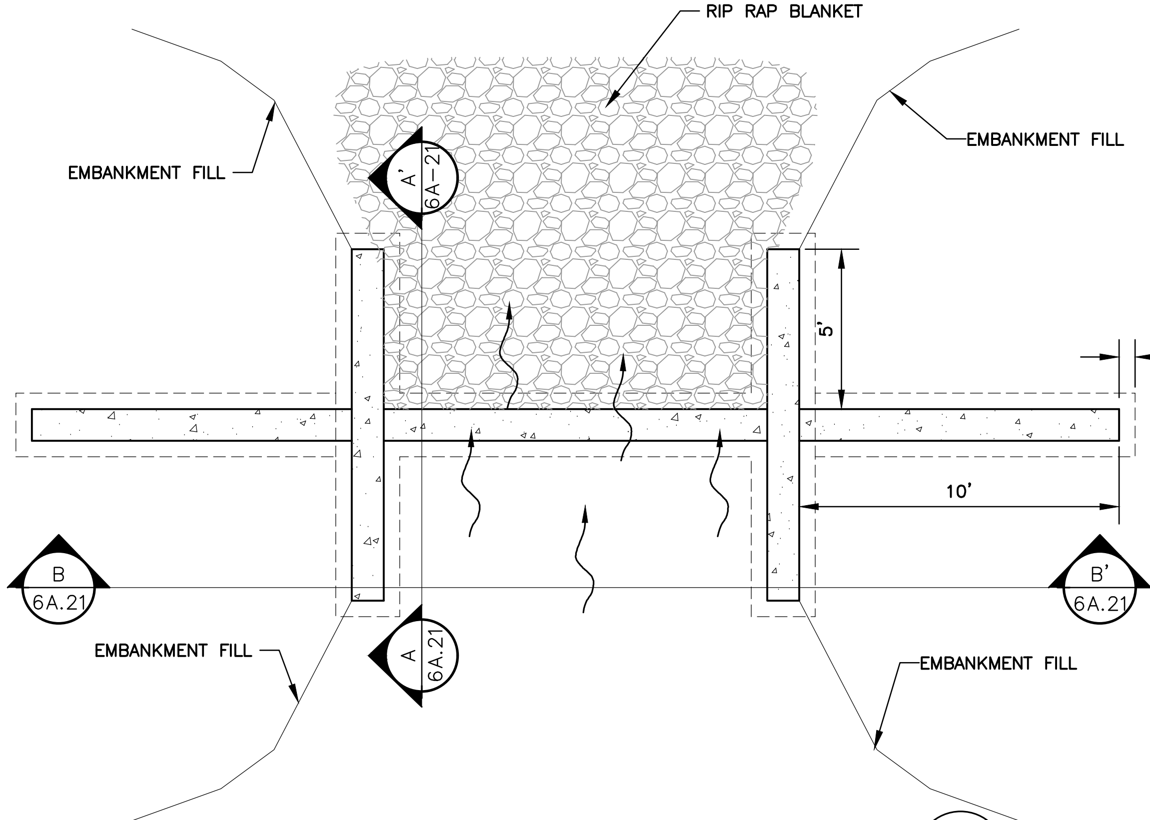
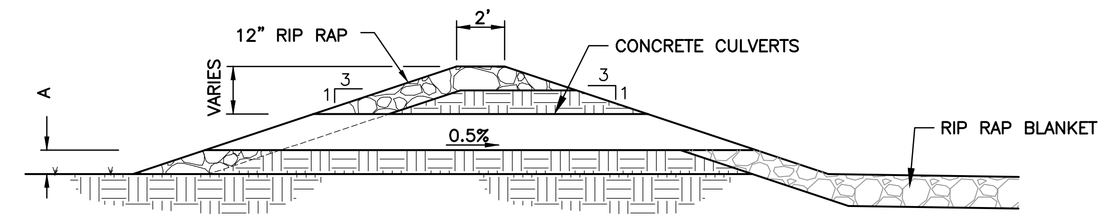


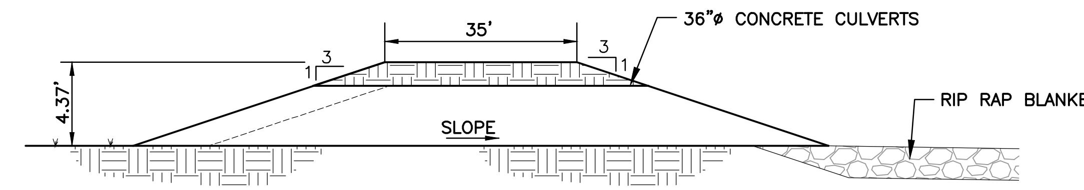
EAST DISPOSAL AREA EAST BASIN OUTLET (A / 6A.14)
NTS

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
5/13/2020



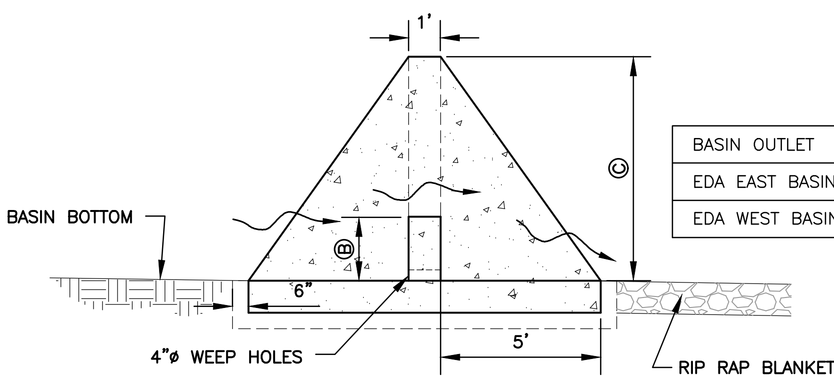
TYPICAL BASIN OUTLET CULVERT (B / 6A.14)
NTS

BASIN OUTLET	POND BOTTOM ELEVATION (FT)	CULVERT SIZE (INCH)	NO. CULVERTS	LENGTH (FT)	A (FT)
WDA BASIN	531	21	2	25	3.5



PERIMETER CHANNEL CULVERT (C / 6A.14)
NTS

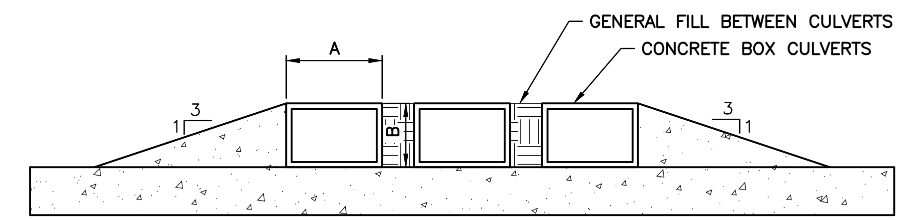
PERIMETER CHANNEL CULVERT	CHANNEL BOTTOM ELEVATION (FT)	SLOPE (%)	NO. CULVERTS	LENGTH (FT)
EDA PERIMETER CHANNEL CULVERT	537.50	0.25	2	70
WDA PERIMETER CHANNEL CULVERT 1	536.67	0.60	2	70
WDA PERIMETER CHANNEL CULVERT 2	535.19	0.56	2	70



SECTION A–A'
NTS

WEIR OUTLET CONFIGURATION DIMENSIONS (FT)

BASIN OUTLET	BOTTOM ELEVATION	A	B	C	NO. WEEP HOLES
EDA EAST BASIN	534	10	2.5	6.0	5
EDA WEST BASIN	530	7	4.5	7.0	3



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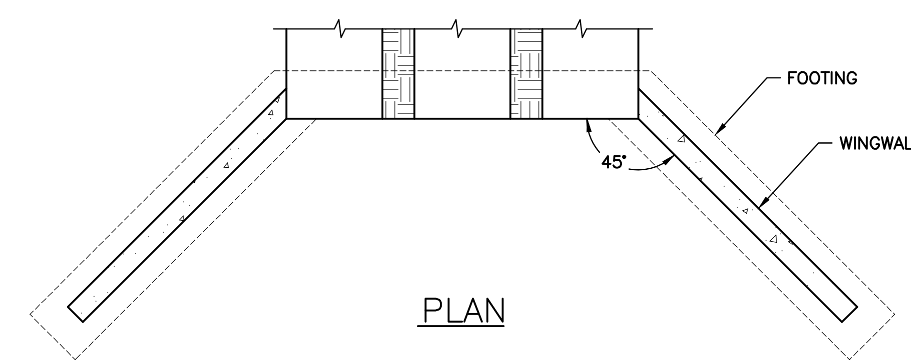
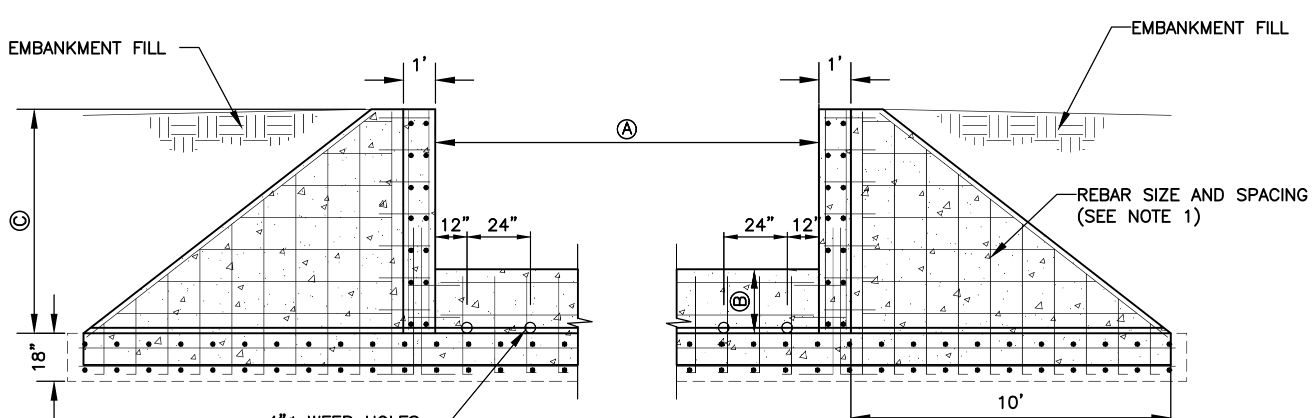


PLAN

PERIMETER ACCESS ROAD CULVERT (D / 6A.14)
NTS

BOX CULVERT	SLOPE (%)	NO. OF BOXES	LENGTH (FT)	A (FT)	B (FT)
PERIMETER ACCESS ROAD CULVERT 1	1.00	3	38	4	3
PERIMETER ACCESS ROAD CULVERT 2	0.50	4	32	8	8



SECTION B–B'
NTS

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: BASIN OUTLET DETAILS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6A-14

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. **6A.14**

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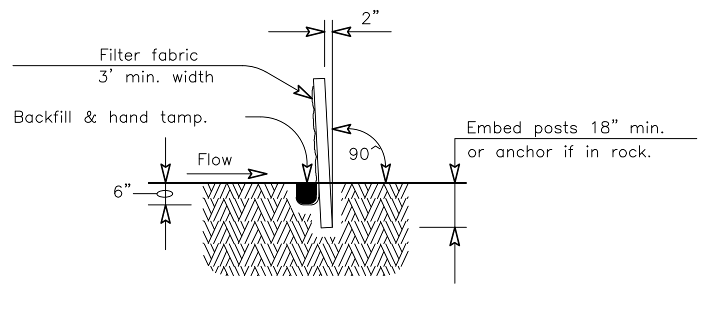
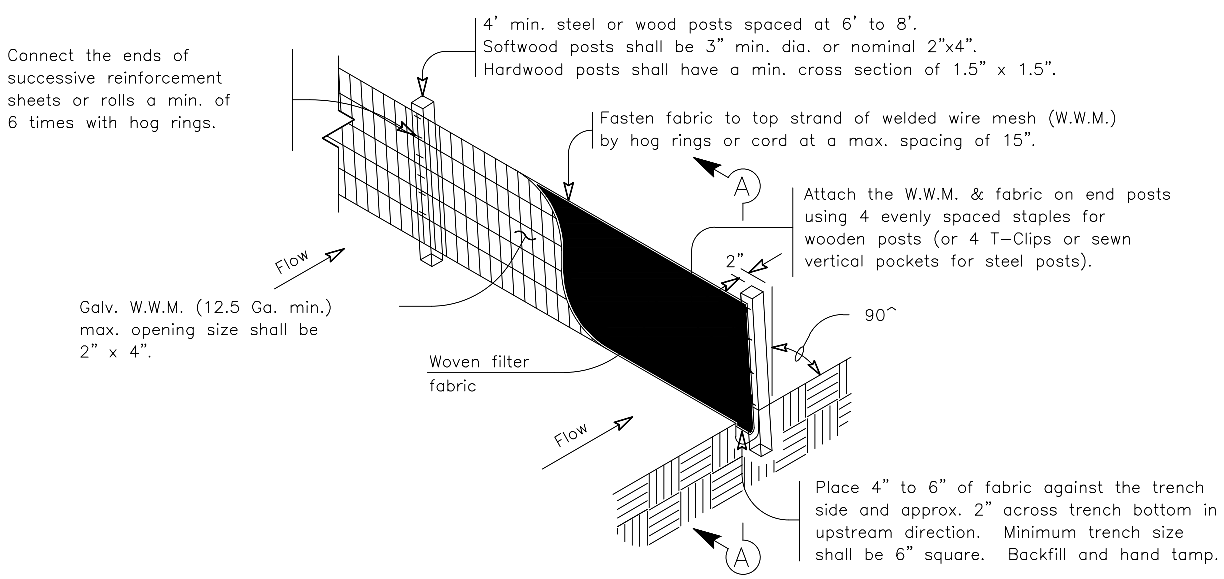
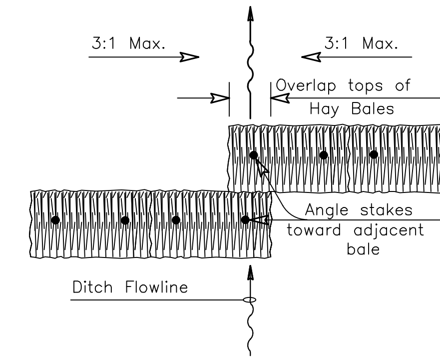


SECTION A–A

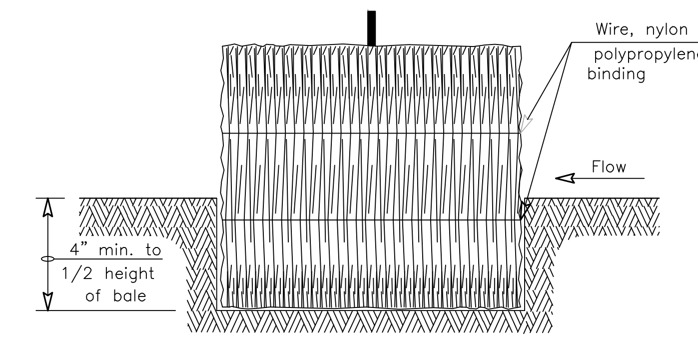


SILT FENCE

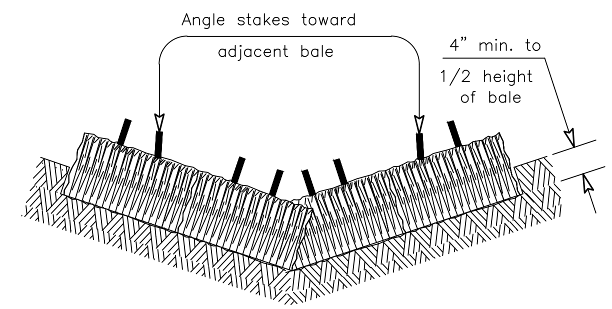
NTS



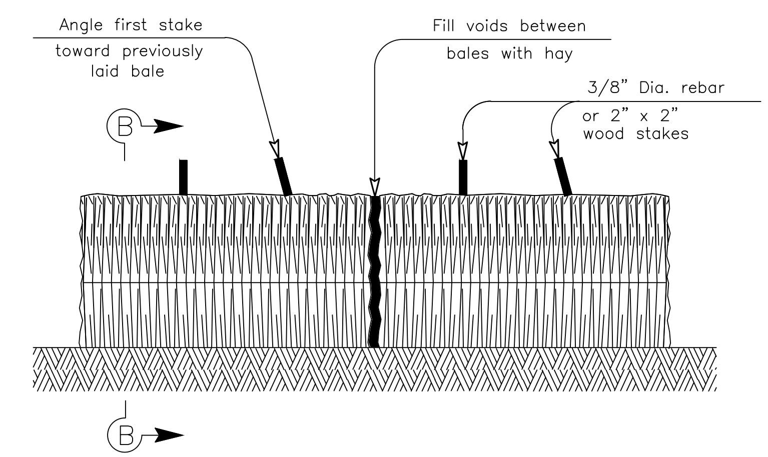
PLAN VIEW



SECTION B–B



PROFILE VIEW



GENERAL NOTES

1. Hay bales shall be a minimum of 30" in length and weigh a minimum of 50 Lbs.
2. Hay bales shall be bound by either wire or nylon or polypropylene string. The bales shall be composed entirely of vegetative matter.
3. Hay bales shall be embedded in the soil a minimum of 4" and where possible 1/2 the height of the bale.
4. Hay bales shall be placed in a row with ends tightly abutting the adjacent bales. The bales shall be placed with bindings parallel to the ground.
5. Hay bales shall be securely anchored in place with 3/8" Dia. rebar or 2" x 2" wood stakes, driven through the bales. The first stake shall be angled towards the previously laid bale to force the bales together.

NOTE:
THESE SPECIFICATIONS ARE REFERENCED FROM TXDOT TEMPORARY EROSION, SEDIMENT AND WATER POLLUTION CONTROL MEASURES, FENCED & BALED HAY, EC(1)–93.

HAY BALES

NTS

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: SPECIFICATIONS FOR SILT FENCES AND HAY BALES

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO.: 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

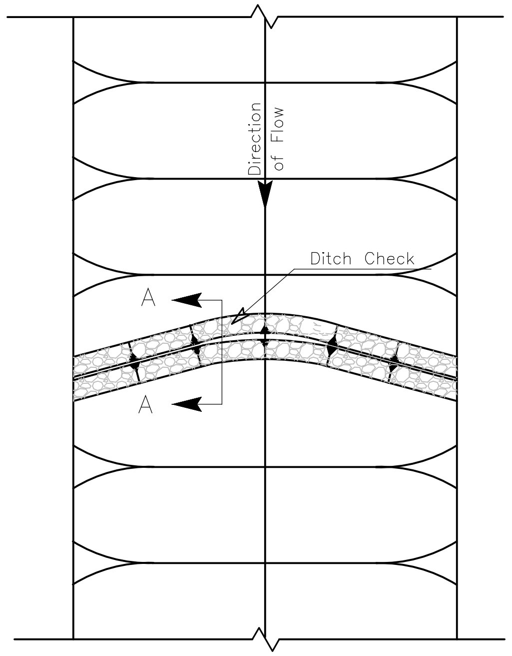
CADD FILE: 6A15 – SILT FENCE

DATE: 04/2020

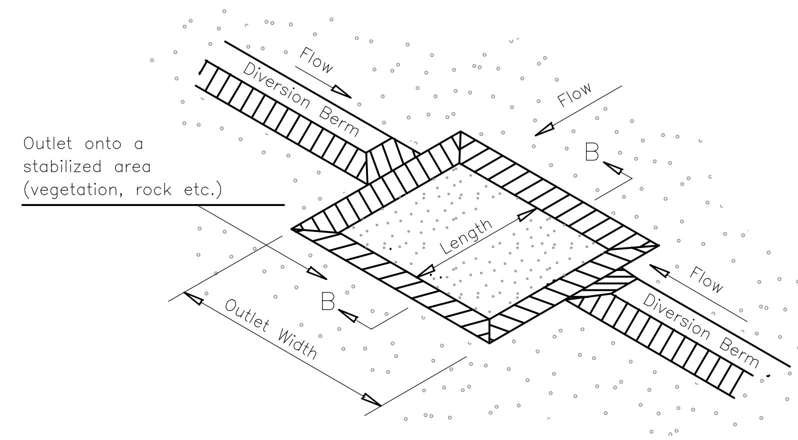
SCALE: AS SHOWN

DRAWING NO. 6A.15

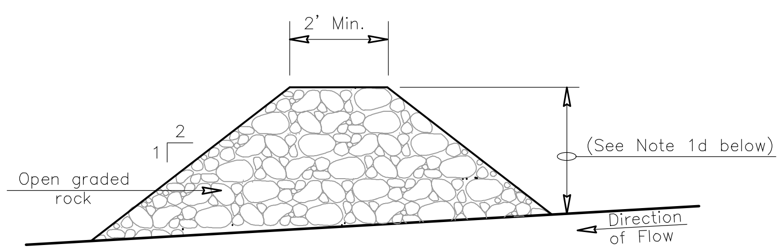
5/11/2020 6:19 PM G:\WACO\16216088.00 T172 - SITE 50 SITING STUDY_Permit Dwgs_DWG_Att 6\6A15 - SILT FENCE



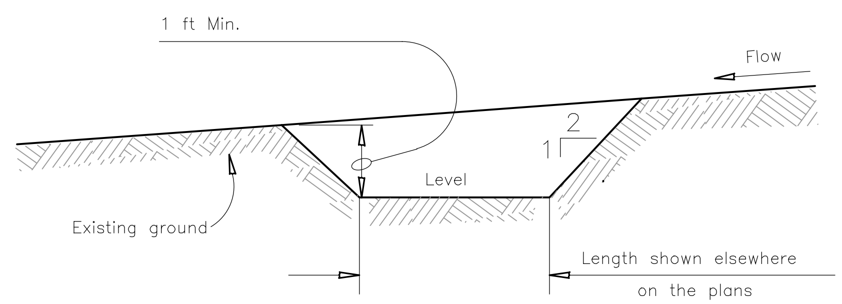
PLAN VIEW



ISOMETRIC VIEW



SECTION A–A



SECTION B–B

Ditch Check Specifications:

1. The drainage area for a ditch check should not exceed 5 acres. When ditch checks are installed, they should be placed as follows:
   a. A non–woven geotextile shall be installed over the soil surface where the ditch check is installed.
   b. The body of the ditch check shall be comprised of 6–inch d50 riprap.
   c. The upstream face of the ditch check shall be comprised of a 1–foot thick layer of 1–inch d50 washed stone.
   d. The height of the ditch check shall be 2–foot below the top of the channel or 2–feet in height, whichever is greater.
   e. The spacing between ditch checks should be such that the toe of the upstream check is at the same elevation as the top of the downstream check.

Sediment Trap Specifications:

1. The drainage area for a sediment trap should not exceed 5 acres The trap capacity should be 1800 CF/Acre (0.5" over the drainage area).

2. When sediment traps are installed, they can be placed in the following locations:
   a. Within drainage ditches spaced @ 500'± on center
   b. Immediately preceding ditch inlets
   c. Just before the drainage enters a water course
   d. Just before the drainage leaves the right of way

3. The trap should be cleaned when the capacity has been reduced by 1/2 or the sediment has accumulated to a depth of 1', whichever is less.

DITCH CHECK
NTS

SEDIMENT TRAP DETAIL
NTS

FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
SPECIFICATIONS FOR SEDIMENT TRAPS AND CHECK DAMS

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DWN. BY: NR | Q/A RVW BY: RRK
DSN. BY: BG/RRK | CHK. BY: BJD | APP. BY: RRK

CADD FILE: 6A16 – EROSION CONTROL
DATE: 04/2020
SCALE: AS SHOWN
DRAWING NO.
6A.16

5/11/2020 6:17 PM G:\WACO\16216088.00 T172 – SITE 50 SITING STUDY_Permit Dwgs_DWG_Att 6\6A16 – EROSION CONTROL

APPENDIX 6A-A

HEC-HMS INPUT PARAMETERS

- Reservoir 19 (Elevation-Area-Discharge Relationship)
- Pre-development Subbasins
- Post-development Subbasins
- Post-development Perimeter Drainage Channels
- Post-Development Detention Basins (Elevation-Area-Discharge Relationships)
- Precipitation Data
- SCS Curve Numbers
- Manning's Coefficients
- Kinematic Wave Method – Roughness Factors

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6A-A-1 to 6A-A-29

RESERVOIR 19
(ELEVATION-AREA-DISCHARGE RELATIONSHIP)

WACO LANDFILL
Elevation-Area-Discharge Relationship
- Reservoir 19 -

Elevation	Area (sf)	Area (acres)	Principal Spillway (Crest at 520.69 - FT. MSL)		Culvert Discharge (Invert at 504.78 ft		Primary Discharge Structure Summary				Emergency Weir/Spillway Discharge Calculations				Total Discharge (cfs)	Use
			Head on Spillway (ft)	[2]Orifice Discharge (cfs)	[1]Weir Discharge (cfs)	Head on Culvert (ft)	[3]Culvert Pipe Discharge (cfs)	Orifice Discharge (cfs)	Weir Discharge (cfs)	Pipe Discharge (cfs)	Discharge (cfs)	Head on Weir (ft) (Crest at 532.74)	Weir Coefficient	Weir Length (ft)	Weir Discharge (cfs) [4]		
520.69	8,313,406	191	0.0	0.00	0.00	15.91	76.74	0.00	0.00	76.74	0.00	0.00	2.60	0.0	0.0	0.0	Pond Pool
522	10,639,173	244	1.3	153.08	38.23	17.22	80.15	153.08	38.23	80.15	38.23	0.00	2.60	0.0	0.0	38.2	Pond Pool
524	13,243,602	304	3.3	243.33	153.56	19.22	85.10	243.33	153.56	85.10	85.10	0.00	2.60	0.0	0.0	85.1	Pond Pool
526	16,171,170	371	5.3	308.20	312.02	21.22	89.77	308.20	312.02	89.77	89.77	0.00	2.60	0.0	0.0	89.8	Pond Pool
528	18,816,883	432	7.3	361.62	503.98	23.22	94.21	361.62	503.98	94.21	94.21	0.00	2.60	0.0	0.0	94.2	Pond Pool
530	22,496,378	516	9.3	408.10	724.38	25.22	98.46	408.10	724.38	98.46	98.46	0.00	2.60	0.0	0.0	98.5	Pond Pool
532	26,446,863	607	11.3	449.80	969.92	27.22	102.52	449.80	969.92	102.52	102.52	0.00	2.60	309.5	0.0	102.5	Pond Pool
532.74	28,340,713	651	12.1	464.28	1066.65	27.96	103.99	464.28	1066.65	103.99	103.99	0.00	2.60	309.5	0.0	104.0	Pond Pool
533	28,784,928	661	12.3	469.27	1101.35	28.22	104.50	469.27	1101.35	104.50	104.50	0.26	2.60	309.5	106.7	211.2	Pond Pool
533.5	29,529,181	678	12.8	478.70	1169.13	28.72	105.47	478.70	1169.13	105.47	105.47	0.76	2.60	309.5	533.2	638.7	Pond Pool
534	35,578,051	817	13.3	487.95	1238.25	29.22	106.43	487.95	1238.25	106.43	106.43	1.26	2.60	309.5	1138.2	1244.6	Pond Pool
535	37,801,737	868	14.3	505.95	1380.38	30.22	108.34	505.95	1380.38	108.34	108.34	2.26	2.60	309.5	2734.2	2842.5	Pond Pool
536	40,175,155	922	15.3	523.33	1527.58	31.22	110.21	523.33	1527.58	110.21	110.21	3.26	2.60	309.5	4736.9	4847.1	Pond Pool

[1] The weir equation was used for culvert discharge when under weir flow conditions and spillway discharge, as defined below:

$$Q = CLH^{1.5} \ (cfs)$$

Where,

C = Weir Coefficient, assumed to be 3.4 (average)
L = Weir Length, ft
H = Hydrostatic Head, ft

$$C = 3.27 + 0.4\ H/W$$

H = Average Head on Spillway (5.9)
W = Height of Culvert (15" - 5')

[2] When under orifice flow conditions, the culvert discharge was calculated using the orifice equation, as defined below:

$$Q = C'A\sqrt{2gH} \ (cfs)$$

Where,

C' = orifice coefficient, assumed to be 0.8
A = cross-sectional area of culvert, ft^2 (30-inch culvert)
g = Gravitational Constant, 32.2 ft^2/s^2
H = Hydrostatic Head, ft

**Reference: Orifice Coefficient came from Design Hydrology and Sedimentology for Small Catchments. Haan, C.T. Academic Press, 1994.*

[3] Spillway Outlet Pipe Equation was used for the Culvert Pipe Discharge
Where,

$$Q_p = A\sqrt{\frac{2gH}{1 + K_e + K_b + K_c L}}$$

$$K_c = \frac{5087\ n^2}{d^{\frac{4}{3}}}$$

Qp = discharge through the principal spillway pipe (cfs)
A = Cross-sectional area of pipe (ft2)
H = Head above center of pipe at the outfall (ft)
Ke = Entrance loss coefficient (1.0)
Kb = Bend loss coefficient (0.5)
Kc = Friction loss coefficient
L = Length of the pipe (ft)

n = Manning's coefficient; and
d= Diameter of the principal spillway pipe (30 inches)

L = 165.1
Ke = 1.0
Kb = 0.5
Kc = 0.008
n = 0.012
d = 30.0 in

**Reference: Manning's coefficent and entrance, friction, and bend coefficients came from Design Hydrology and Sedimentology for Small Catchments. Haan, C.T. Academic Press, 1994.*

[4] Discharge of an overflow spillway is given by the ogee weir equation
Where,

$$Q = C_w L h^{3/2}$$

Q = discharge (cfs)
Cw = coefficient
L = length of the crest (ft)
h = head on the spillway (vertical distance from the crest of the emergency spillway to the reservoir level (ft))

**Reference: Formulas for ogee weir equation and coefficient values came from McGraw-Hill Series in Water Resources and Environmental Engineering. Linsley, Ray K., McGraw-Hill, Inc., 1992.*

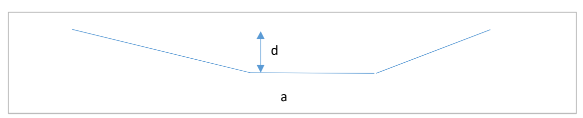
PRE-DEVELOPMENT SUBBASINS

CITY OF WACO LANDFILL
SCS METHOD INPUT PARAMETERS
- PRE-DEVELOPMENT CONDITIONS -

2-yr, 24-hr Rainfall Depth = 4.25 inches

Discharge Study Point	Contributing Drainage Areas	Drainage Areas		Curve Number (CN)	Sheet Flow				Shallow Concentrated Flow				Open Channel Flow								Time of Concentration (Tc)				Total Lag Time
		(acres)	(sq. miles)		Surface Description	Length (feet)	Slope (ft/ft)	Manning n	Surface Description	Length (feet)	Slope (ft/ft)	Avg. Velocity (ft/s)	Surface Description	Length (feet)	Slope (ft/ft)	Manning n	Cross-sectional Area (ft2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Avg. Velocity (ft/s)	Sheet Flow T_c (min)	Shallow Concentrated Flow T_c (min)	Channel Flow T_c (min)	Total T_c (min)	(min)
POD-1	Pre-1	65	0.1022	75.3	Grass	300	0.010	0.15	Grass	1466	0.014	0.8	Grass	2364	0.011	0.027	9.9	14.0	0.7	4.5	27	29	9	65	39
	OS-5	8	0.0131	80.0	Grass	300	0.008	0.15	Grass	2149	0.010	0.7	-	-	-	-	-	-	-	-	29	51	-	81	48
POD-2	Pre-2	16	0.0248	73.0	Grass	300	0.010	0.15	Grass	1026	0.014	0.8	-	-	-	-	-	-	-	-	27	21	-	48	29
POD-3	Pre-3	15	0.0235	73.0	Grass	300	0.023	0.15	Grass	1560	0.014	0.8	-	-	-	-	-	-	-	-	19	32	-	52	31
POD-4	Pre-4	4	0.0056	73.0	Grass	300	0.023	0.15	Grass	172	0.017	0.9	-	-	-	-	-	-	-	-	19	3	-	22	13
POD-5	Pre-5	27	0.0422	73.0	Grass	300	0.020	0.15	Grass	1827	0.011	0.7	Grass	760	0.012	0.027	5.1	10.5	0.5	3.8	20	42	3	65	39
POD-6	Pre-6	3	0.0043	73.0	Grass	300	0.007	0.15	Grass	458	0.009	0.7	-	-	-	-	-	-	-	-	31	12	-	43	26
POD-7	Pre-7	15	0.0233	73.0	Grass	300	0.031	0.15	Grass	1572	0.012	0.8	-	-	-	-	-	-	-	-	17	35	-	52	31
POD-8	Pre-8A	56	0.0873	73.8	Grass	300	0.005	0.15	Grass	-	-	-	Grass	3100	0.001	0.027	22.7	15.3	1.5	2.3	36	-	23	59	35
	Pre-8B	33	0.0510	77.4	Grass	300	0.009	0.15	Grass	991	0.011	0.7	Grass	2723	0.007	0.027	12.2	22.0	0.6	3.2	29	23	14	66	39
	Pre-8C	197	0.3085	73.1	Grass	300	0.007	0.15	Grass	1486	0.024	1.1	Grass	8902	0.001	0.027	46.6	25.0	1.9	3.2	30	23	47	100	60
	Pre-8D	49	0.0770	74.8	Grass	300	0.009	0.15	Grass	1395	0.013	0.8	-	-	-	-	-	-	-	-	28	29	-	57	34
	OS-1	1011	1.5800	79.7	Grass	300	0.013	0.15	Grass	2460	0.013	0.8	Grass	11834	0.006	0.027	137.1	110.4	1.2	5.1	24	52	39	115	69
	OS-2	37	0.0580	80.0	Grass	300	0.017	0.15	Grass	1133	0.016	0.9	Grass	920	0.011	0.027	6.8	9.3	0.7	4.6	22	22	3	47	28
	OS-3	15	0.0233	80.0	Grass	300	0.005	0.15	Grass	611	0.015	0.8	-	-	-	-	-	-	-	-	37	12	-	49	29
	OS-4	6	0.0095	80.0	Grass	198	0.009	0.15	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	20	12
POD-9	Pre-9	2	0.0029	73.0	Grass	300	0.002	0.15	Grass	164	0.004	0.5	-	-	-	-	-	-	-	-	48	6	-	54	33
POD-10	Pre-10A	5	0.0085	80.0	Grass	300	0.032	0.15	Grass	488	0.012	0.8	-	-	-	-	-	-	-	-	17	-	-	17	10
	Pre-10B	9	0.0135	79.6	Grass	300	0.010	0.15	Grass	1216	0.008	0.6	-	-	-	-	-	-	-	-	27	32	-	59	35
POD-11	Pre-11	7	0.0104	80.0	Grass	300	0.015	0.15	Grass	516	0.021	1.0	-	-	-	-	-	-	-	-	23	9	-	31	19

Channel Section:



Total Area = 2.469 sq. miles
Total Area = 1580 acres
Permit Property Total Area = 502 acres

	a (ft)	d (ft)	left slope (%)	right slope (%)	Area (ft2)	Wetted P (ft)	2-year, 24 hour		
PRE-1 Channel Section:	0.63	1.5	22.0	23.0	9.9	14.0	Q2yr :	54.6	cfs
PRE- 5 Channel Section:	3.19	0.8	15.5	31.0	5.1	10.5	Q2 yr:	20.2	cfs
PRE-8A Channel Section:	2.75	2.5	54.0	32.0	22.7	15.3	Q2 yr:	46.2	cfs
PRE-8B Channel Section:	1.21	1.1	15.0	8.2	12.2	22.0	Q2 yr:	29.9	cfs
PRE-8C Channel Section:	4.65	3.2	22.5	50.0	46.6	25.0	Q2 yr:	114.0	cfs
OS-1 Channel Section:	42.00	1.8	7.7	4.0	137.1	110.4	Q2 yr:	710.3	cfs
OS-2 Channel Section:	0.75	1.6	27.1	85.1	6.8	9.3	Q2 yr:	44.6	cfs

Note:

1. Drainage Areas Pre-10A, Pre-10B, and Pre-11 were not included in the HEC-HMS Model, as these areas do not contribute runoff to pre-development "Points of Demonstration" (POD).

Methodology:

Reference: United States Department of Agriculture. Hydrology National Engineering Handbook, Part 630 (May 2010). Chapter 15, Time of Concentration.

Sheet Flow T_c

$$T_t = \frac{0.007(nl)^{0.8}}{(P_2)^{0.5}S^{0.4}} \quad \text{(ep. 15-8)}$$

where:

T_t = travel time, h
n = Manning's roughness coefficient (0.15, short-grass prairie)
l = sheet flow length, ft
P_2 = 2-year, 24-hour rainfall, in (4.25 inches)
S = slope of land surface, ft/ft

Shallow Concentrated Flow T_c

$$V = 6.962\ (s)^{0.5}$$

where:

V = Average velocity, ft/s
s = slope of the hydraulic grade line, ft/ft

(Table 15-3 for Short-grass pasture flow type)

Channel Flow T_c

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \quad \text{(eq. 15-10)}$$

where:

V = Average velocity, ft/s
r = hydraulic radius, ft
$= \frac{a}{P_w}$
a = cross-sectional flow area, ft2
P_w = Wetted perimeter, ft
s = slope of the hydraulic grade line, ft/ft
n = Manning's n value for open channel flow (0.027, grass)

Lag time

$$V = 0.6\ T_c \quad \text{(eq. 15-3)}$$

where:

L = lag, h
T_c = time of concentration, h

CITY OF WACO LANDFILL
SCS METHOD INPUT PARAMETERS
- PRE-DEVELOPMENT CONDITIONS -

Discharge Study Point	Reach	Stream Length (feet)	Y (feet/foot)	Manning's n	Bottom Width (feet)	Side Slope (xH:1V)
POD-1	Pre-1 PW	2364	0.011	0.033	38.9	4.44
POD-8	Pre-8A HC	3400	0.001	0.033	33.0	2.33
POD-8	Pre-8C HC	8902	0.001	0.033	28.8	2.33
POD-8	OS-3 REACH	2039	0.003	0.033	5.0	10.00
POD-10	Pre-10 TK Parkway	1216	0.008	0.033	17.8	0.12

Note:
Manning's "n" used for drainage channels, rip rap or TRM lined, established channels.
Reference: C.T. Haan, B.J. Barfield, J.C. Hayes. Design Hydrology and Sedimentology for Small Catchments. Academic Press. 1994.

POST-DEVELOPMENT SUBBASINS

CITY OF WACO LANDFILL
KINEMATIC WAVE INPUT PARAMETERS
- POST-DEVELOPMENT CONDITIONS -

Discharge Study Point	Contributing Drainage Areas	Drainage Plane			Collector							Main Channel					Area (sq. mi.)	Curve Number (CN)	SCS Method				
		Length	Slope	Roughness	Area	No. of Collectors	Length	Slope	Manning's Coefficient	Width	Sideslope	Length	Slope	Manning's Coefficient	Width	Sideslope			Stream Length	Slope	Manning n	Sheet Flow T_c	Lag Time
		(ft)	(ft/ft)		(sq. mil.)		(ft)	(ft/ft)		(ft)	xH:1V	(ft)	(ft/ft)		(ft)	xH:1V			(ft)	(ft/ft)		(min)	(min)
POD-1	DA-1A	130	0.25	0.15	0.00395	9	847	0.01	0.027	0	3	536	0.25	0.033	15	2	0.0355	85.0	-	-	-	-	-
	DA-1B	189	0.05	0.15	-	-		-	-	-	-	906	0.01	0.027	0	3	0.0055	85.0	-	-	-	-	-
	*DA-1C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0042	85.0	179	0.0100	0.15	17.87	11
	*DA-1D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0023	85.0	138	0.0100	0.15	14.52	9
	**DA-1E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0019	85.0	179	0.2500	0.15	4.92	5
POD-8	DA-2A	130	0.25	0.15	0.00353	8	757	0.01	0.027	0	3	950	0.25	0.033	15	2	0.0282	85.0	-	-	-	-	-
	DA-2B	117	0.05	0.15	-	-	-	-	-	-	-	496	0.01	0.027	0	3	0.0030	85.0	-	-	-	-	-
	DA-3A	130	0.25	0.15	0.00373	10	799	0.01	0.027	0	3	634	0.25	0.033	15	2	0.0373	85.0	-	-	-	-	-
	DA-3B	179	0.05	0.15	-	-	-	-	-	-	-	808	0.01	0.027	0	3	0.0040	85.0	-	-	-	-	-
	DA-3C	130	0.25	0.15	0.00421	10	903	0.01	0.027	0	3	568	0.25	0.033	15	2	0.0421	85.0	-	-	-	-	-
	DA-3D	161	0.05	0.15	-	-	-	-	-	-	-	822	0.01	0.027	0	3	0.0040	85.0	-	-	-	-	-
	DA-3E	130	0.25	0.15	0.00376	9	807	0.01	0.027	0	3	693	0.25	0.033	15	2	0.0339	85.0	-	-	-	-	-
	DA-3F	181	0.05	0.15	-	-	-	-	-	-	-	866	0.01	0.027	0	3	0.0027	85.0	-	-	-	-	-
	DA-4A	130	0.25	0.15	0.00375	8	804	0.01	0.027	0	3	438	0.25	0.033	15	2	0.0300	85.0	-	-	-	-	-
	DA-4B	236	0.05	0.15	-	-	-	-	-	-	-	566	0.01	0.027	0	3	0.0050	85.0	-	-	-	-	-
	DA-4C	130	0.25	0.15	0.00324	6	694	0.01	0.027	0	3	387	0.25	0.033	15	2	0.0194	85.0	-	-	-	-	-
	DA-4D	218	0.05	0.15	-	-	-	-	-	-	-	368	0.01	0.027	0	3	0.0027	85.0	-	-	-	-	-
	*DA-4E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0047	85.0	104	0.0100	0.15	11.54	7
	DA-5A	130	0.25	0.15	0.00484	7	1038	0.01	0.027	0	3	844	0.25	0.033	15	2	0.0379	85.0	-	-	-	-	-
	DA-5B	176	0.05	0.15	-	-	-	-	-	-	-	554	0.01	0.027	0	3	0.0036	85.0	-	-	-	-	-
	DA-5C	130	0.25	0.15	0.00199	5	427	0.01	0.027	0	3	370	0.25	0.033	15	2	0.0099	85.0	-	-	-	-	-
	DA-5D	242	0.05	0.15	-	-	-	-	-	-	-	491	0.01	0.027	0	3	0.0048	85.0	-	-	-	-	-
	*DA-5E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0033	85.0	96	0.0100	0.15	10.87	7

Total Area = 0.33 sq. miles
Waste Diposal Total Area = 207 acres

Note:
1. *, Drainage areas indicated with an asterisk, include areas modeled using the Velocity method, as described in Attachment 6A, Section 2.2.
1. **, Drainage area DA-1E indicated with two asterisks, open channel was included into lag time calculation.

Open Channel Flow								
Surface Description	Length	Slope (ft/ft)	Manning n	Cross-sectional Area	Wetted Perimeter	Hydraulic Radius	Avg. Velocity	Channel Flow T_c
	(feet)	(ft/ft)		(ft2)	(ft)	(ft)	(ft/s)	(min)
Grass	1006	0.013	0.027	5.8	9.0	0.6	4.6	4

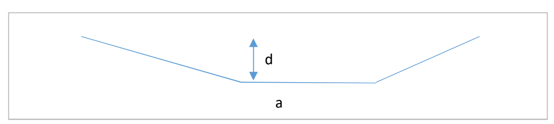
	a (ft)	d (ft)	left slope (%)	right slope (%)	Area (ft2)	Wetted P (ft)
DA-1E	2.85	1.0	32.0	37.0	5.8	9.0

CITY OF WACO LANDFILL
VELOCITY METHOD INPUT PARAMETERS
- POST-DEVELOPMENT CONDITIONS -

2-yr, 24-hr Rainfall Depth = 4.25 imches

				Sheet Flow				Shallow Concentrated Flow				Open Channel Flow								Time of Concentration (Tc)				
Discharge Study Point	Contributing Drainage Areas	Area (sq. mi.)	Curve Number (CN)	Surface Description	Length	Slope	Manning n	Surface Description	Length	Slope	Avg. Velocity	Surface Description	Length	Slope (ft/ft)	Manning n	Cross-sectional Area	Wetted Perimeter	Hydraulic Radius	Avg. Velocity	Sheet Flow T_c	Shallow Concentrated Flow T_c	Channel Flow T_c	Total T_c	Total Lag Time
					(feet)	(ft/ft)			(feet)	(ft/ft)	(ft/s)		(feet)	(ft/ft)		(ft2)	(ft)	(ft)	(ft/s)	(min)	(min)	(min)	(min)	(min)
POD-1	PRE-1R	0.0149	74.7	Grass	262	0.021	0.15	-	-	-	-	Grass	472	0.028	0.027	5.8	9.0	0.6	6.9	18	-	1	19	11
	OS-5	0.0131	80.0	Grass	300	0.008	0.15	Grass	2149	0.010	0.7	-	-	-	-	-	-	-	-	29	51	-	81	48
	EDA East	0.0030	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
POD-2	PRE-2R	0.0086	73.0	Grass	300	0.009	0.15	-	-	-	-	-	-	-	-	-	-	-	-	28	-	-	28	17
POD-3 & 4	PRE-3R	0.0207	73.0	Grass	300	0.014	0.15	Grass	1045	0.014	0.8	-	-	-	-	-	-	-	-	24	21	-	45	27
	PRE-4R	0.0056	73.0	Grass	300	0.013	0.15	Grass	172	0.017	0.9	-	-	-	-	-	-	-	-	24	3	-	27	16
POD-5 & 6	PRE-5R	0.0352	73.0	Grass	300	0.017	0.15	Grass	1287	0.017	0.9	Grass	760	0.013	0.027	5.1	10.5	0.5	3.8	22	24	3	49	29
	PRE-6R	0.0043	73.0	Grass	300	0.007	0.15	Grass	458	0.009	0.7	-	-	-	-	-	-	-	-	31	12	-	43	26
POD-7	PRE-7R	0.0223	73.0	Grass	300	0.028	0.15	Grass	1375	0.010	0.7	-	-	-	-	-	-	-	-	18	33	-	51	30
POD-8	PRE-8ABR	0.0847	73.8	Grass	300	0.005	0.15	Grass	-	-	-	Grass	3100	0.001	0.027	22.7	15.3	1.5	2.3	36	-	23	59	35
	PRE-8CR	0.1898	73.1	-	-	-	-	Grass	613	0.018	0.9	Grass	8832	0.001	0.027	40.6	24.3	1.7	2.9	-	11	51	62	37
	PRE-8DR	0.0312	73.7	Grass	300	0.010	0.15	Grass	1466	0.012	0.8	-	-	-	-	-	-	-	-	27	32	-	59	35
	OS-1	1.5800	79.7	Grass	300	0.013	0.15	Grass	2460	0.013	0.8	Grass	11834	0.006	0.027	137.1	110.4	1.2	5.1	24	52	39	115	69
	OS-2	0.0580	80.0	Grass	300	0.017	0.15	Grass	1133	0.016	0.9	Grass	920	0.011	0.027	6.8	9.3	0.7	4.6	22	22	3	47	28
	OS-3	0.0233	80.0	Grass	300	0.005	0.15	Grass	611	0.015	0.8	-	-	-	-	-	-	-	-	37	12	-	49	29
	EDA WEST	0.0120	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	WDA	0.0100	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
POD-9	PRE-9R	0.0029	73.0	Grass	300	0.002	0.15	Grass	164	0.004	0.5	-	-	-	-	-	-	-	-	48	6	-	54	33
POD-10	PRE-10AR	0.0016	80.0	Grass	300	0.014	0.15	Grass	678	0.008	0.6	-	-	-	-	-	-	-	-	23	18	-	42	25
	PRE-10BR	0.0029	80.0	Grass	300	0.007	0.15	Grass	946	0.009	0.7	-	-	-	-	-	-	-	-	32	23	-	55	33
POD-11	PRE-11R	0.0100	80.0	Grass	300	0.015	0.15	Grass	516	0.021	1.0	-	-	-	-	-	-	-	-	23	9	-	31	19

Channel Section:



Total Area = 2.14 sq. miles
Total Area = 1372 acres
Permit Property Total Area = 292 acres

	a (ft)	d (ft)	left slope (%)	right slope (%)	Area (ft2)	Wetted P (ft)	2-year, 24 hour		
PRE-1R Channel Section:	2.85	1.0	32.0	37.0	5.8	9.0	Q2yr :	16.9	cfs
PRE-5R Channel Section:	3.19	0.8	15.5	31.0	5.1	10.5	Q2yr:	16.2	cfs
PRE-8ABR Channel Section:	2.75	2.5	54.0	32.0	22.7	15.3	Q2 yr:	44.2	cfs
PRE-8CR Channel Section:	4.65	2.9	22.5	50.0	40.6	24.3	Q2 yr:	94.5	cfs
OS-1 Channel Section:	42.00	1.8	7.7	4.0	137.1	110.4	Q2 yr:	710.3	cfs
OS-2 Channel Section:	0.75	1.6	27.1	85.1	6.8	9.3	Q2 yr:	44.6	cfs

Note:

1. Drainage Areas Pre-10A, Pre-10B, and Pre-11 were not included in the HEC-HMS Model due to the following: (1) these areas will not be disturbed during development of the landfill; and (2) these areas due not contribute run-on/runoff to the post-development perimeter drainage

Methodology:

Reference: United States Department of Agriculture. Hydrology National Engineering Handbook, Part 630 (May 2010). Chapter 15, Time of Concentration.

Sheet Flow T_c

$$T_t = \frac{0.007(nl)^{0.8}}{(P_2)^{0.5}S^{0.4}} \quad \text{(eq. 15-8)}$$

where:

T_t = travel time, h
n = Manning's roughness coefficient (0.15, short-grass prairie)
l = sheet flow length, ft
P_2 = 2-year, 24-hour rainfall, in (4.25 inches)
S = slope of land surface, ft/ft

Shallow Concentrated Flow T_c

$$V = 6.962\,(s)^{0.5}$$

where:

V = Average velocity, ft/s
s = slope of the hydraulic grade line, ft/ft

(Table 15-3 for Short-grass pasture flow type)

Channel Flow T_c

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \quad \text{(eq. 15-10)}$$

where:

V = Average velocity, ft/s
r = hydraulic radius, ft $= \frac{a}{P_w}$
a = cross-sectional flow area, ft2
P_w = Wetted perimeter, ft
s = slope of the hydraulic grade line, ft/ft
n = Manning's n value for open channel flow (0.027, grass)

Lag time

$$V = 0.6\,T_c \quad \text{(eq. 15-3)}$$

where:

L = lag, h
T_c = time of concentration, h

POST-DEVELOPMENT PERIMETER DRAINAGE CHANNELS

KINEMATIC WAVE INPUT PARAMETERS

- POST-DEVELOPMENT CONDITIONS -

Channel Name	Receiving Basin	Receiving POD	Channel Length (ft)	Bottom Slope (ft/ft)	Bottom Width (ft)	Sideslope (XH:1V)	Depth (ft)	Mannings Coefficient	Lining Material
1A1	EDA EAST BASIN	POD 1	404	0.0100	5	3	2.00	0.027	Grass
1A2	EDA EAST BASIN	POD 1	1,274	0.0080	5	3	2.00	0.027	Grass
1A3	EDA EAST BASIN	POD 1	348	0.0025	10	3	3.50	0.027	Grass
1A4	EDA EAST BASIN	POD 1	711	0.0220	10	3	3.00	0.033	TRM/Rip Rap
2A1	EDA WEST BASIN	POD 8	223	0.0225	10	3	2.25	0.033	TRM/Rip Rap
2A2	EDA WEST BASIN	POD 8	818	0.0070	10	3	3.00	0.027	Grass
2A3	EDA WEST BASIN	POD 8	762	0.0225	10	3	3.00	0.033	TRM/Rip Rap
2A4	EDA WEST BASIN	POD 8	1,159	0.0025	10	3	3.00	0.027	Grass
2A5	EDA WEST BASIN	POD 8	852	0.0025	10	3	4.05	0.027	Grass
3A1	EDA WEST BASIN	POD 8	2,037	0.0025	10	3	3.20	0.027	Grass
4A1	WDA BASIN	POD 8	434	0.0025	5	3	2.00	0.027	Grass
4A2	WDA BASIN	POD 8	416	0.0300	5	3	2.00	0.027	Grass
4A3	WDA BASIN	POD 8	338	0.0150	10	3	2.30	0.033	TRM/Rip Rap
4A4	WDA BASIN	POD 8	1,636	0.0060	10	3	2.50	0.027	Grass
4A5	WDA BASIN	POD 8	240	0.0025	10	3	3.00	0.027	Grass
4B1	WDA BASIN	POD 8	448	0.0060	5	3	2.00	0.027	Grass
4B2	WDA BASIN	POD 8	104	0.0190	5	3	2.00	0.027	Grass
4B3	WDA BASIN	POD 8	714	0.0070	10	3	2.20	0.027	Grass
4B4	WDA BASIN	POD 8	341	0.0100	10	3	2.20	0.027	Grass
4B5	WDA BASIN	POD 8	699	0.0065	10	3	2.23	0.027	Grass
4B6	WDA BASIN	POD 8	495	0.0100	10	3	2.20	0.027	Grass
4B7	WDA BASIN	POD 8	245	0.0100	10	3	3.70	0.033	TRM/Rip Rap
4B8	WDA BASIN	POD 8	1,406	0.0025	11	3	3.74	0.027	Grass

Note: TRM = Turf Reinforcing Mat, a permanent reinforcing mat placed below vegetation layer to increase resistance to erosion.

POST-DEVELOPMENT DETENTION BASINS
(ELEVATION-AREA-DISCHARGE RELATIONSHIPS)

CITY OF WACO LANDFILL
Elevation-Area-Discharge Relationship
- EDA East Basin -

Elevation	Area (sf)	Area (acres)	Head on Weep Holes (Ft)	Head on Weir (ft)	Weir Coefficient	Weir Length (ft)	Weir Discharge (cfs) [1]	Weep Hole Discharge (cfs) [2]	Total Discharge (cfs)	Use
534	49,514.68	1.14	0.0	0.0	3.1	10.0	0.0	0.0	0.0	Basin Pool
535	52,966.87	1.22	1.0	0.0	3.1	10.0	0.0	2.8	2.8	Sediment Control
536	56,478.70	1.30	2.0	0.5	3.1	10.0	11.0	4.0	14.9	Sediment Control
537	60,011.74	1.38	3.0	1.5	3.1	10.0	57.0	4.9	61.8	Basin Pool
538	63,558.26	1.46	4.0	2.5	3.1	10.0	122.5	5.6	128.1	Basin Pool
539	67,204.19	1.54	5.0	3.5	3.1	10.0	203.0	6.3	209.2	Free Board
540	70,951.57	1.63	6.0	4.5	3.1	10.0	295.9	6.9	302.8	Free Board

[1] Weir discharge was calculated using the weir equation, as defined below:

$$Q = CLH^{1.5} \ (cfs)$$

Where,

C = Weir Coefficient, assumed to be 3.1 (average)
L = Weir Length, ft
H = Hydrostatic Head, ft

[2] Weep hole discharge was calculated using the orifice equation for 4-inch diameter weep holes, as defined below:

$$Q = NC'A\sqrt{2gH} \ (cfs)$$

Where,

N = number of weep holes, half the weir length
C' = orifice coefficient, assumed to be 0.8
A = cross-sectional area of one hole, ft^2
g = Gravitational Constant, 32.2 ft^2/s^2
H = Hydrostatic Head, ft

CITY OF WACO LANDFILL
Elevation-Area-Discharge Relationship
- EDA West Basin -

Elevation	Area (sf)	Area (acres)	Head on Weep Holes (Ft)	Head on Weir (ft)	Weir Coefficien t	Weir Length (ft)	Weir Discharge (cfs) [1]	Weep Hole Discharge (cfs) [2]	Total Discharge (cfs)	Use
530	238,888	5.48	0.0	0.0	3.1	7.0	0.0	0.0	0.0	Basin Pool
531	249,024	5.72	0.5	0.0	3.1	7.0	0.0	1.4	1.4	Sediment Control
532	259,232	5.95	1.5	0.0	3.1	7.0	0.0	2.4	2.4	Sediment Control
533	269,512	6.19	2.5	0.0	3.1	7.0	0.0	3.1	3.1	Basin Pool
534	279,864	6.42	3.5	0.0	3.1	7.0	0.0	3.7	3.7	Basin Pool
535	290,287	6.66	4.5	0.5	3.1	7.0	7.7	4.2	11.8	Basin Pool
536	300,782	6.91	5.5	1.5	3.1	7.0	39.9	4.6	44.5	Basin Pool
537	311,349	7.15	6.5	2.5	3.1	7.0	85.8	5.0	90.8	Free Board

[1] Weir discharge was calculated using the weir equation, as defined below:

$$Q = CLH^{1.5} \ (cfs)$$

Where,

C = Weir Coefficient, assumed to be 3.1 (average)
L = Weir Length, ft
H = Hydrostatic Head, ft

[2] Weep hole discharge was calculated using the orifice equation for 4-inch diameter weep holes, as defined below:

$$Q = NC'A\sqrt{2gH} \ (cfs)$$

Where,

N = number of weep holes, half the weir length
C' = orifice coefficient, assumed to be 0.8
A = cross-sectional area of one hole, ft^2
g = Gravitational Constant, 32.2 ft^2/s^2
H = Hydrostatic Head, ft

CITY OF WACO LANDFILL
Elevation-Area-Discharge Relationship
- WDA Basin -

Elevation	Area (sf)	Area (acres)	Head on Culvert (ft)	Culvert Pipe Discharge (cfs)	Number of Culverts	Total Discharge (cfs)	Use
531	227,807	5.2	0.0	0.00	2.00	0.0	Basin Invert
532	234,065	5.4	0.0	0.00	2.00	0.0	Sediment Control
533	240,371	5.5	0.0	0.00	2.00	0.0	Basin Pool
534	246,752	5.7	0.0	0.00	2.00	0.0	Basin Pool
535	253,209	5.8	0.5	0.00	2.00	0.0	Basin Pool
536	259,740	6.0	1.5	7.72	2.00	15.4	Basin Pool
537	266,346	6.1	2.5	13.85	2.00	27.7	Basin Pool
538	273,028	6.3	3.5	18.00	2.00	36.0	Free Board

Spillway Outlet Pipe Equation was used for the Culvert Pipe Discharge
Where,

$$Q_p = A\sqrt{\frac{2gH}{1 + K_e + K_b + K_c L}}$$

Qp = discharge through the principal spillway pipe (cfs)
A = Cross-sectional area of pipe (ft2)
H = Head above center of pipe at the outfall (ft)
Ke = Entrance loss coefficient (1.0)
Kb = Bend loss coefficient (0.5)
Kc = Friction loss coefficient
L = Length of the pipe (ft)

$$K_c = \frac{5087\, n^2}{d^{\frac{4}{3}}}$$

n = Manning's coefficient; and
d= Diameter of the principal spillway pipe (30 inches)

L =	25.0	
Ke =	1.0	
Kb =	0.5	
Kc =	0.013	
n =	0.012	
d =	21.0	in

**Reference: Manning's coefficent and entrance, friction, and bend coefficients came from Design Hydrology and Sedimentology for Small Catchments. H Academic Press, 1994.*

PRECIPITATION DATA

Design Hydrology and Sedimentology for Small Catchments

C. T. Haan
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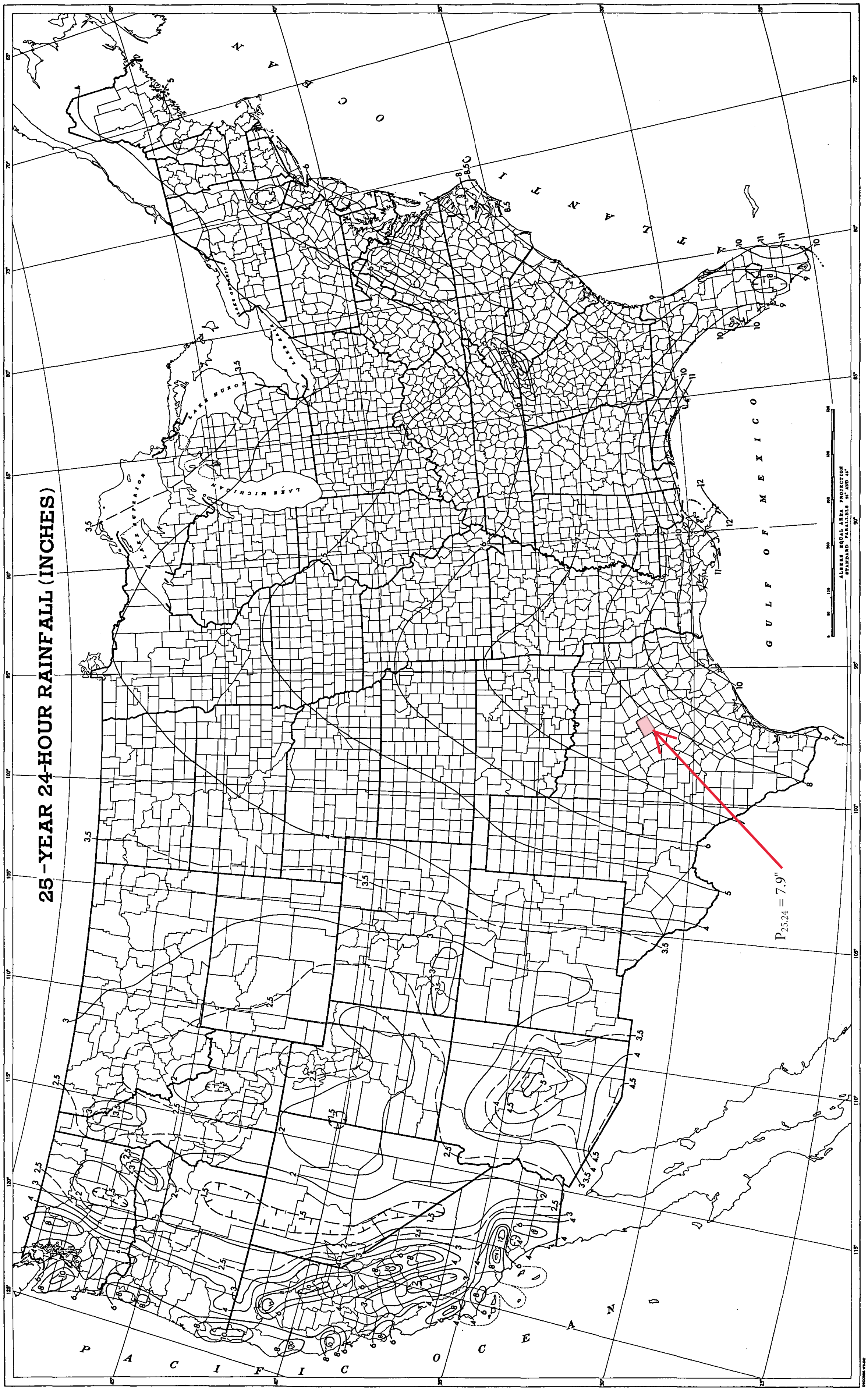
Academic Press
An Imprint of Elsevier
Amsterdam Boston Heidelberg London New York Oxford
Paris San Diego San Francisco Singapore Sydney Tokyo


25-YEAR 24-HOUR RAINFALL (INCHES)
P25,24 = 7.9"
ATLANTIC OCEAN
GULF OF MEXICO
PACIFIC OCEAN
54

SCS CURVE NUMBERS

Urban Hydrology for Small Watersheds

TR-55

United States Department of Agriculture

Natural Resources Conservation Service

Conservation Engineering Division

Technical Release 55

June 1986

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Post Development CN = 85

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Pre-Development

	Cover description		Curve numbers for hydrologic soil group			
	Cover type	Hydrologic condition	A	B	C	D
1	Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
2	Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
		Fair	35	56	70	77
		Good	30 [4/]	48	65	73
	Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79
	Woods. [6/]	Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30 [4/]	55	70	77
	Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

MANNING'S COEFFICIENTS

Waco Texas Landfill
Hydraulic Analysis
Manning's "n" References

Pre-development Conditions

Description	Use	Reference	Mannings "n"
Natural winding streams and creeks.	HEC-HMS Kinematic Wave Method (main channel).	See Item 1, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.040
Shallow preferential flow paths or ditches, i.e., channel not well defined.	HEC-HMS Kinematic Wave Method (main channel).	See Item 2, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.030
Straight man-made road side ditches, established channels.	HEC-HMS Kinematic Wave Method (main channel).	See Item 3, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.027

Post-development Conditions

Description	Use	Reference	Mannings "n"
Drainage swales, short grass and some weeds, established channels.	HEC-HMS Kinematic Wave Method model (collector or main channel).	See Item 3, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.027
Downchutes, gabion or rip rap lined, established channels.	HEC-HMS Kinematic Wave Method model (main channel)..	HydroCalc standard default for built-up channels with rip rap.	0.033
Drainage Channels, short grass and some weeds, established channels	HEC-HMS Muskingum-Cunge Standard model for routing reaches.	See Item 3, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.027
Drainage Channels, rip rap or TRM lined, established channels.	HEC-HMS Muskingum-Cunge Standard model for routing reaches.	HydroCalc standard default for built-up channels with rip rap.	0.033
CMP channel or detention basin outlet structures	HydroCalc calculations for CMPs.	Standard default in HydroCalc program for CMP.	0.024

Note: Manning's "n" used for drainage swales, downchutes, and culverts were incorporated into HEC-HMS, as well as the Hydraulic Analysis using HydroCalc.

Reference: C.T. Haan, B.J. Barfield, J.C. Hayes. Design Hydrology and Sedimentology for Small Catchments. Academic Press. 1994.

Design Hydrology and Sedimentology for Small Catchments

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An Irish engineer named Manning found that the equation

$$v = KR^{2/3}S^{1/2}$$

fit experimental data quite nicely. This equation is known as Manning's equation and differs from Chezy's equation only in the exponent on R. So that the factor related to the channel roughness would increase as roughness increased, Manning's equation is generally written as

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

in the metric system with v in meters per second and R in meters. The coefficient n is known as Manning's n. In the English system of units, Manning's equation is

$$v = \frac{1.49}{n}R^{2/3}S^{1/2}, \qquad (4.23)$$

where v is in fps, R is in feet, and S is in feet per foot. Tables of Manning's n are widely available. Table 4.1 is such a table taken from several sources, drawing heavily on Schwab *et al.* (1966, 1971). Manning's n is influenced by many factors, including the physical roughness of the channel surface, the irregularity of the channel cross section, channel alignment and bends, vegetation, silting and scouring, and obstruction within the channel. Chow (1959) displays some photographs of typical channels and the associated values for Manning's n.

Figure 4.9 contains some useful relationships for calculating the hydraulic properties of A, P, R, and top width, T, for three common channels. For natural channels, these properties are best determined from measurements based on the actual cross sections of the channel.

Table 4.1 Typical Values for Manning's n

Type and description of conduits	n Values[a]		
	Min.	Design	Max.
Channels, lined			
Asphaltic concrete, machine placed		0.014	
Asphalt, exposed prefabricated		0.015	
Concrete	0.012	0.015	0.018
Concrete, rubble	0.016		0.029
Metal, smooth (flumes)	0.011		0.015
Metal, corrugated	0.021	0.024	0.026
Plastic	0.012		0.014
Shotcrete	0.016		0.017
Wood, planed (flumes)	0.009	0.012	0.016
Wood, unplaned (flumes)	0.011	0.013	0.015
Channels, earth			
Earth bottom, rubble sides	0.028	0.032	0.035
Drainage ditches, large, no vegetation			
(a) < 2.5 hydraulic radius	0.040		0.045
(b) 2.5–4.0 hydraulic radius	0.035		0.040
(c) 4.0–5.0 hydraulic radius	0.030		0.035
(d) > 5.0 hydraulic radius	0.025		0.030
Small drainage ditches	0.035	0.040	0.040
Stony bed, weeds on bank	0.025	0.035	0.040
Straight and uniform	0.017	0.0225	0.025
Winding, sluggish	0.0225	0.025	0.030
Channels, vegetated			
(See subsequent discussion)			

Type and description of conduits	n Values[a]		
	Min.	Design	Max.
Natural Streams			
3 (a) Clean, straight bank, full stage, no rifts or deep pools	0.025	0.027	0.033
2 (b) Same as (a) but some weeds and stones	0.030		0.040
1 (c) Winding, some pools and shoals, clean	0.035	0.040	0.050
(d) Same as (c), lower stages, more ineffective slopes and sections	0.040		0.055
(e) Same as (c), some weeds and stones	0.033		0.045
(f) Same as (d), stony sections	0.045		0.060
(g) Sluggish river reaches, rather weedy or with very deep pools	0.050		0.080
(h) Very weedy reaches	0.075		0.150
Pipe			
Asbestos cement		0.009	
Cast iron, coated	0.011	0.013	0.014
Cast iron, uncoated	0.012		0.015
Clay or concrete drain tile (4–12 in.)	0.010	0.0108	0.020
Concrete	0.010	0.014	0.017
Metal, corrugated	0.021	0.025	0.0255
Steel, riveted and spiral	0.013	0.016	0.017
Vitrified sewer pipe	0.010	0.014	0.017
Wood stave	0.010	0.013	
Wrought iron, black	0.012		0.015
Wrought iron, galvanized	0.013	0.016	0.017

[a] Selected from numerous sources.

KINEMATIC WAVE METHOD – ROUGHNESS FACTORS

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Conservation
Engineering
Division

Technical
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Urban Hydrology for Small Watersheds

TR-55

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Post-Development, landfill final cover
Grass: Short grass prairie n = 0.15 Post-Development, landfill final cover.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}s^{0.4}} \quad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

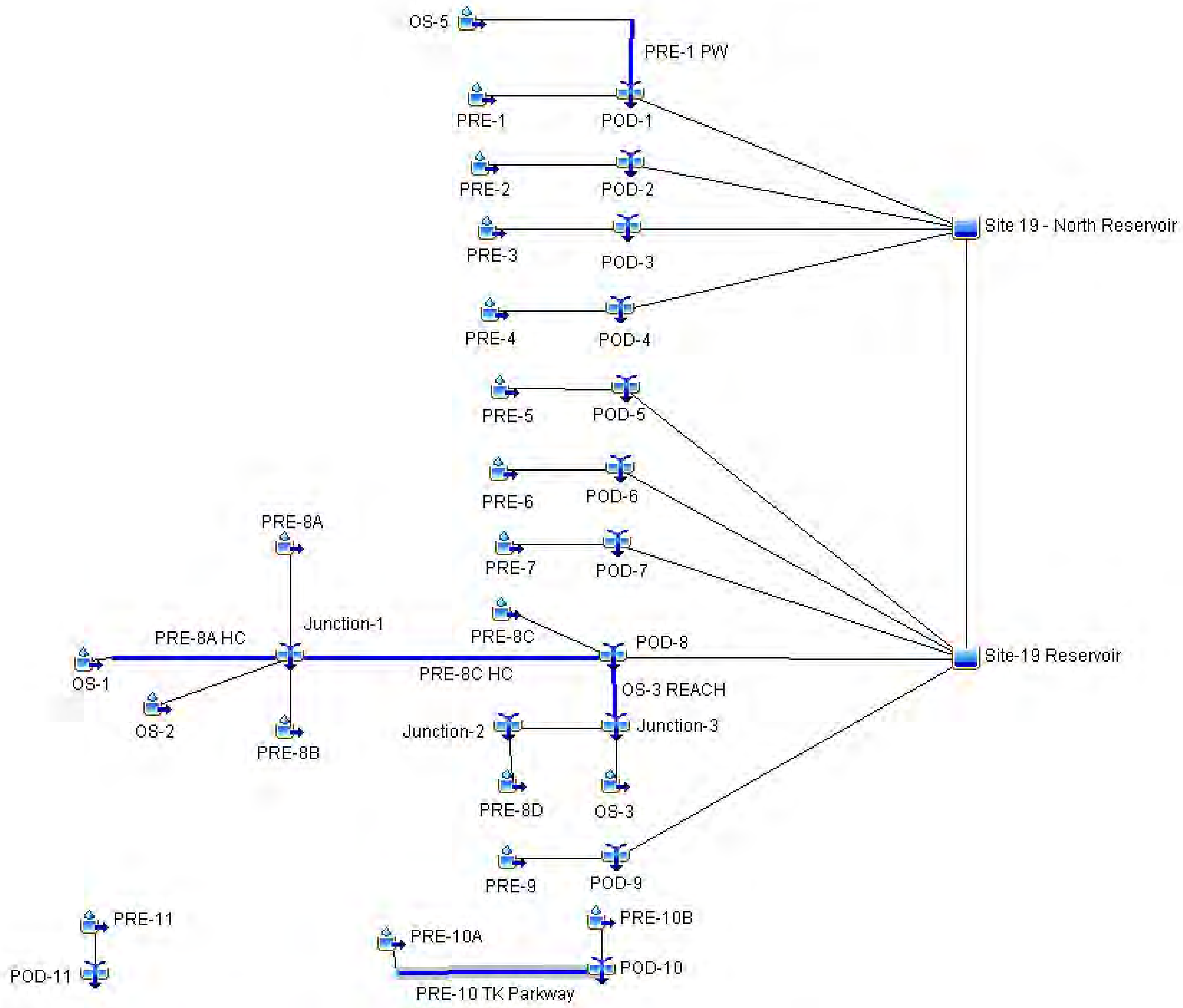
APPENDIX 6A-B

HEC-HMS PRE-DEVELOPMENT INPUT/OUTPUT FILES

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6A-B-1 to 6A-B-61

BLOSSOM PRAIRIE LANDFILL
HEC-HMS INPUT SCHEMATIC
PRE-DEVELOPMENT CONDITIONS



PRE-DEVELOPMENT INPUT FILES

```
Basin: PRE-DEVELOPMENT
     Description: WACO LANDFILL
     Last Modified Date: 7 April 2020
     Last Modified Time: 03:22:44
     Version: 4.0
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: OS-1
     Canvas X: -6043.995437291279
     Canvas Y: -844.4490044262448
     Label X: -25.0
     Label Y: -19.0
     Area: 1.58
     Downstream: PRE-8A HC

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79.7

     Transform: SCS
     Lag: 69
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: PRE-8A HC
     Canvas X: -4112.935085015774
     Canvas Y: -816.6639633863088
     From Canvas X: -5828.634848187532
     From Canvas Y: -829.6210936695293
     Label X: -45.0
     Label Y: 11.0
     Downstream: Junction-1

     Route: Muskingum Cunge
```

```
     Channel: Trapezoid
     Length: 3400
     Energy Slope: 0.001
     Width: 33
     Side Slope: 2.33
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: PRE-8A
     Canvas X: -4112.935085015774
     Canvas Y: 280.8451576911357
     Label X: -33.0
     Label Y: 13.0
     Area: 0.0873
     Downstream: Junction-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.8

     Transform: SCS
     Lag: 35
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: OS-2
     Canvas X: -5388.486632319504
     Canvas Y: -1278.7112608447533
     Label X: -29.0
     Label Y: -21.0
     Area: 0.058
     Downstream: Junction-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80
```

```
     Transform: SCS
     Lag: 28
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: PRE-8B
     Canvas X: -4112.935085015774
     Canvas Y: -1497.397468864724
     Label X: -36.0
     Label Y: -20.0
     Area: 0.0510
     Downstream: Junction-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 77.4

     Transform: SCS
     Lag: 39
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-1
     Canvas X: -4112.935085015774
     Canvas Y: -816.6639633863088
     Label X: -3.0
     Label Y: 21.0
     Downstream: PRE-8C HC
End:

Reach: PRE-8C HC
     Canvas X: -975.2120183559127
     Canvas Y: -823.8327427273098
     From Canvas X: -4112.935085015774
     From Canvas Y: -816.6639633863088
     Label X: -35.0
     Label Y: -14.0
     Downstream: POD-8

     Route: Muskingum Cunge
```

```
     Channel: Trapezoid
     Length: 8902
     Energy Slope: 0.001
     Width: 28.8
     Side Slope: 2.33
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: PRE-8C
     Canvas X: -2006.566227205818
     Canvas Y: -369.4213406019235
     Label X: -38.0
     Label Y: -21.0
     Area: 0.3085
     Downstream: POD-8

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.1

     Transform: SCS
     Lag: 60
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: PRE-8D
     Canvas X: -1958.708862982512
     Canvas Y: -2028.4766336765624
     Label X: -36.0
     Label Y: -22.0
     Area: 0.0770
     Downstream: Junction-2

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 74.8
```

```
     Transform: SCS
     Lag: 34
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-2
     Canvas X: -1990.613772464716
     Canvas Y: -1502.0456272201864
     Label X: -86.0
     Label Y: -5.0
     Downstream: Junction-3
End:

Subbasin: OS-3
     Canvas X: -953.7042142930677
     Canvas Y: -2028.4766336765624
     Label X: -28.0
     Label Y: -23.0
     Area: 0.024
     Downstream: Junction-3

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 29
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-3
     Canvas X: -953.7042142930677
     Canvas Y: -1502.0456272201864
     Label X: 2.0
     Label Y: -1.0
     Downstream: OS-3 REACH
End:

Reach: OS-3 REACH
     Canvas X: -975.2120183559127
```

```
     Canvas Y: -823.8327427273098
     From Canvas X: -953.7042142930677
     From Canvas Y: -1502.0456272201864
     Label X: -8.0
     Label Y: -1.0
     Downstream: POD-8

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 2039
     Energy Slope: 0.0030
     Width: 5
     Side Slope: 10
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: POD-8
     Canvas X: -975.2120183559127
     Canvas Y: -823.8327427273098
     Label X: 3.0
     Label Y: 8.0
     Downstream: Site-19 Reservoir
End:

Subbasin: PRE-1
     Canvas X: -2245.853048322353
     Canvas Y: 4623.6969933630935
     Label X: -31.0
     Label Y: -20.0
     Area: 0.1022
     Downstream: POD-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 75.3

     Transform: SCS
     Lag: 39
     Unitgraph Type: STANDARD

     Baseflow: None
End:
```

```
Subbasin: OS-5
     Canvas X: -2341.5677767689667
     Canvas Y: 5357.509911453799
     Label X: -57.0
     Label Y: -4.0
     Area: 0.013
     Downstream: PRE-1 PW

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 48
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: PRE-1 PW
     Canvas X: -810.1321216231463
     Canvas Y: 4623.6969933630935
     From Canvas X: -801.5243995527253
     From Canvas Y: 5361.832736262741
     Label X: -3.0
     Label Y: 1.0
     Downstream: POD-1

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 2364
     Energy Slope: 0.011
     Width: 38.9
     Side Slope: 4.44
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: POD-1
     Canvas X: -810.1321216231463
     Canvas Y: 4623.6969933630935
     Label X: -33.0
     Label Y: -20.0
     Downstream: Site 19 - North Reservoir
```

```
End:

Subbasin: PRE-2
     Canvas X: -2213.948138840149
     Canvas Y: 3953.693894236797
     Label X: -31.0
     Label Y: -20.0
     Area: 0.0248
     Downstream: POD-2

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 29
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-2
     Canvas X: -810.1321216231463
     Canvas Y: 3953.693894236797
     Label X: -33.0
     Label Y: -20.0
     Downstream: Site 19 - North Reservoir
End:

Subbasin: PRE-3
     Canvas X: -2150.1383198757394
     Canvas Y: 3331.5481593338072
     Label X: -31.0
     Label Y: -21.0
     Area: 0.0235
     Downstream: POD-3

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73
```

```
     Transform: SCS
     Lag: 31
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-3
     Canvas X: -842.0370311053521
     Canvas Y: 3331.5481593338072
     Label X: -31.0
     Label Y: -26.0
     Downstream: Site 19 - North Reservoir
End:

Subbasin: PRE-4
     Canvas X: -2118.2334103935355
     Canvas Y: 2533.925422278693
     Label X: -34.0
     Label Y: -22.0
     Area: 0.0056
     Downstream: POD-4

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 13
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-4
     Canvas X: -905.84685006976
     Canvas Y: 2533.925422278693
     Label X: -28.0
     Label Y: -23.0
     Downstream: Site 19 - North Reservoir
End:

Reservoir: Site 19 - North Reservoir
     Canvas X: 2444.16864556172
```

```
     Canvas Y: 3331.5481593338072
     Downstream: Site-19 Reservoir

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 520.69
     Elevation-Area Table: Site 19 Reservoir
     Elevation-Outflow Table: Site 19 Reservoir
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-5
     Canvas X: -2022.51868194692
     Canvas Y: 1784.1600494468858
     Label X: -29.0
     Label Y: -22.0
     Area: 0.0422
     Downstream: POD-5

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 39
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-5
     Canvas X: -857.989485846454
     Canvas Y: 1768.2075947057829
     Label X: -36.0
     Label Y: -20.0
     Downstream: Site-19 Reservoir
End:

Subbasin: PRE-7
     Canvas X: -1974.661317723614
     Canvas Y: 268.6768490421682
     Label X: -30.0
     Label Y: -19.0
     Area: 0.0233
     Downstream: POD-7
```

```
     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 31
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-7
     Canvas X: -937.7517595519657
     Canvas Y: 268.6768490421682
     Label X: -28.0
     Label Y: -21.0
     Downstream: Site-19 Reservoir
End:

Subbasin: PRE-6
     Canvas X: -2038.4711366880238
     Canvas Y: 1002.4897671328736
     Label X: -28.0
     Label Y: -25.0
     Area: 0.0043
     Downstream: POD-6

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 26
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-6
```

```
     Canvas X: -905.84685006976
     Canvas Y: 1002.4897671328736
     Label X: -37.0
     Label Y: -21.0
     Downstream: Site-19 Reservoir
End:

Subbasin: PRE-9
     Canvas X: -1958.708862982512
     Canvas Y: -2762.289551767266
     Label X: -32.0
     Label Y: -22.0
     Area: 0.0029
     Downstream: POD-9

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 33
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-9
     Canvas X: -953.7042142930677
     Canvas Y: -2762.289551767266
     Label X: -31.0
     Label Y: -20.0
     Downstream: Site-19 Reservoir
End:

Reservoir: Site-19 Reservoir
     Canvas X: 2444.16864556172
     Canvas Y: -832.0425280938907

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 520.69
     Elevation-Area Table: Site 19 Reservoir
     Elevation-Outflow Table: Site 19 Reservoir
     Primary Table: Elevation-Outflow
End:
```

```
Subbasin: PRE-10B
     Canvas X: -1087.7731701331886
     Canvas Y: -3352.8371223919185
     Label X: 0.0
     Label Y: -2.0
     Area: 0.0135
     Downstream: POD-10

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79.6

     Transform: SCS
     Lag: 35
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: PRE-10A
     Canvas X: -3113.2071036119805
     Canvas Y: -3559.7739436369993
     Area: 0.0085
     Downstream: PRE-10 TK Parkway

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 10
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: PRE-10 TK Parkway
     Canvas X: -1087.7731701331886
     Canvas Y: -3871.134268525755
```

```
     From Canvas X: -3083.0660183803902
     From Canvas Y: -3877.2254122533195
     Label X: -70.0
     Label Y: -18.0
     Downstream: POD-10

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1215.664
     Energy Slope: 0.008
     Width: 17.8
     Side Slope: 0.12
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: POD-10
     Canvas X: -1087.7731701331886
     Canvas Y: -3871.134268525755
End:

Subbasin: PRE-11
     Canvas X: -5990.584011939755
     Canvas Y: -3394.861215321689
     Area: 0.0104
     Downstream: POD-11

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80.0

     Transform: SCS
     Lag: 19
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-11
     Canvas X: -5990.584011939755
     Canvas Y: -3913.1583614555257
     Label X: -72.0
     Label Y: -3.0
End:
```

```
Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
     Maximum View N: 5880.5970149253735
     Maximum View S: -3971.33220910624
     Maximum View W: -6264.755480607084
     Maximum View E: 4915.682967959527
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Name
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Fix Element Locations: No
     Fix Hydrologic Order: No
End:
```

PRE-DEVELOPMENT OUTPUT FILES

Project: City of Waco Landfill Simulation Run: 25 yr, 24 hr (pre)

Start of Run: 02Oct2018, 00:00 Basin Model: PRE-DEVELOPMENT
End of Run: 04Oct2018, 00:00 Meteorologic Model: 25-year, 24-hour
Compute Time: 06Apr2020, 22:23:59 Control Specifications: 48-hour

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OS-1	1.58	1709.8	02Oct2018, 13:10	463.2
PRE-8A HC	1.58	1677.8	02Oct2018, 13:20	462.5
PRE-8A	0.0873	123.7	02Oct2018, 12:40	22.4
OS-2	0.058	104.2	02Oct2018, 12:30	17.1
PRE-8B	0.0510	73.6	02Oct2018, 12:40	14.2
Junction-1	1.7763	1820.9	02Oct2018, 13:20	516.3
PRE-8C HC	1.7763	1729.7	02Oct2018, 13:40	514.5
PRE-8C	0.3085	314.9	02Oct2018, 13:10	77.9
PRE-8D	0.0770	113.1	02Oct2018, 12:40	20.2
Junction-2	0.0770	113.1	02Oct2018, 12:40	20.2
OS-3	0.024	42.3	02Oct2018, 12:30	7.1
Junction-3	0.1010	153.7	02Oct2018, 12:40	27.3
OS-3 REACH	0.1010	150.6	02Oct2018, 12:50	27.4
POD-8	2.1858	2030.2	02Oct2018, 13:40	619.7
PRE-1	0.1022	140.7	02Oct2018, 12:40	27.2
OS-5	0.013	17.7	02Oct2018, 12:50	3.8
PRE-1 PW	0.013	17.4	02Oct2018, 13:10	3.8
POD-1	0.1152	153.9	02Oct2018, 12:50	31.0
PRE-2	0.0248	37.5	02Oct2018, 12:30	6.2
POD-2	0.0248	37.5	02Oct2018, 12:30	6.2
PRE-3	0.0235	34.2	02Oct2018, 12:40	5.9
POD-3	0.0235	34.2	02Oct2018, 12:40	5.9
PRE-4	0.0056	11.2	02Oct2018, 12:20	1.4
POD-4	0.0056	11.2	02Oct2018, 12:20	1.4
Site 19 - North Reservoir	0.1691	5.3	03Oct2018, 00:30	13.9
PRE-5	0.0422	55.0	02Oct2018, 12:40	10.6
POD-5	0.0422	55.0	02Oct2018, 12:40	10.6
PRE-7	0.0233	33.9	02Oct2018, 12:40	5.9
POD-7	0.0233	33.9	02Oct2018, 12:40	5.9
PRE-6	0.0043	6.9	02Oct2018, 12:30	1.1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
POD-6	0.0043	6.9	02Oct2018, 12:30	1.1
PRE-9	0.0029	4.1	02Oct2018, 12:40	0.7
POD-9	0.0029	4.1	02Oct2018, 12:40	0.7
Site-19 Reservoir	2.4276	63.5	03Oct2018, 01:50	168.6
PRE-10B	0.0135	21.6	02Oct2018, 12:40	3.9
PRE-10A	0.0085	21.2	02Oct2018, 12:10	2.5
PRE-10 TK Parkway	0.0085	20.0	02Oct2018, 12:20	2.5
POD-10	0.0220	36.9	02Oct2018, 12:30	6.5
PRE-11	0.0104	21.9	02Oct2018, 12:20	3.1
POD-11	0.0104	21.9	02Oct2018, 12:20	3.1

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-1	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	140.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	43.1 (AC-FT)	Direct Runoff Volume:	27.2 (AC-FT)
Loss Volume:	15.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	27.2 (AC-FT)	Discharge Volume:	27.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-2	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	37.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	10.4 (AC-FT)	Direct Runoff Volume:	6.2 (AC-FT)
Loss Volume:	4.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	6.2 (AC-FT)	Discharge Volume:	6.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-3	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	34.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	9.9 (AC-FT)	Direct Runoff Volume:	5.9 (AC-FT)
Loss Volume:	4.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	5.9 (AC-FT)	Discharge Volume:	5.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-4	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	11.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Precipitation Volume:	2.4 (AC-FT)	Direct Runoff Volume:	1.4 (AC-FT)
Loss Volume:	0.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.4 (AC-FT)	Discharge Volume:	1.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-5	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	55.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	17.8 (AC-FT)	Direct Runoff Volume:	10.6 (AC-FT)
Loss Volume:	7.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	10.6 (AC-FT)	Discharge Volume:	10.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Subbasin: PRE-6

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	1.8 (AC-FT)	Direct Runoff Volume:	1.1 (AC-FT)
Loss Volume:	0.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-7	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	33.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	9.8 (AC-FT)	Direct Runoff Volume:	5.9 (AC-FT)
Loss Volume:	3.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	5.9 (AC-FT)	Discharge Volume:	5.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-8A	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	123.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	36.8 (AC-FT)	Direct Runoff Volume:	22.4 (AC-FT)
Loss Volume:	14.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	22.4 (AC-FT)	Discharge Volume:	22.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Subbasin: PRE-8B

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	73.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	21.5 (AC-FT)	Direct Runoff Volume:	14.2 (AC-FT)
Loss Volume:	7.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	14.2 (AC-FT)	Discharge Volume:	14.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-8C	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	314.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Precipitation Volume:	130.0 (AC-FT)	Direct Runoff Volume:	77.9 (AC-FT)
Loss Volume:	52.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	77.9 (AC-FT)	Discharge Volume:	77.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-8D	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	113.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	32.4 (AC-FT)	Direct Runoff Volume:	20.2 (AC-FT)
Loss Volume:	12.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	20.2 (AC-FT)	Discharge Volume:	20.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-9	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: IN

Computed Results

Peak Discharge:	4.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	7.90 (IN)	Direct Runoff Volume:	4.72 (IN)
Loss Volume:	3.18 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	4.72 (IN)	Discharge Volume:	4.72 (IN)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Subbasin:	PRE-10A	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: IN

Computed Results

Peak Discharge:	21.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	7.90 (IN)	Direct Runoff Volume:	5.53 (IN)
Loss Volume:	2.37 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	5.53 (IN)	Discharge Volume:	5.53 (IN)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Subbasin: PRE-10B

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: IN

Computed Results

Peak Discharge:	21.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	7.90 (IN)	Direct Runoff Volume:	5.48 (IN)
Loss Volume:	2.42 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	5.48 (IN)	Discharge Volume:	5.48 (IN)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Subbasin: PRE-11

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: IN

Computed Results

Peak Discharge:	21.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Precipitation Volume:	7.90 (IN)	Direct Runoff Volume:	5.53 (IN)
Loss Volume:	2.37 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	5.53 (IN)	Discharge Volume:	5.53 (IN)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Subbasin: OS-1

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	1709.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Precipitation Volume:	665.7 (AC-FT)	Direct Runoff Volume:	463.2 (AC-FT)
Loss Volume:	202.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	463.2 (AC-FT)	Discharge Volume:	463.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Subbasin: OS-2

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	104.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	24.4 (AC-FT)	Direct Runoff Volume:	17.1 (AC-FT)
Loss Volume:	7.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	17.1 (AC-FT)	Discharge Volume:	17.1 (AC-FT)

Project: City of Waco Landfill Simulation Run: 25 yr, 24 hr (pre)

Subbasin: OS-3

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	42.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	10.1 (AC-FT)	Direct Runoff Volume:	7.1 (AC-FT)
Loss Volume:	3.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	7.1 (AC-FT)	Discharge Volume:	7.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Subbasin: OS-5

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	17.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:50
Precipitation Volume:	5.5 (AC-FT)	Direct Runoff Volume:	3.8 (AC-FT)
Loss Volume:	1.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	3.8 (AC-FT)	Discharge Volume:	3.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Junction: Junction-1

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	1820.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:20
Volume:	516.3 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Junction:	Junction-2	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	113.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	20.2 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
		Junction:	Junction-3

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	153.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	27.3 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Reach:	PRE-1 PW	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	17.7 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:50
Peak Discharge:	17.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Inflow Volume:	3.8 (AC-FT)	Discharge Volume:	3.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Reach:	PRE-8A HC	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	1709.8 (CFS)	Date/Time of Peak Inflow	02Oct2018, 13:10
Peak Discharge:	1677.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:20
Inflow Volume:	463.2 (AC-FT)	Discharge Volume:	462.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Reach: PRE-8C HC

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	1820.9 (CFS)	Date/Time of Peak Inflow	02Oct2018, 13:20
Peak Discharge:	1729.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:40
Inflow Volume:	516.3 (AC-FT)	Discharge Volume:	514.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Reach:	PRE-10 TK Parkway	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	21.2 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	20.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Inflow Volume:	2.5 (AC-FT)	Discharge Volume:	2.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Reach:	OS-3 REACH	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	153.7 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:40
Peak Discharge:	150.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:50
Inflow Volume:	27.3 (AC-FT)	Discharge Volume:	27.4 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Junction: POD-1

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	153.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:50
Volume:	31.0 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Junction: POD-2

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	37.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Volume:	6.2 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Junction: POD-3

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	34.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	5.9 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Junction: POD-4

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	11.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Volume:	1.4 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Junction: POD-5

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	55.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	10.6 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Junction: POD-6

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Volume:	1.1 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)

Junction: POD-7

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	33.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	5.9 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Junction: POD-8

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	2030.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:40
Volume:	619.7 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Junction: POD-9

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	4.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	0.7 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Junction: POD-10

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	36.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Volume:	6.5 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (pre)

Junction: POD-11

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	21.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Volume:	3.1 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Reservoir:	Site 19 - North Reservoir	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	229.2 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 12:40
Peak Discharge:	5.3 (CFS)	Date/Time of Peak Discharge:	03Oct2018, 00:30
Inflow Volume:	44.6 (AC-FT)	Peak Storage:	39.6 (AC-FT)
Discharge Volume:	13.9 (AC-FT)	Peak Elevation:	520.9 (FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (pre)
	Reservoir:	Site-19 Reservoir	

Start of Run:	02Oct2018, 00:00	Basin Model:	PRE-DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	06Apr2020, 22:23:59	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	2069.4 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 13:40
Peak Discharge:	63.5 (CFS)	Date/Time of Peak Discharge:	03Oct2018, 01:50
Inflow Volume:	651.9 (AC-FT)	Peak Storage:	579.3 (AC-FT)
Discharge Volume:	168.6 (AC-FT)	Peak Elevation:	523.1 (FT)

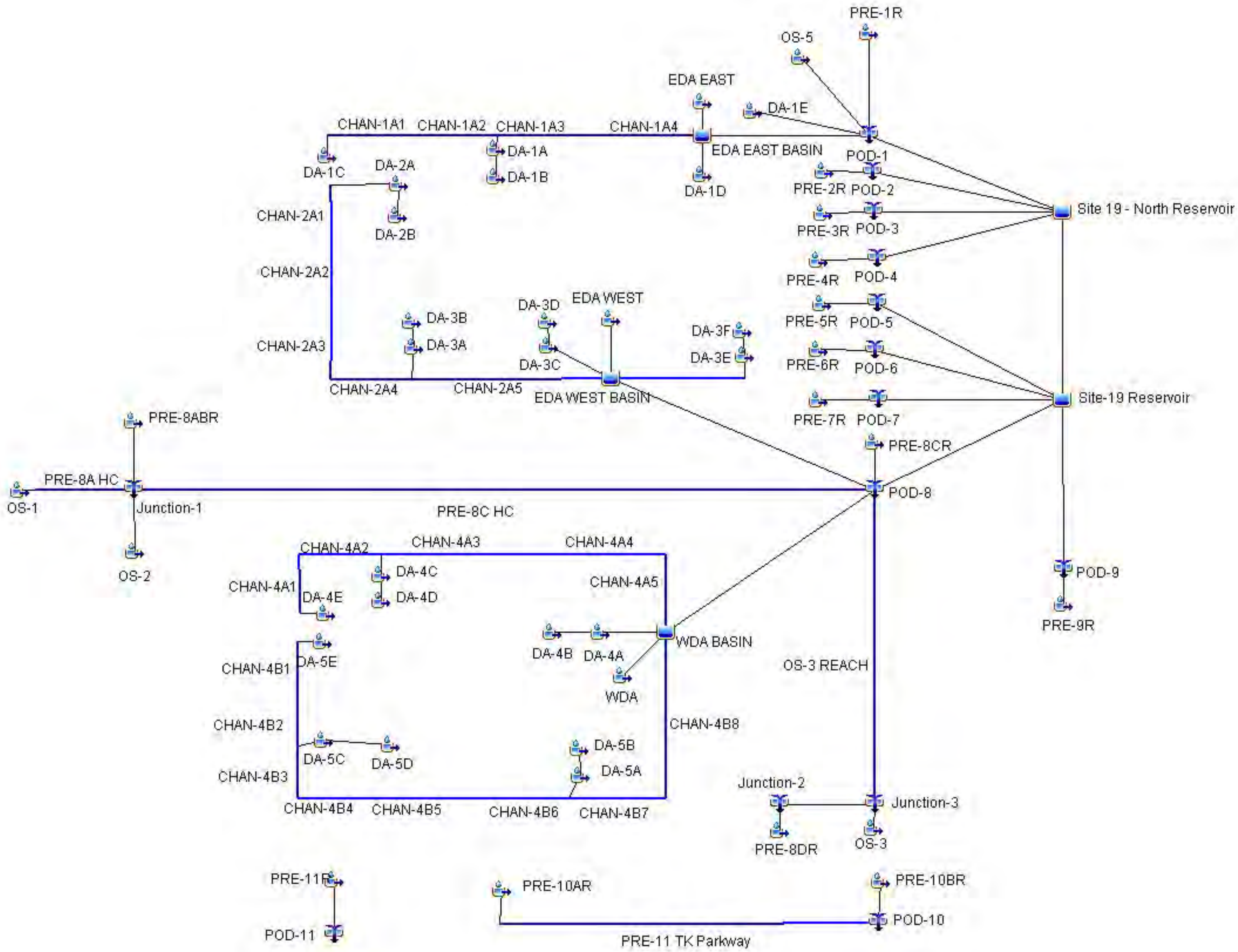
APPENDX 6A-C

HEC-HMS POST-DEVELOPMENT INPUT/OUTPUT FILES

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6A-C-1 to 6A-C-141

BLOSSOM PRAIRIE LANDFILL
HEC-HMS INPUT SCHEMATIC
POST-DEVELOPMENT CONDITIONS



HEC-HMS POST-DEVELOPMENT INPUT FILES FOR EDA WEST BASIN, EDA EAST BASIN, & WDA BASIN / POD-1, POD-2, POD-3, POD-4, POD-5, POD-6, POD-7, POD-8, POD-9, POD-10, & POD-11

```
Basin: POST DEVELOPMENT
     Last Modified Date: 8 April 2020
     Last Modified Time: 03:21:44
     Version: 4.0
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: OS-1
     Canvas X: -150894.52344252676
     Canvas Y: -5202.0848120902665
     Label X: -24.0
     Label Y: -18.0
     Area: 1.57999
     Downstream: PRE-8A HC

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79.7

     Transform: SCS
     Lag: 69
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: PRE-8A HC
     Canvas X: -130124.43961737608
     Canvas Y: -5202.0848120902665
     From Canvas X: -148114.91489719463
     From Canvas Y: -5108.832399101095
     Label X: -47.0
     Label Y: 6.0
     Downstream: Junction-1

     Route: Muskingum Cunge
     Channel: Trapezoid
```

```
     Length: 558
     Energy Slope: 0.0912
     Width: 33
     Side Slope: 0.12
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: PRE-8ABR
     Canvas X: -130124.43961737608
     Canvas Y: 7539.2271142626705
     Area: 0.0847
     Downstream: Junction-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.8

     Transform: SCS
     Lag: 35
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: OS-2
     Canvas X: -129872.61508243698
     Canvas Y: -16456.2298412394
     Label X: -27.0
     Label Y: -24.0
     Area: 0.058
     Downstream: Junction-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 28
```

```
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-1
     Canvas X: -130124.43961737608
     Canvas Y: -5202.0848120902665
     Label X: -10.0
     Label Y: -18.0
     Downstream: PRE-8C HC
End:

Reach: PRE-8C HC
     Canvas X: 5841.067103568348
     Canvas Y: -5202.0848120902665
     From Canvas X: -130124.43961737608
     From Canvas Y: -5202.0848120902665
     Label X: -70.0
     Label Y: -21.0
     Downstream: POD-8

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 10612
     Energy Slope: 0.0048
     Width: 28.8
     Side Slope: 0.21
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: PRE-8CR
     Canvas X: 5740.873729981919
     Canvas Y: 3575.4795055499417
     Label X: -1.0
     Label Y: -6.0
     Area: 0.1898
     Downstream: POD-8

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.1
```

```
     Transform: SCS
     Lag: 37
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: DA-3B
     Canvas X: -78984.65339242521
     Canvas Y: 25691.23314632714
     Area: 0.0040
     Downstream: DA-3A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 179
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 808
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-3A
     Canvas X: -78711.93695564542
     Canvas Y: 21065.962378541488
     Label X: -2.0
     Label Y: -1.0
     Area: 0.0373
     Downstream: CHAN-2A5
```

```
      Canopy 1: None
      Plant Uptake Method: None

      Surface 1: None

      LossRate 1: SCS
      Percent Impervious Area: 0.0
      Curve Number: 85

      Transform: Kinematic Wave

      Plane: 1
      Plane 1 Length: 130
      Plane 1 Slope: 0.25
      Plane 1 Roughness: 0.15
      Plane 1 Percent of Area: 100
      Plane 1 Number of Steps: 5

      Channel: 2
      Collector Length: 779
      Collector Slope: 0.01
      Collector Mannings N: 0.027
      Shape: Triangle
      Collector Side Slope: 3
      Collector Area: 0.00363
      Collector Number of Steps: 5

      Channel: Main
      Channel Length: 634
      Channel Slope: 0.25
      Channel Mannings N: 0.033
      Shape: Trapezoid
      Channel Width: 15
      Channel Side Slope: 2
      Channel Number of Steps: 5
      Route Upstream: Yes

      Baseflow: None
End:

Subbasin: DA-2B
      Canvas X: -81602.73118551144
      Canvas Y: 45065.00881516517
      Label X: -32.0
      Label Y: -19.0
      Area: 0.0030
      Downstream: DA-2A

      Canopy 1: None
      Plant Uptake Method: None
```

```
     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 117
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 496
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-2A
     Canvas X: -81351.83206367402
     Canvas Y: 50824.779959954874
     Label X: -33.0
     Label Y: 13.0
     Area: 0.0282
     Downstream: CHAN-2A1

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
```

```
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 757
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00342
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 950
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Reach: CHAN-2A1
     Canvas X: -93794.06375591485
     Canvas Y: 38453.34497887773
     From Canvas X: -93884.94450762353
     From Canvas Y: 50604.63980581959
     Label X: -76.0
     Label Y: -1.0
     Downstream: CHAN-2A2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 223
     Energy Slope: 0.0225
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A2
     Canvas X: -93774.9276375098
     Canvas Y: 28958.301758432593
     From Canvas X: -93794.06375591485
     From Canvas Y: 38453.34497887773
```

```
     Label X: -74.0
     Label Y: 2.0
     Downstream: CHAN-2A3

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 818
     Energy Slope: 0.0075
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A3
     Canvas X: -93911.69029629939
     Canvas Y: 15038.91265134334
     From Canvas X: -93774.9276375098
     From Canvas Y: 28958.301758432593
     Label X: -76.0
     Label Y: -7.0
     Downstream: CHAN-2A4

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 762
     Energy Slope: 0.0225
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A4
     Canvas X: -79087.93352393302
     Canvas Y: 15109.185256967845
     From Canvas X: -93911.69029629939
     From Canvas Y: 15038.91265134334
     Label X: -48.0
     Label Y: -11.0
     Downstream: CHAN-2A5

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1029
     Energy Slope: 0.0025
     Width: 10
     Side Slope: 3
```

```
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A5
     Canvas X: -42598.784300469284
     Canvas Y: 15180.899256403536
     From Canvas X: -79087.93352393302
     From Canvas Y: 15109.185256967845
     Label X: -62.0
     Label Y: -11.0
     Downstream: EDA WEST BASIN

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 852
     Energy Slope: 0.0025
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: DA-3D
     Canvas X: -54200.18361787565
     Canvas Y: 25865.771665866218
     Label X: -38.0
     Label Y: 11.0
     Area: 0.0040
     Downstream: DA-3C

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 161
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5
```

```
     Channel: Main
     Channel Length: 822
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-3C
     Canvas X: -54025.645098336565
     Canvas Y: 21153.231638311023
     Label X: -38.0
     Label Y: -19.0
     Area: 0.0421
     Downstream: EDA WEST BASIN

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 903
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00429
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 568
     Channel Slope: 0.25
```

```
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-3F
     Canvas X: -18441.453268080426
     Canvas Y: 24146.990494238868
     Label X: -56.0
     Label Y: -3.0
     Area: 0.0027
     Downstream: DA-3E

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 181
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 866
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-3E
     Canvas X: -17974.119327917317
     Canvas Y: 19579.462550758006
```

```
      Label X: -59.0
      Label Y: -5.0
      Area: 0.0339
      Downstream: CHAN-3A1

      Canopy 1: None
      Plant Uptake Method: None

      Surface 1: None

      LossRate 1: SCS
      Percent Impervious Area: 0.0
      Curve Number: 85

      Transform: Kinematic Wave

      Plane: 1
      Plane 1 Length: 130
      Plane 1 Slope: 0.25
      Plane 1 Roughness: 0.15
      Plane 1 Percent of Area: 100
      Plane 1 Number of Steps: 5

      Channel: 2
      Collector Length: 807
      Collector Slope: 0.01
      Collector Mannings N: 0.027
      Shape: Triangle
      Collector Side Slope: 3
      Collector Area: 0.00402
      Collector Number of Steps: 5

      Channel: Main
      Channel Length: 693
      Channel Slope: 0.25
      Channel Mannings N: 0.033
      Shape: Trapezoid
      Channel Width: 15
      Channel Side Slope: 2
      Channel Number of Steps: 5
      Route Upstream: Yes

      Baseflow: None
End:

Reach: CHAN-3A1
      Canvas X: -42598.784300469284
      Canvas Y: 15180.899256403536
      From Canvas X: -17996.21916407974
      From Canvas Y: 15142.540755769209
```

```
     Label X: -36.0
     Label Y: -13.0
     Downstream: EDA WEST BASIN

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 2037
     Energy Slope: 0.0025
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: EDA WEST
     Canvas X: -42598.784300469284
     Canvas Y: 26208.023808937538
     Label X: -46.0
     Label Y: 15.0
     Area: 0.011
     Downstream: EDA WEST BASIN

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 99

     Transform: SCS
     Lag: 1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: EDA WEST BASIN
     Canvas X: -42598.784300469284
     Canvas Y: 15180.899256403536
     From Canvas X: -25843.4367849071
     From Canvas Y: 10575.944546616312
     Label X: -78.0
     Label Y: -19.0
     Downstream: POD-8

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
```

```
     Initial Elevation: 530
     Elevation-Area Table: EDA WEST BASIN
     Elevation-Outflow Table: EDA WEST BASIN
     Primary Table: Elevation-Outflow
End:

Subbasin: DA-5B
     Canvas X: -48245.013980368705
     Canvas Y: -52566.31666460971
     Area: 0.0036
     Downstream: DA-5A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 176
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 554
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-5A
     Canvas X: -48068.6615501185
     Canvas Y: -57504.18471161605
     Label X: 5.0
     Label Y: 1.0
     Area: 0.0379
     Downstream: CHAN-4B7

     Canopy 1: None
```

```
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 1038
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00484
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 844
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-5D
     Canvas X: -83031.76531423768
     Canvas Y: -51891.13878879456
     Label X: -29.0
     Label Y: -19.0
     Area: 0.0048
     Downstream: DA-5C

     Canopy 1: None
     Plant Uptake Method: None
```

```
     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 242
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 491
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-5C
     Canvas X: -95271.27899691576
     Canvas Y: -50931.17693132961
     Label X: -30.0
     Label Y: -19.0
     Area: 0.0099
     Downstream: CHAN-4B3

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
```

```
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 427
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00199
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 370
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-5E
     Canvas X: -95507.46528742944
     Canvas Y: -32814.84447658433
     Label X: -35.0
     Label Y: -20.0
     Area: 0.0033
     Downstream: CHAN-4B1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: CHAN-4B1
     Canvas X: -99918.46890222236
```

```
     Canvas Y: -43191.250020324485
     From Canvas X: -100018.86951473463
     From Canvas Y: -32978.82169526743
     Label X: -78.0
     Label Y: -2.0
     Downstream: CHAN-4B2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 448
     Energy Slope: 0.006
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B2
     Canvas X: -99985.96232959302
     Canvas Y: -52140.32237768591
     From Canvas X: -99918.46890222236
     From Canvas Y: -43191.250020324485
     Label X: -85.0
     Label Y: -6.0
     Downstream: CHAN-4B3

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 104
     Energy Slope: 0.0190
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B3
     Canvas X: -99946.73749156627
     Canvas Y: -61737.672879597725
     From Canvas X: -99985.96232959302
     From Canvas Y: -52140.32237768591
     Label X: -81.0
     Label Y: -7.0
     Downstream: CHAN-4B4

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 714
```

```
     Energy Slope: 0.007
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B4
     Canvas X: -90099.30028619742
     Canvas Y: -61766.4197427996
     From Canvas X: -99946.73749156627
     From Canvas Y: -61737.672879597725
     Label X: -48.0
     Label Y: -11.0
     Downstream: CHAN-4B5

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 341
     Energy Slope: 0.01
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B5
     Canvas X: -65530.197431344655
     Canvas Y: -61720.77131889899
     From Canvas X: -90099.30028619742
     From Canvas Y: -61766.4197427996
     Label X: -53.0
     Label Y: -12.0
     Downstream: CHAN-4B6

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 699
     Energy Slope: 0.0065
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B6
     Canvas X: -50312.959806994026
```

```
      Canvas Y: -61791.14000809468
      From Canvas X: -65530.197431344655
      From Canvas Y: -61720.77131889899
      Label X: -45.0
      Label Y: -14.0
      Downstream: CHAN-4B7

      Route: Muskingum Cunge
      Channel: Trapezoid
      Length: 495
      Energy Slope: 0.01
      Width: 10
      Side Slope: 3
      Mannings n: 0.027
      Use Variable Time Step: No
      Channel Loss: None
End:

Reach: CHAN-4B7
      Canvas X: -32511.75550095027
      Canvas Y: -61742.09825398881
      From Canvas X: -50312.959806994026
      From Canvas Y: -61791.14000809468
      Label X: -45.0
      Label Y: -15.0
      Downstream: CHAN-4B8

      Route: Muskingum Cunge
      Channel: Trapezoid
      Length: 245
      Energy Slope: 0.01
      Width: 10
      Side Slope: 3
      Mannings n: 0.033
      Use Variable Time Step: No
      Channel Loss: None
End:

Reach: CHAN-4B8
      Canvas X: -32523.194823561003
      Canvas Y: -31245.30784735731
      From Canvas X: -32511.75550095027
      From Canvas Y: -61742.09825398881
      Label X: -10.0
      Label Y: -10.0
      Downstream: WDA BASIN

      Route: Muskingum Cunge
      Channel: Trapezoid
      Length: 1406
```

```
     Energy Slope: 0.0025
     Width: 11
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: DA-4B
     Canvas X: -53182.882027375046
     Canvas Y: -31227.672604332285
     Label X: -30.0
     Label Y: -21.0
     Area: 0.005
     Downstream: DA-4A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 236
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 566
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-4A
     Canvas X: -44541.61294511394
     Canvas Y: -31227.672604332285
     Label X: -27.0
     Label Y: -23.0
```

```
     Area: 0.0300
     Downstream: WDA BASIN

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 804
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00375
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 438
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-4D
     Canvas X: -84744.4245372149
     Canvas Y: -25448.55307862372
     Area: 0.0027
     Downstream: DA-4C

     Canopy 1: None
```

```
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 218
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 368
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-4C
     Canvas X: -84744.4245372149
     Canvas Y: -20561.474531529442
     Area: 0.0194
     Downstream: CHAN-4A3

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
```

```
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 694
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00324
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 387
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-4E
     Canvas X: -94802.05556642853
     Canvas Y: -27700.623999327756
     Label X: -33.0
     Label Y: 11.0
     Area: 0.0047
     Downstream: CHAN-4A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: CHAN-4A1
     Canvas X: -99612.41688037939
```

```
     Canvas Y: -16947.720817565078
     From Canvas X: -99594.44755383424
     From Canvas Y: -27707.389718607825
     Label X: -73.0
     Label Y: -5.0
     Downstream: CHAN-4A2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 434
     Energy Slope: 0.0025
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4A2
     Canvas X: -84758.90482867799
     Canvas Y: -17039.526632119327
     From Canvas X: -99612.41688037939
     From Canvas Y: -16947.720817565078
     Label X: -47.0
     Label Y: 3.0
     Downstream: CHAN-4A3

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 416
     Energy Slope: 0.030
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4A3
     Canvas X: -58838.42769660833
     Canvas Y: -17017.39364914017
     From Canvas X: -84758.90482867799
     From Canvas Y: -17039.526632119327
     Label X: -47.0
     Label Y: 8.0
     Downstream: CHAN-4A4

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 338
```

```
     Energy Slope: 0.015
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4A4
     Canvas X: -32438.239348354735
     Canvas Y: -17017.393649140184
     From Canvas X: -58838.42769660833
     From Canvas Y: -17017.39364914017
     Label X: -37.0
     Label Y: 8.0
     Downstream: CHAN-4A5

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1636
     Energy Slope: 0.006
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4A5
     Canvas X: -32523.194823561003
     Canvas Y: -31245.30784735731
     From Canvas X: -32438.239348354735
     From Canvas Y: -17017.393649140184
     Label X: -78.0
     Label Y: 7.0
     Downstream: WDA BASIN

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 240
     Energy Slope: 0.0025
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: WDA
     Canvas X: -40411.640574288234
```

```
     Canvas Y: -39237.09612221115
     Label X: -27.0
     Label Y: -21.0
     Area: 0.010
     Downstream: WDA BASIN

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 99

     Transform: SCS
     Lag: 1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: WDA BASIN
     Canvas X: -32523.194823561003
     Canvas Y: -31245.30784735731
     Label X: -4.0
     Label Y: -11.0
     Downstream: POD-8

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 531
     Elevation-Area Table: WDA BASIN
     Elevation-Outflow Table: WDA BASIN
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-8DR
     Canvas X: -11572.526109834085
     Canvas Y: -67521.00274982891
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
     Label X: -34.0
     Label Y: -19.0
     Area: 0.0312
     Downstream: Junction-2

     Canopy: None
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.7

     Transform: SCS
     Lag: 35
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-2
     Canvas X: -11563.708488321572
     Canvas Y: -62794.75761912284
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
     Label X: -48.0
     Label Y: 16.0
     Downstream: Junction-3
End:

Subbasin: OS-3
     Canvas X: 5666.528584029264
     Canvas Y: -67163.25924846418
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
     Label X: -29.0
     Label Y: -16.0
     Area: 0.02334
     Downstream: Junction-3

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 29
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-3
```

```
     Canvas X: 5841.067103568348
     Canvas Y: -62799.79625998715
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
     Label X: 2.0
     Label Y: -1.0
     Downstream: OS-3 REACH
End:

Reach: OS-3 REACH
     Canvas X: 5841.067103568348
     Canvas Y: -5202.0848120902665
     From Canvas X: 5841.067103568348
     From Canvas Y: -62799.79625998715
     Label X: -91.0
     Label Y: -18.0
     Downstream: POD-8

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 2039
     Energy Slope: 0.0030
     Width: 5
     Side Slope: 10
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: POD-8
     Canvas X: 5841.067103568348
     Canvas Y: -5202.0848120902665
     Label X: -1.0
     Label Y: -5.0
     Downstream: Site-19 Reservoir
End:

Subbasin: DA-1B
     Canvas X: -63587.67541213843
     Canvas Y: 52187.0269040249
     Label X: -3.0
     Label Y: -3.0
     Area: 0.0055
     Downstream: DA-1A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None
```

```
    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 189
    Plane 1 Slope: 0.05
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5

    Channel: Main
    Channel Length: 906
    Channel Slope: 0.01
    Channel Mannings N: 0.027
    Shape: Triangle
    Channel Side Slope: 3
    Channel Number of Steps: 5

    Baseflow: None
End:

Subbasin: DA-1A
    Canvas X: -63587.67541213843
    Canvas Y: 57301.24738128147
    Label X: -3.0
    Label Y: -5.0
    Area: 0.0355
    Downstream: CHAN-1A3

    Canopy 1: None
    Plant Uptake Method: None

    Surface 1: None

    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 130
    Plane 1 Slope: 0.25
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5
```

```
     Channel: 2
     Collector Length: 847
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00395
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 536
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-1C
     Canvas X: -94518.58163140346
     Canvas Y: 56060.93554612731
     Label X: -33.0
     Label Y: -17.0
     Area: 0.0042
     Downstream: CHAN-1A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 11
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: CHAN-1A1
     Canvas X: -77549.52569158612
     Canvas Y: 59683.305800276365
     From Canvas X: -94492.294979086
```

```
        From Canvas Y: 59688.335798792956
        Label X: -43.0
        Label Y: 7.0
        Downstream: CHAN-1A2

        Route: Muskingum Cunge
        Channel: Trapezoid
        Length: 404
        Energy Slope: 0.01
        Width: 5
        Side Slope: 3
        Mannings n: 0.027
        Use Variable Time Step: No
        Channel Loss: None
End:

Reach: CHAN-1A2
        Canvas X: -63474.03227483758
        Canvas Y: 59755.354935152754
        From Canvas X: -77549.52569158612
        From Canvas Y: 59683.305800276365
        Label X: -48.0
        Label Y: 6.0
        Downstream: CHAN-1A3

        Route: Muskingum Cunge
        Channel: Trapezoid
        Length: 1274
        Energy Slope: 0.008
        Width: 5
        Side Slope: 3
        Mannings n: 0.027
        Use Variable Time Step: No
        Channel Loss: None
End:

Reach: CHAN-1A3
        Canvas X: -50544.58613689869
        Canvas Y: 59702.141025402394
        From Canvas X: -63474.03227483758
        From Canvas Y: 59755.354935152754
        Label X: -44.0
        Label Y: 5.0
        Downstream: CHAN-1A4

        Route: Muskingum Cunge
        Channel: Trapezoid
        Length: 348
        Energy Slope: 0.0025
        Width: 10
```

```
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-1A4
     Canvas X: -25848.255338589923
     Canvas Y: 59770.18140478464
     From Canvas X: -50544.58613689869
     From Canvas Y: 59702.141025402394
     Label X: -34.0
     Label Y: 5.0
     Downstream: EDA EAST BASIN

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 711
     Energy Slope: 0.022
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: EDA EAST
     Canvas X: -25848.255338589923
     Canvas Y: 65942.51646354258
     Label X: -42.0
     Label Y: 16.0
     Area: 0.003
     Downstream: EDA EAST BASIN

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 99

     Transform: SCS
     Lag: 1
     Unitgraph Type: STANDARD

     Baseflow: None
End:
```

```
Subbasin: DA-1D
     Canvas X: -25848.255338589923
     Canvas Y: 52539.73176452535
     Label X: -28.0
     Label Y: -17.0
     Area: 0.0023
     Downstream: EDA EAST BASIN

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: EDA EAST BASIN
     Canvas X: -25848.255338589923
     Canvas Y: 59770.18140478464
     From Canvas X: -43225.466802242976
     From Canvas Y: -15498.126506176006
     Label X: -5.0
     Label Y: -15.0
     Downstream: POD-1

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 534
     Elevation-Area Table: EDA EAST BASIN
     Elevation-Outflow Table: EDA EAST BASIN
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-1R
     Canvas X: 4804.744643805054
     Canvas Y: 78663.67382643836
     Label X: -29.0
     Label Y: 14.0
     Area: 0.0149
     Downstream: POD-1

     Canopy: None
```

```
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 74.7

     Transform: SCS
     Lag: 11
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: OS-5
     Canvas X: -7674.759503239271
     Canvas Y: 74103.85500347985
     Label X: -30.0
     Label Y: 14.0
     Area: 0.01309
     Downstream: POD-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 48
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: DA-1E
     Canvas X: -16554.40668479004
     Canvas Y: 64264.24596446414
     Area: 0.0019
     Downstream: POD-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None
```

```
     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-1
     Canvas X: 4793.83598633387
     Canvas Y: 59726.24445644802
     Label X: -32.0
     Label Y: -20.0
     Downstream: Site 19 - North Reservoir
End:

Subbasin: PRE-3R
     Canvas X: -3619.031505548861
     Canvas Y: 45573.810769641415
     Label X: -35.0
     Label Y: -18.0
     Area: 0.0207
     Downstream: POD-3

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 27
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-3
     Canvas X: 5692.376811663096
     Canvas Y: 45767.79844291666
     Label X: -28.0
     Label Y: -17.0
     Downstream: Site 19 - North Reservoir
End:
```

```
Subbasin: PRE-2R
     Canvas X: -3474.926376830117
     Canvas Y: 53268.319233502014
     Label X: -39.0
     Label Y: -18.0
     Area: 0.0086
     Downstream: POD-2

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 17
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-2
     Canvas X: 5304.401465112605
     Canvas Y: 53139.330027376134
     Label X: -31.0
     Label Y: -18.0
     Downstream: Site 19 - North Reservoir
End:

Subbasin: PRE-4R
     Canvas X: -4394.982198649843
     Canvas Y: 37038.35314553045
     Label X: -40.0
     Label Y: -20.0
     Area: 0.0056
     Downstream: POD-4

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73
```

```
     Transform: SCS
     Lag: 16
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-4
     Canvas X: 6190.144142646517
     Canvas Y: 37210.775435906515
     Label X: -32.0
     Label Y: -18.0
     Downstream: Site 19 - North Reservoir
End:

Reservoir: Site 19 - North Reservoir
     Canvas X: 40283.90600524505
     Canvas Y: 45838.339415016744
     Downstream: Site-19 Reservoir

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 520.69
     Elevation-Area Table: Site 19 Reservoir
     Elevation-Outflow Table: Site 19 Reservoir
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-5R
     Canvas X: -3933.0899906202103
     Canvas Y: 29007.465017569688
     Label X: -44.0
     Label Y: -18.0
     Area: 0.0352
     Downstream: POD-5

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 29
     Unitgraph Type: STANDARD

     Baseflow: None
```

```
End:

Junction: POD-5
     Canvas X: 6190.144142646517
     Canvas Y: 29007.465017569688
     Label X: -36.0
     Label Y: -19.0
     Downstream: Site-19 Reservoir
End:

Subbasin: PRE-7R
     Canvas X: -4394.982198649843
     Canvas Y: 11431.980273197536
     Label X: -34.0
     Label Y: -20.0
     Area: 0.0223
     Downstream: POD-7

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 30
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-7
     Canvas X: 6539.221181724686
     Canvas Y: 11379.074544122464
     Label X: -31.0
     Label Y: -20.0
     Downstream: Site-19 Reservoir
End:

Subbasin: PRE-6R
     Canvas X: -4394.982198649843
     Canvas Y: 20549.400917134255
     Label X: -40.0
     Label Y: -16.0
     Area: 0.0043
     Downstream: POD-6
```

```
     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 26
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-6
     Canvas X: 5841.067103568348
     Canvas Y: 20455.0775601547
     Label X: -30.0
     Label Y: -18.0
     Downstream: Site-19 Reservoir
End:

Subbasin: PRE-9R
     Canvas X: 40399.69397230647
     Canvas Y: -25972.16863724096
     Label X: -31.0
     Label Y: -21.0
     Area: 0.0029
     Downstream: POD-9

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 33
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-9
     Canvas X: 40399.69397230647
```

```
     Canvas Y: -19863.32045337312
     Label X: -2.0
     Label Y: -5.0
     Downstream: Site-19 Reservoir
End:

Reservoir: Site-19 Reservoir
     Canvas X: 40283.90600524505
     Canvas Y: 11449.615516222555
     Label X: 1.0
     Label Y: -1.0

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 520.69
     Elevation-Area Table: Site 19 Reservoir
     Elevation-Outflow Table: Site 19 Reservoir
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-10BR
     Canvas X: 6939.229369923327
     Canvas Y: -76720.93367392311
     From Canvas X: -63197.73402814632
     From Canvas Y: -71490.31052731218
     Label X: 0.0
     Label Y: -2.0
     Area: 0.0029
     Downstream: POD-10

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 33
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: PRE-10AR
     Canvas X: -62523.229194442625
     Canvas Y: -78336.3396870479
     From Canvas X: -63197.73402814632
```

```
     From Canvas Y: -71490.31052731218
     Label X: 5.0
     Label Y: 0.0
     Area: 0.0016
     Downstream: PRE-11 TK Parkway

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 25
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: PRE-11 TK Parkway
     Canvas X: 6400.760698881728
     Canvas Y: -84528.72940402626
     From Canvas X: -62928.07381661901
     From Canvas Y: -84770.30826319466
     Label X: -70.0
     Label Y: -18.0
     Downstream: POD-10

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1215.664
     Energy Slope: 0.008
     Width: 17.8
     Side Slope: 0.12
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: POD-10
     Canvas X: 6400.760698881728
     Canvas Y: -84528.72940402626
     From Canvas X: -66253.37766246771
     From Canvas Y: -86828.97280601399
End:

Subbasin: PRE-11R
```

```
     Canvas X: -93215.94344381365
     Canvas Y: -76451.69933840231
     From Canvas X: -63197.73402814632
     From Canvas Y: -71490.31052731218
     Label X: -67.0
     Label Y: -2.0
     Area: 0.010
     Downstream: POD-11

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80.0

     Transform: SCS
     Lag: 19
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-11
     Canvas X: -93215.94344381365
     Canvas Y: -86682.60408819266
     From Canvas X: -66253.37766246771
     From Canvas Y: -86828.97280601399
     Label X: -72.0
     Label Y: -3.0
End:

Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
     Maximum View N: 53477.804796960794
     Maximum View S: -61263.896628055125
     Maximum View W: -117782.14367979346
     Maximum View E: 17236.009823300818
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Name
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
```

```
     Fix Element Locations: No
     Fix Hydrologic Order: No
End:
```

HEC-HMS OUTPUT FILES
FOR
EDA WEST BASIN, EDA EAST BASIN, & WDA BASIN /
POD-1, POD-2, POD-3, POD-4, POD-5, POD-6,
POD-7, POD-8, POD-9, POD-10, & POD-11

Project: City of Waco Landfill Simulation Run: 25 yr, 24 hr (post)

Start of Run: 02Oct2018, 00:00 Basin Model: POST DEVELOPMEN
End of Run: 04Oct2018, 00:00 Meteorologic Model: 25-year, 24-hour
Compute Time: 07Apr2020, 20:44:29 Control Specifications: 48-hour

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OS-1	1.57999	1709.8	02Oct2018, 13:10	463.2
PRE-8A HC	1.57999	1707.8	02Oct2018, 13:10	463.2
PRE-8ABR	0.0847	120.0	02Oct2018, 12:40	21.7
OS-2	0.058	104.2	02Oct2018, 12:30	17.1
Junction-1	1.72269	1831.2	02Oct2018, 13:10	502.0
PRE-8C HC	1.72269	1811.1	02Oct2018, 13:20	501.9
PRE-8CR	0.1898	256.5	02Oct2018, 12:40	47.9
DA-3B	0.0040	12.7	02Oct2018, 12:10	1.3
DA-3A	0.0413	131.7	02Oct2018, 12:10	13.5
DA-2B	0.0030	9.6	02Oct2018, 12:10	1.0
DA-2A	0.0312	99.7	02Oct2018, 12:10	10.2
CHAN-2A1	0.0312	99.5	02Oct2018, 12:10	10.2
CHAN-2A2	0.0312	98.1	02Oct2018, 12:10	10.2
CHAN-2A3	0.0312	95.9	02Oct2018, 12:10	10.2
CHAN-2A4	0.0312	87.2	02Oct2018, 12:10	10.3
CHAN-2A5	0.0725	207.8	02Oct2018, 12:10	23.8
DA-3D	0.0040	12.7	02Oct2018, 12:10	1.3
DA-3C	0.0461	147.1	02Oct2018, 12:10	15.1
DA-3F	0.0027	8.6	02Oct2018, 12:10	0.9
DA-3E	0.0366	116.7	02Oct2018, 12:10	12.0
CHAN-3A1	0.0366	110.6	02Oct2018, 12:10	12.1
EDA WEST	0.011	37.7	02Oct2018, 12:10	4.6
EDA WEST BASIN	0.1662	41.8	02Oct2018, 14:10	35.4
DA-5B	0.0036	11.4	02Oct2018, 12:10	1.2
DA-5A	0.0415	132.4	02Oct2018, 12:10	13.6
DA-5D	0.0048	15.2	02Oct2018, 12:10	1.6
DA-5C	0.0147	46.7	02Oct2018, 12:10	4.8
DA-5E	0.0033	9.7	02Oct2018, 12:10	1.1
CHAN-4B1	0.0033	9.3	02Oct2018, 12:10	1.1
CHAN-4B2	0.0033	9.2	02Oct2018, 12:10	1.1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CHAN-4B3	0.0180	54.8	02Oct2018, 12:10	5.9
CHAN-4B4	0.0180	53.9	02Oct2018, 12:10	5.9
CHAN-4B5	0.0180	51.5	02Oct2018, 12:10	5.9
CHAN-4B6	0.0180	49.6	02Oct2018, 12:10	5.9
CHAN-4B7	0.0595	180.8	02Oct2018, 12:10	19.5
CHAN-4B8	0.0595	169.0	02Oct2018, 12:10	19.5
DA-4B	0.005	15.9	02Oct2018, 12:10	1.6
DA-4A	0.0350	111.5	02Oct2018, 12:10	11.4
DA-4D	0.0027	8.6	02Oct2018, 12:10	0.9
DA-4C	0.0221	70.5	02Oct2018, 12:10	7.2
DA-4E	0.0047	13.9	02Oct2018, 12:10	1.5
CHAN-4A1	0.0047	13.0	02Oct2018, 12:10	1.5
CHAN-4A2	0.0047	12.6	02Oct2018, 12:10	1.5
CHAN-4A3	0.0268	82.5	02Oct2018, 12:10	8.8
CHAN-4A4	0.0268	78.1	02Oct2018, 12:10	8.8
CHAN-4A5	0.0268	75.6	02Oct2018, 12:10	8.8
WDA	0.010	34.3	02Oct2018, 12:10	4.1
WDA BASIN	0.1313	22.5	02Oct2018, 15:30	21.8
PRE-8DR	0.0312	44.1	02Oct2018, 12:40	8.0
Junction-2	0.0312	44.1	02Oct2018, 12:40	8.0
OS-3	0.02334	41.1	02Oct2018, 12:30	6.9
Junction-3	0.05454	83.6	02Oct2018, 12:40	14.9
OS-3 REACH	0.05454	81.9	02Oct2018, 12:50	14.9
POD-8	2.26453	2060.3	02Oct2018, 13:20	621.8
DA-1B	0.0055	17.5	02Oct2018, 12:10	1.8
DA-1A	0.0410	130.8	02Oct2018, 12:10	13.4
DA-1C	0.0042	11.0	02Oct2018, 12:10	1.4
CHAN-1A1	0.0042	10.4	02Oct2018, 12:10	1.4
CHAN-1A2	0.0042	10.4	02Oct2018, 12:20	1.4
CHAN-1A3	0.0452	137.0	02Oct2018, 12:10	14.8
CHAN-1A4	0.0452	134.9	02Oct2018, 12:10	14.8
EDA EAST	0.003	10.3	02Oct2018, 12:10	1.2
DA-1D	0.0023	6.4	02Oct2018, 12:10	0.8
EDA EAST BASIN	0.0505	106.3	02Oct2018, 12:20	16.8
PRE-1R	0.0149	31.9	02Oct2018, 12:10	3.9

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OS-5	0.01309	17.8	02Oct2018, 12:50	3.9
DA-1E	0.0019	5.8	02Oct2018, 12:10	0.6
POD-1	0.08039	150.9	02Oct2018, 12:20	25.2
PRE-3R	0.0207	32.6	02Oct2018, 12:30	5.2
POD-3	0.0207	32.6	02Oct2018, 12:30	5.2
PRE-2R	0.0086	16.3	02Oct2018, 12:20	2.2
POD-2	0.0086	16.3	02Oct2018, 12:20	2.2
PRE-4R	0.0056	10.9	02Oct2018, 12:20	1.4
POD-4	0.0056	10.9	02Oct2018, 12:20	1.4
Site 19 - North Reservoir	0.11529	3.9	03Oct2018, 00:30	10.5
PRE-5R	0.0352	53.2	02Oct2018, 12:30	8.9
POD-5	0.0352	53.2	02Oct2018, 12:30	8.9
PRE-7R	0.0223	33.0	02Oct2018, 12:30	5.6
POD-7	0.0223	33.0	02Oct2018, 12:30	5.6
PRE-6R	0.0043	6.9	02Oct2018, 12:30	1.1
POD-6	0.0043	6.9	02Oct2018, 12:30	1.1
PRE-9R	0.0029	4.1	02Oct2018, 12:40	0.7
POD-9	0.0029	4.1	02Oct2018, 12:40	0.7
Site-19 Reservoir	2.44452	62.6	03Oct2018, 01:40	167.8
PRE-10BR	0.0029	4.8	02Oct2018, 12:40	0.9
PRE-10AR	0.0016	3.0	02Oct2018, 12:30	0.5
PRE-11 TK Parkway	0.0016	3.0	02Oct2018, 12:40	0.5
POD-10	0.0045	7.8	02Oct2018, 12:40	1.3
PRE-11R	0.010	21.0	02Oct2018, 12:20	3.0
POD-11	0.010	21.0	02Oct2018, 12:20	3.0

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Subbasin: PRE-1R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	31.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	6.3 (AC-FT)	Direct Runoff Volume:	3.9 (AC-FT)
Loss Volume:	2.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	3.9 (AC-FT)	Discharge Volume:	3.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-2R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	16.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Precipitation Volume:	3.6 (AC-FT)	Direct Runoff Volume:	2.2 (AC-FT)
Loss Volume:	1.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2.2 (AC-FT)	Discharge Volume:	2.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-3R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	32.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	8.7 (AC-FT)	Direct Runoff Volume:	5.2 (AC-FT)
Loss Volume:	3.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	5.2 (AC-FT)	Discharge Volume:	5.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-4R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	10.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Precipitation Volume:	2.4 (AC-FT)	Direct Runoff Volume:	1.4 (AC-FT)
Loss Volume:	0.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.4 (AC-FT)	Discharge Volume:	1.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-5R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	53.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	14.8 (AC-FT)	Direct Runoff Volume:	8.9 (AC-FT)
Loss Volume:	6.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	8.9 (AC-FT)	Discharge Volume:	8.9 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Subbasin: PRE-6R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	1.8 (AC-FT)	Direct Runoff Volume:	1.1 (AC-FT)
Loss Volume:	0.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-7R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	33.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	9.4 (AC-FT)	Direct Runoff Volume:	5.6 (AC-FT)
Loss Volume:	3.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	5.6 (AC-FT)	Discharge Volume:	5.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-8ABR

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	120.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	35.7 (AC-FT)	Direct Runoff Volume:	21.7 (AC-FT)
Loss Volume:	13.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	21.7 (AC-FT)	Discharge Volume:	21.7 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	PRE-8CR	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	256.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	80.0 (AC-FT)	Direct Runoff Volume:	47.9 (AC-FT)
Loss Volume:	32.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	47.9 (AC-FT)	Discharge Volume:	47.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-8DR

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	44.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	13.1 (AC-FT)	Direct Runoff Volume:	8.0 (AC-FT)
Loss Volume:	5.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	8.0 (AC-FT)	Discharge Volume:	8.0 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-9R

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	4.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	1.2 (AC-FT)	Direct Runoff Volume:	0.7 (AC-FT)
Loss Volume:	0.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.7 (AC-FT)	Discharge Volume:	0.7 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-10AR

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	3.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	0.7 (AC-FT)	Direct Runoff Volume:	0.5 (AC-FT)
Loss Volume:	0.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.5 (AC-FT)	Discharge Volume:	0.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: PRE-10BR

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	4.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	1.2 (AC-FT)	Direct Runoff Volume:	0.9 (AC-FT)
Loss Volume:	0.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.9 (AC-FT)	Discharge Volume:	0.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	PRE-11R	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	21.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Precipitation Volume:	4.2 (AC-FT)	Direct Runoff Volume:	3.0 (AC-FT)
Loss Volume:	1.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	3.0 (AC-FT)	Discharge Volume:	3.0 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Subbasin: OS-1

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	1709.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Precipitation Volume:	665.7 (AC-FT)	Direct Runoff Volume:	463.2 (AC-FT)
Loss Volume:	202.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	463.2 (AC-FT)	Discharge Volume:	463.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	OS-2	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	104.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	24.4 (AC-FT)	Direct Runoff Volume:	17.1 (AC-FT)
Loss Volume:	7.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	17.1 (AC-FT)	Discharge Volume:	17.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: OS-3

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	41.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	9.8 (AC-FT)	Direct Runoff Volume:	6.9 (AC-FT)
Loss Volume:	2.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	6.9 (AC-FT)	Discharge Volume:	6.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: OS-5

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	17.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:50
Precipitation Volume:	5.5 (AC-FT)	Direct Runoff Volume:	3.9 (AC-FT)
Loss Volume:	1.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	3.9 (AC-FT)	Discharge Volume:	3.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
		Reach:	PRE-8A HC

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	1709.8 (CFS)	Date/Time of Peak Inflow	02Oct2018, 13:10
Peak Discharge:	1707.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Inflow Volume:	463.2 (AC-FT)	Discharge Volume:	463.2 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Reach: PRE-8C HC

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	1831.2 (CFS)	Date/Time of Peak Inflow	02Oct2018, 13:10
Peak Discharge:	1811.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:20
Inflow Volume:	502.0 (AC-FT)	Discharge Volume:	501.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	PRE-11 TK Parkway	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	3.0 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:30
Peak Discharge:	3.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Inflow Volume:	0.5 (AC-FT)	Discharge Volume:	0.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	OS-3 REACH	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	83.6 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:40
Peak Discharge:	81.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:50
Inflow Volume:	14.9 (AC-FT)	Discharge Volume:	14.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Junction:	Junction-1	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	1831.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Volume:	502.0 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Junction:	Junction-2	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	44.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	8.0 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Junction: Junction-3

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	83.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	14.9 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-1A1	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	11.0 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	10.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	1.4 (AC-FT)	Discharge Volume:	1.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-1A2	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	10.4 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	10.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Inflow Volume:	1.4 (AC-FT)	Discharge Volume:	1.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
		Reach:	CHAN-1A3

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	139.1 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	137.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	14.8 (AC-FT)	Discharge Volume:	14.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-1A4	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	137.0 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	134.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	14.8 (AC-FT)	Discharge Volume:	14.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-2A1	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	99.7 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	99.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	10.2 (AC-FT)	Discharge Volume:	10.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
		Reach:	CHAN-2A2

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	99.5 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	98.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	10.2 (AC-FT)	Discharge Volume:	10.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-2A3	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	98.1 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	95.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	10.2 (AC-FT)	Discharge Volume:	10.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-2A4	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	95.9 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	87.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	10.2 (AC-FT)	Discharge Volume:	10.3 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
		Reach:	CHAN-2A5

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	219.0 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	207.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	23.8 (AC-FT)	Discharge Volume:	23.8 (AC-FT)

Project: City of Waco Landfill Simulation Run: 25 yr, 24 hr (post)

Reach: CHAN-3A1

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	116.7 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	110.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	12.0 (AC-FT)	Discharge Volume:	12.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
		Reach:	CHAN-4A1

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	13.9 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	13.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4A2	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	13.0 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	12.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
		Reach:	CHAN-4A3

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	83.1 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	82.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	8.8 (AC-FT)	Discharge Volume:	8.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
		Reach:	CHAN-4A4

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	82.5 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	78.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	8.8 (AC-FT)	Discharge Volume:	8.8 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Reach: CHAN-4A5

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	78.1 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	75.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	8.8 (AC-FT)	Discharge Volume:	8.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4B1	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	9.7 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	9.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4B2	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	9.3 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	9.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4B3	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	55.9 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	54.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	5.9 (AC-FT)	Discharge Volume:	5.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4B4	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	54.8 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	53.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	5.9 (AC-FT)	Discharge Volume:	5.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4B5	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	53.9 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	51.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	5.9 (AC-FT)	Discharge Volume:	5.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4B6	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	51.5 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	49.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	5.9 (AC-FT)	Discharge Volume:	5.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Reach: CHAN-4B7

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	182.0 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	180.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	19.5 (AC-FT)	Discharge Volume:	19.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reach:	CHAN-4B8	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	180.8 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:10
Peak Discharge:	169.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Inflow Volume:	19.5 (AC-FT)	Discharge Volume:	19.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	DA-1A	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	130.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	15.0 (AC-FT)	Direct Runoff Volume:	13.4 (AC-FT)
Loss Volume:	3.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	11.6 (AC-FT)	Discharge Volume:	13.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	DA-1B	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	17.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	2.3 (AC-FT)	Direct Runoff Volume:	1.8 (AC-FT)
Loss Volume:	0.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.8 (AC-FT)	Discharge Volume:	1.8 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Subbasin: DA-1C

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	11.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.8 (AC-FT)	Direct Runoff Volume:	1.4 (AC-FT)
Loss Volume:	0.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.4 (AC-FT)	Discharge Volume:	1.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	DA-1D	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.0 (AC-FT)	Direct Runoff Volume:	0.8 (AC-FT)
Loss Volume:	0.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.8 (AC-FT)	Discharge Volume:	0.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-1E

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	5.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	0.8 (AC-FT)	Direct Runoff Volume:	0.6 (AC-FT)
Loss Volume:	0.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.6 (AC-FT)	Discharge Volume:	0.6 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Subbasin: DA-2A

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	99.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	11.9 (AC-FT)	Direct Runoff Volume:	10.2 (AC-FT)
Loss Volume:	2.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	9.2 (AC-FT)	Discharge Volume:	10.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-2B

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	9.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.3 (AC-FT)	Direct Runoff Volume:	1.0 (AC-FT)
Loss Volume:	0.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.0 (AC-FT)	Discharge Volume:	1.0 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-3A

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	131.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	15.7 (AC-FT)	Direct Runoff Volume:	13.5 (AC-FT)
Loss Volume:	3.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	12.2 (AC-FT)	Discharge Volume:	13.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-3B

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	12.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.7 (AC-FT)	Direct Runoff Volume:	1.3 (AC-FT)
Loss Volume:	0.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.3 (AC-FT)	Discharge Volume:	1.3 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-3C

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	147.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	17.7 (AC-FT)	Direct Runoff Volume:	15.1 (AC-FT)
Loss Volume:	4.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	13.7 (AC-FT)	Discharge Volume:	15.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-3D

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	12.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.7 (AC-FT)	Direct Runoff Volume:	1.3 (AC-FT)
Loss Volume:	0.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.3 (AC-FT)	Discharge Volume:	1.3 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	DA-3E	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	116.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	14.3 (AC-FT)	Direct Runoff Volume:	12.0 (AC-FT)
Loss Volume:	3.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	11.1 (AC-FT)	Discharge Volume:	12.0 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Subbasin: DA-3F

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	8.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.1 (AC-FT)	Direct Runoff Volume:	0.9 (AC-FT)
Loss Volume:	0.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.9 (AC-FT)	Discharge Volume:	0.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-4A

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	111.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	12.6 (AC-FT)	Direct Runoff Volume:	11.4 (AC-FT)
Loss Volume:	2.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	9.8 (AC-FT)	Discharge Volume:	11.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-4B

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	15.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	2.1 (AC-FT)	Direct Runoff Volume:	1.6 (AC-FT)
Loss Volume:	0.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.6 (AC-FT)	Discharge Volume:	1.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-4C

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	70.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	8.2 (AC-FT)	Direct Runoff Volume:	7.2 (AC-FT)
Loss Volume:	1.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	6.3 (AC-FT)	Discharge Volume:	7.2 (AC-FT)

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Subbasin: DA-4D

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	8.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.1 (AC-FT)	Direct Runoff Volume:	0.9 (AC-FT)
Loss Volume:	0.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.9 (AC-FT)	Discharge Volume:	0.9 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-4E

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	13.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	2.0 (AC-FT)	Direct Runoff Volume:	1.5 (AC-FT)
Loss Volume:	0.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-5A

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	132.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	16.0 (AC-FT)	Direct Runoff Volume:	13.6 (AC-FT)
Loss Volume:	3.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	12.4 (AC-FT)	Discharge Volume:	13.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-5B

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	11.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.5 (AC-FT)	Direct Runoff Volume:	1.2 (AC-FT)
Loss Volume:	0.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.2 (AC-FT)	Discharge Volume:	1.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-5C

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	46.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	4.2 (AC-FT)	Direct Runoff Volume:	4.8 (AC-FT)
Loss Volume:	0.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	3.2 (AC-FT)	Discharge Volume:	4.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	DA-5D	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	15.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	2.0 (AC-FT)	Direct Runoff Volume:	1.6 (AC-FT)
Loss Volume:	0.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.6 (AC-FT)	Discharge Volume:	1.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: DA-5E

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 20:44:29	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	9.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.4 (AC-FT)	Direct Runoff Volume:	1.1 (AC-FT)
Loss Volume:	0.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Junction: POD-1

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	150.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Volume:	25.2 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Junction: POD-2

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	16.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Volume:	2.2 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Junction: POD-3

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	32.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Volume:	5.2 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Junction: POD-4

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	10.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Volume:	1.4 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Junction: POD-5

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	53.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Volume:	8.9 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Junction: POD-6

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Volume:	1.1 (AC-FT)		

Project: City of Waco Landfill | Simulation Run: 25 yr, 24 hr (post)

Junction: POD-7

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	33.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Volume:	5.6 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Junction: POD-8

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	2060.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:20
Volume:	621.8 (AC-FT)		

Project: City of Waco Landfill   Simulation Run: 25 yr, 24 hr (post)

Junction: POD-9

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	4.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	0.7 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Junction: POD-10

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	7.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Volume:	1.3 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Junction: POD-11

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	21.0 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Volume:	3.0 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: EDA EAST

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	10.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	1.3 (AC-FT)	Direct Runoff Volume:	1.2 (AC-FT)
Loss Volume:	0.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.2 (AC-FT)	Discharge Volume:	1.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reservoir:	EDA EAST BASIN	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	151.7 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 12:10
Peak Discharge:	106.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:20
Inflow Volume:	16.8 (AC-FT)	Peak Storage:	4.7 (AC-FT)
Discharge Volume:	16.8 (AC-FT)	Peak Elevation:	537.7 (FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)

Subbasin: EDA WEST

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	37.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	4.6 (AC-FT)	Direct Runoff Volume:	4.6 (AC-FT)
Loss Volume:	0.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	4.6 (AC-FT)	Discharge Volume:	4.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reservoir:	EDA WEST BASIN	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	503.2 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 12:10
Peak Discharge:	41.8 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 14:10
Inflow Volume:	55.5 (AC-FT)	Peak Storage:	36.6 (AC-FT)
Discharge Volume:	35.4 (AC-FT)	Peak Elevation:	535.9 (FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Subbasin:	WDA	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	34.3 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:10
Precipitation Volume:	4.2 (AC-FT)	Direct Runoff Volume:	4.1 (AC-FT)
Loss Volume:	0.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	4.1 (AC-FT)	Discharge Volume:	4.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reservoir:	WDA BASIN	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	390.4 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 12:10
Peak Discharge:	22.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 15:30
Inflow Volume:	43.9 (AC-FT)	Peak Storage:	31.5 (AC-FT)
Discharge Volume:	21.8 (AC-FT)	Peak Elevation:	536.6 (FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reservoir:	Site 19 - North Reservoir	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	206.5 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 12:20
Peak Discharge:	3.9 (CFS)	Date/Time of Peak Discharge:	03Oct2018, 00:30
Inflow Volume:	34.0 (AC-FT)	Peak Storage:	29.3 (AC-FT)
Discharge Volume:	10.5 (AC-FT)	Peak Elevation:	520.8 (FT)

Project:	City of Waco Landfill	Simulation Run:	25 yr, 24 hr (post)
	Reservoir:	Site-19 Reservoir	

Start of Run:	02Oct2018, 00:00	Basin Model:	POST DEVELOPMENT
End of Run:	04Oct2018, 00:00	Meteorologic Model:	25-year, 24-hour
Compute Time:	07Apr2020, 22:21:55	Control Specifications:	48-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	2101.7 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 13:20
Peak Discharge:	62.6 (CFS)	Date/Time of Peak Discharge:	03Oct2018, 01:40
Inflow Volume:	648.6 (AC-FT)	Peak Storage:	568.6 (AC-FT)
Discharge Volume:	167.8 (AC-FT)	Peak Elevation:	523.0 (FT)

APPENDIX 6A-D

DISCHARGE HYDROGRAPHS

SCS Engineers
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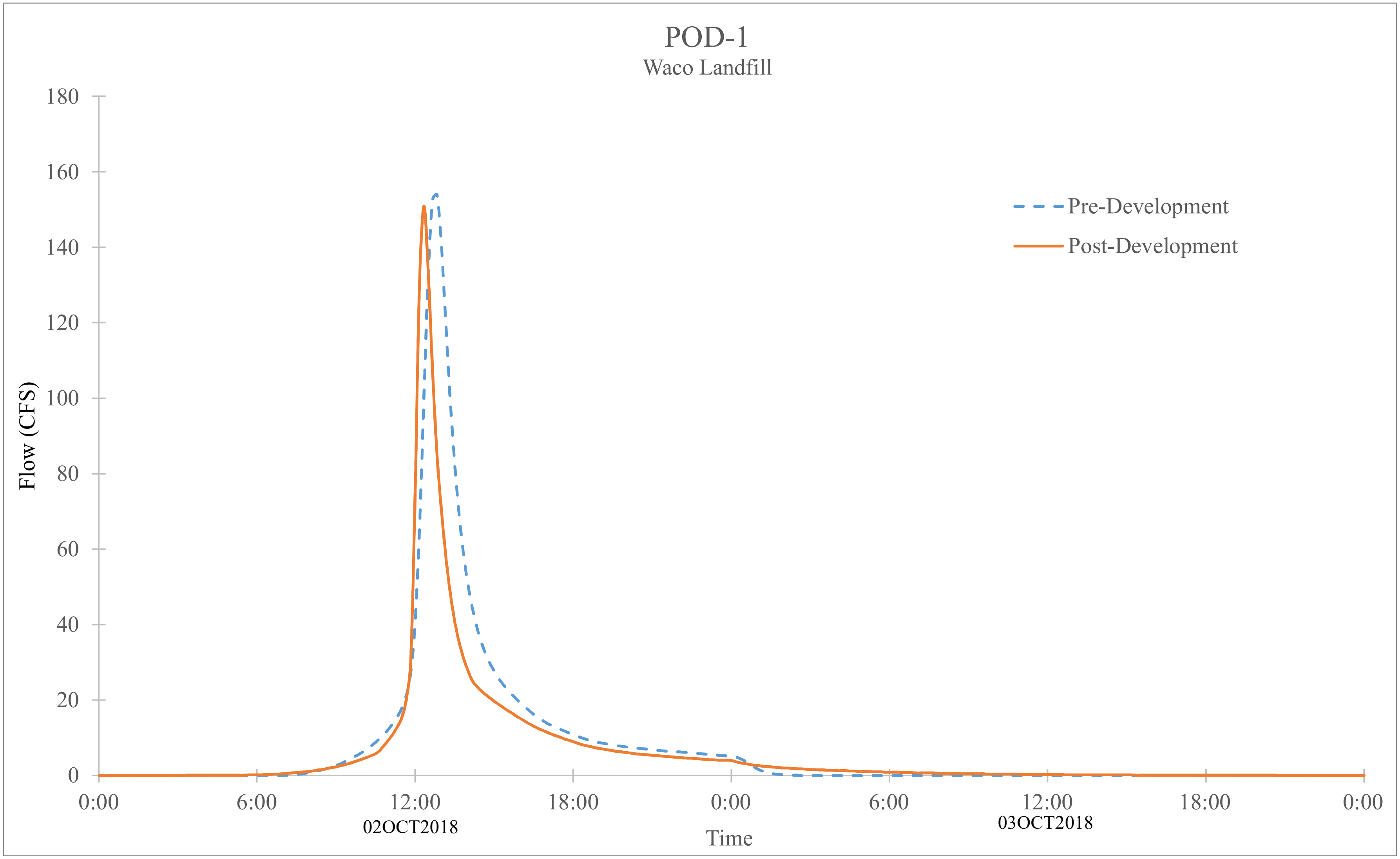
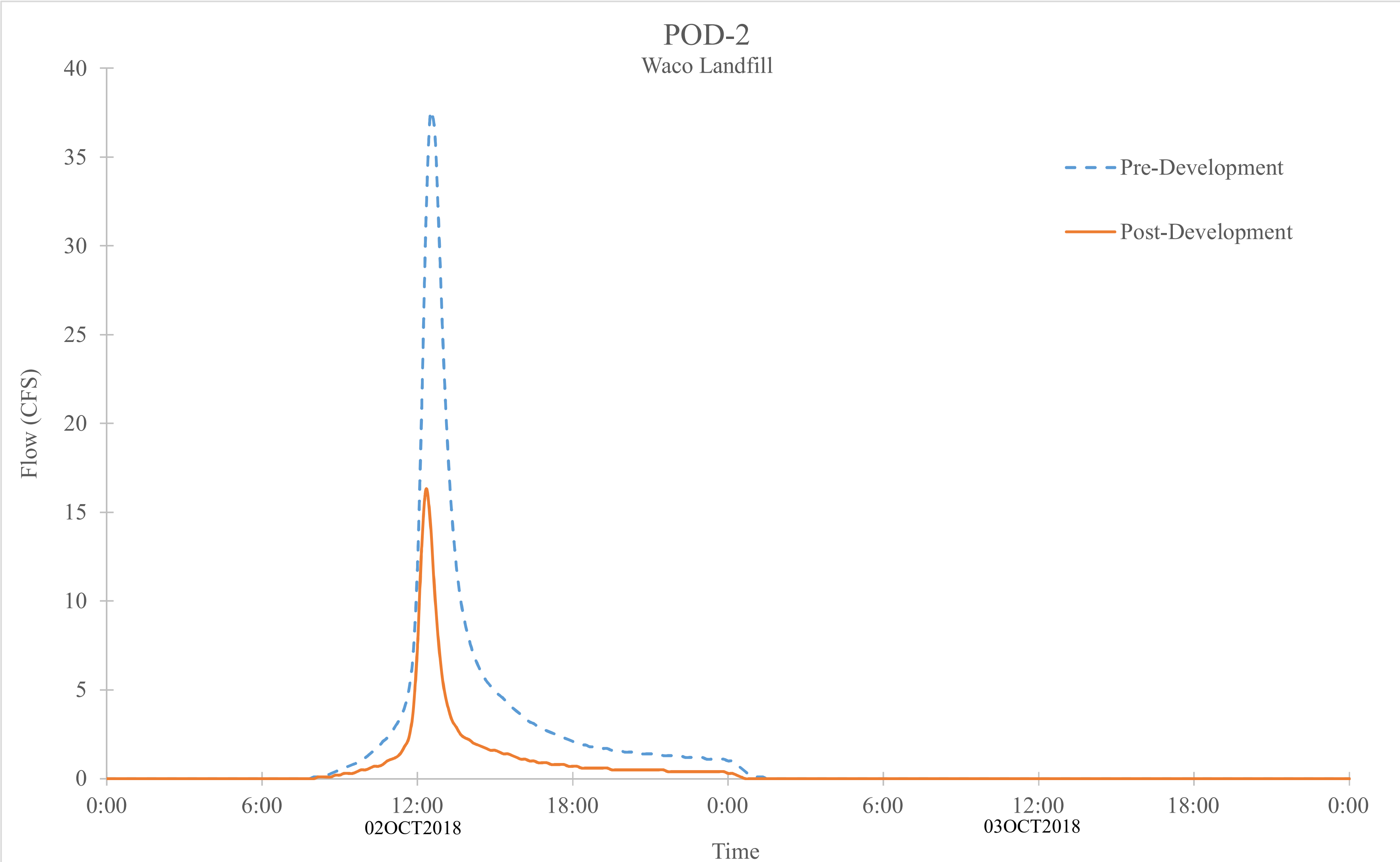
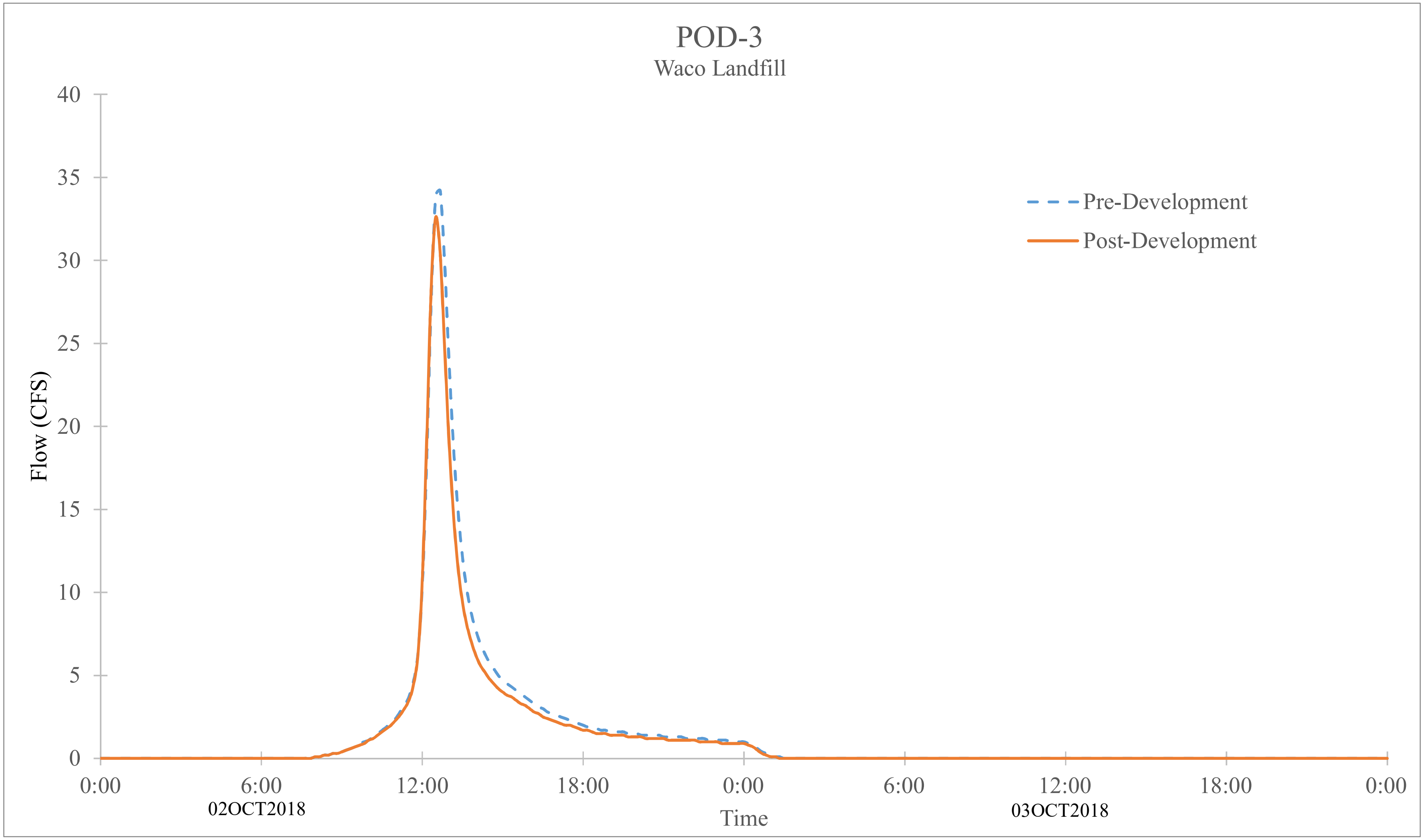
Inclusive of pages 6A-D-1 to 6A-D-12

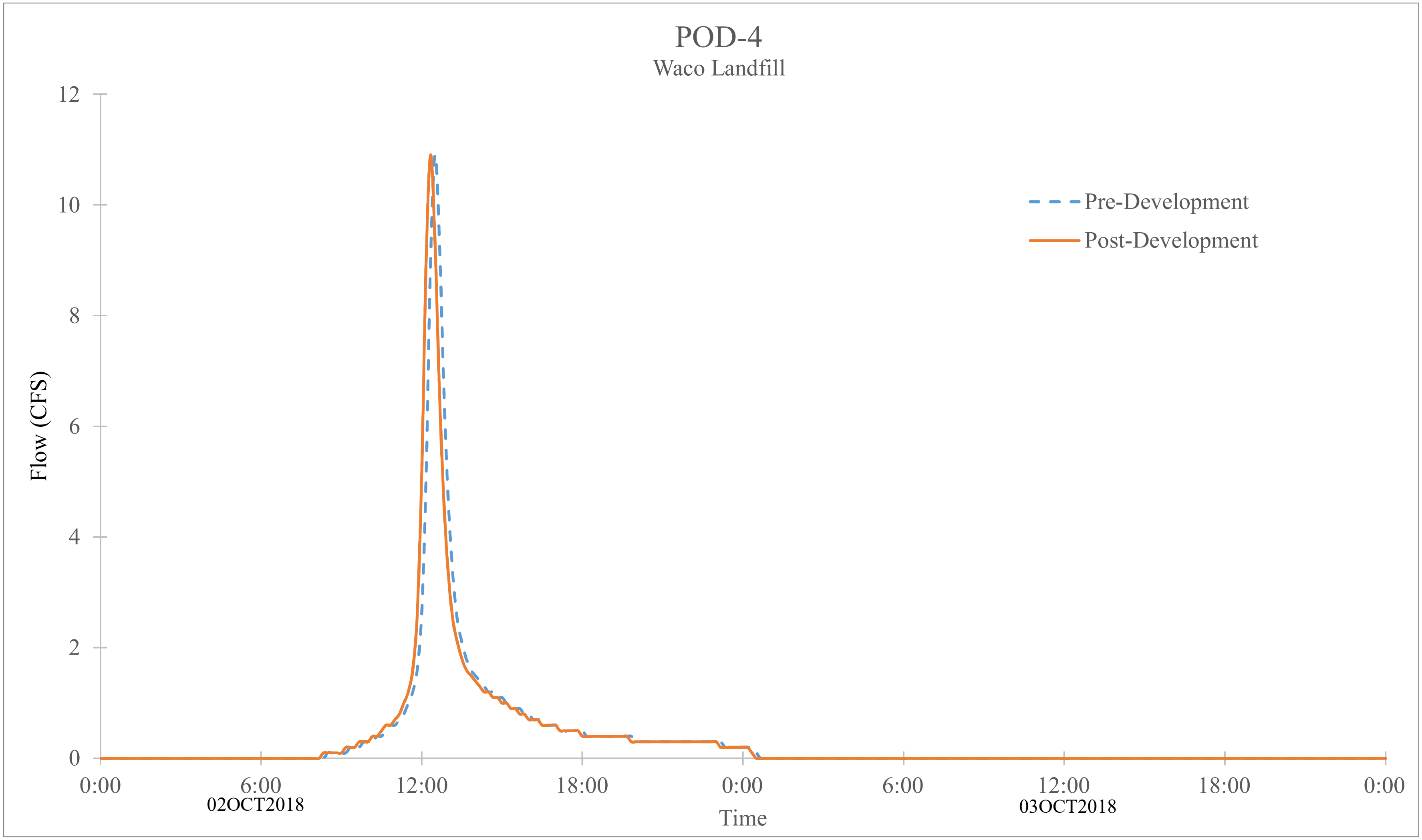


POD-1
Waco Landfill
Flow (CFS)
180
160
140
120
100
80
60
40
20
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
02OCT2018
03OCT2018
Time
Pre-Development
Post-Development

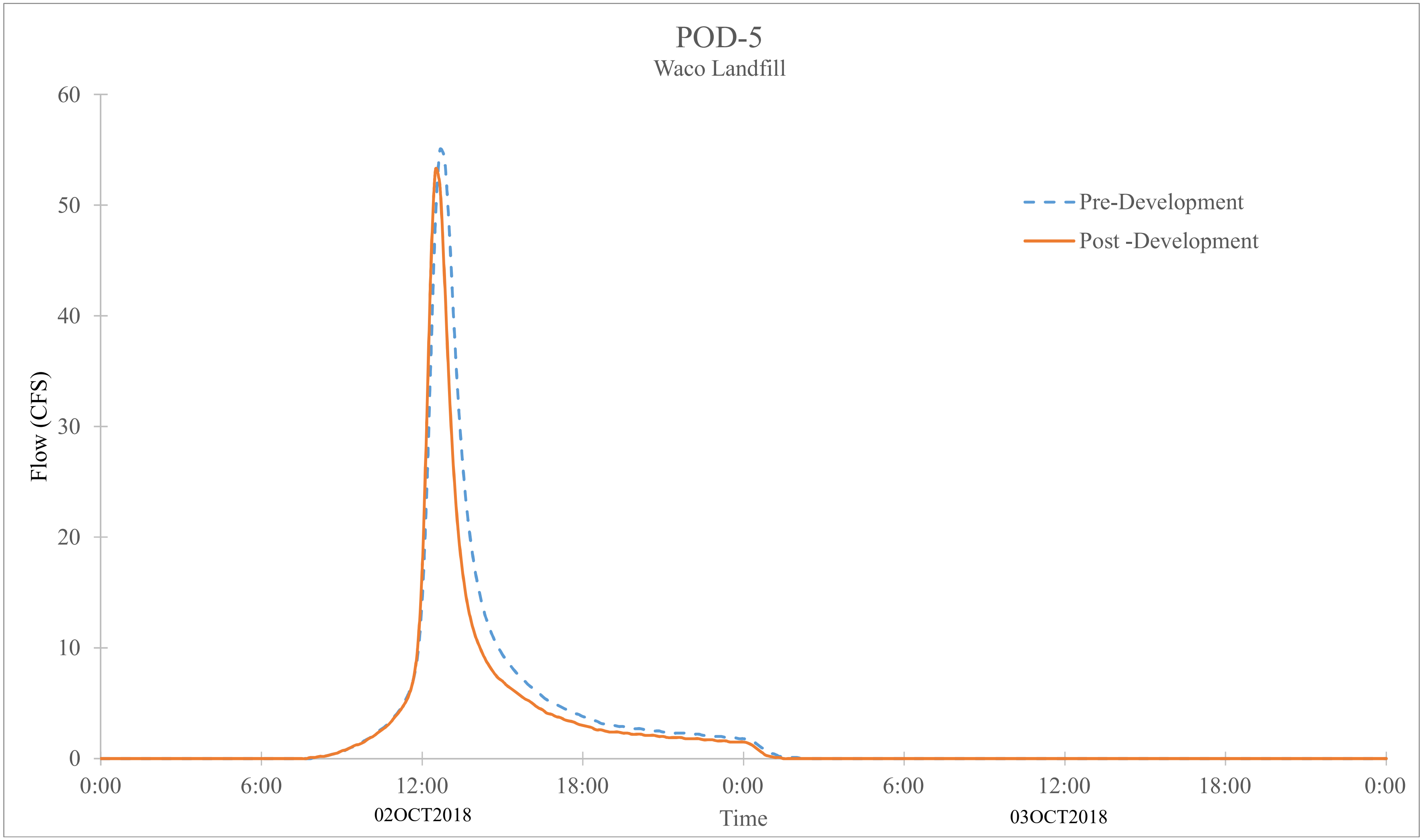

POD-2
Waco Landfill
Flow (CFS)
40
35
30
25
20
15
10
5
0
0:00
6:00
12:00
02OCT2018
18:00
0:00
6:00
12:00
03OCT2018
18:00
0:00
Time
Pre-Development
Post-Development

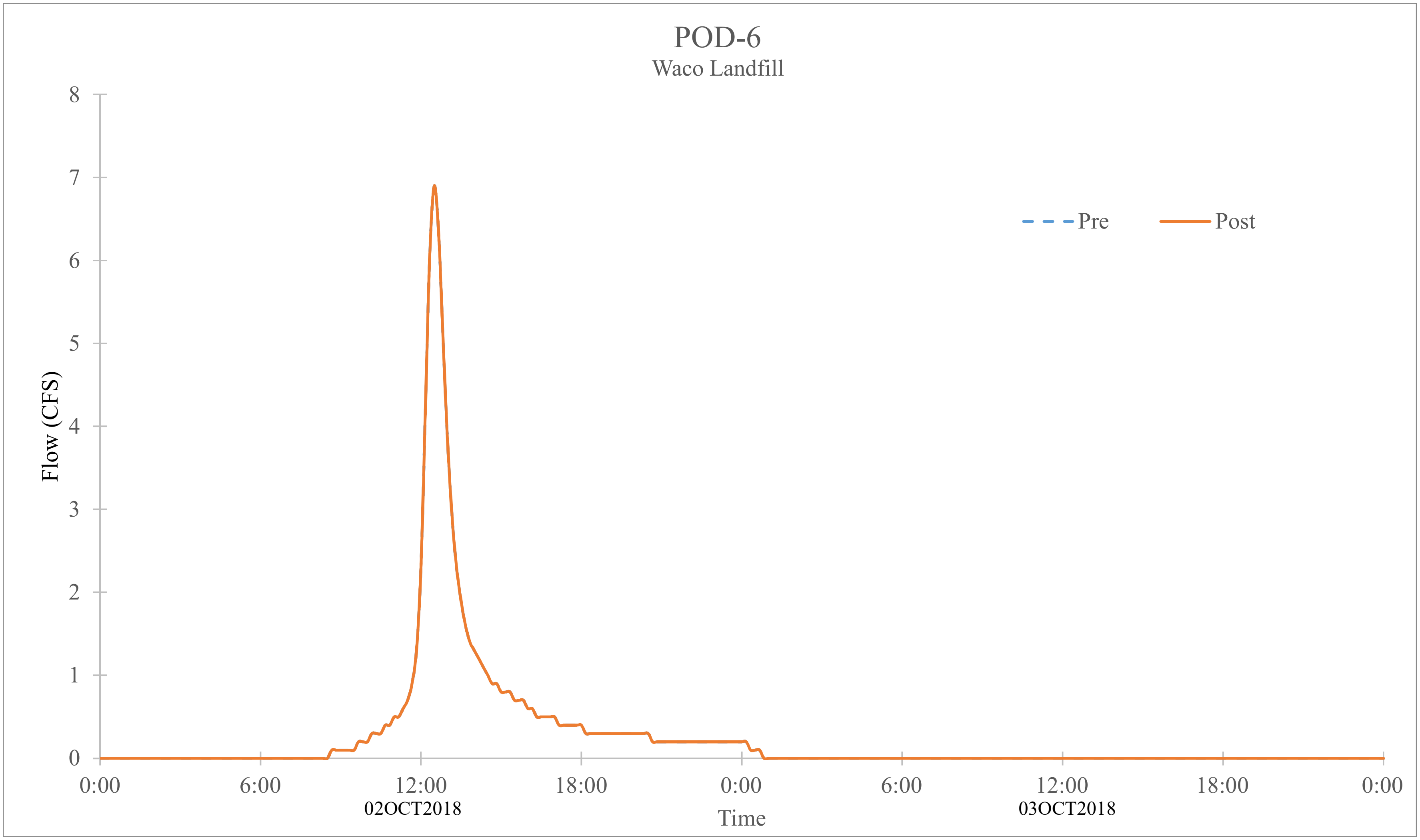


POD-3
Waco Landfill
Flow (CFS)
40
35
30
25
20
15
10
5
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
02OCT2018
03OCT2018
Time
Pre-Development
Post-Development

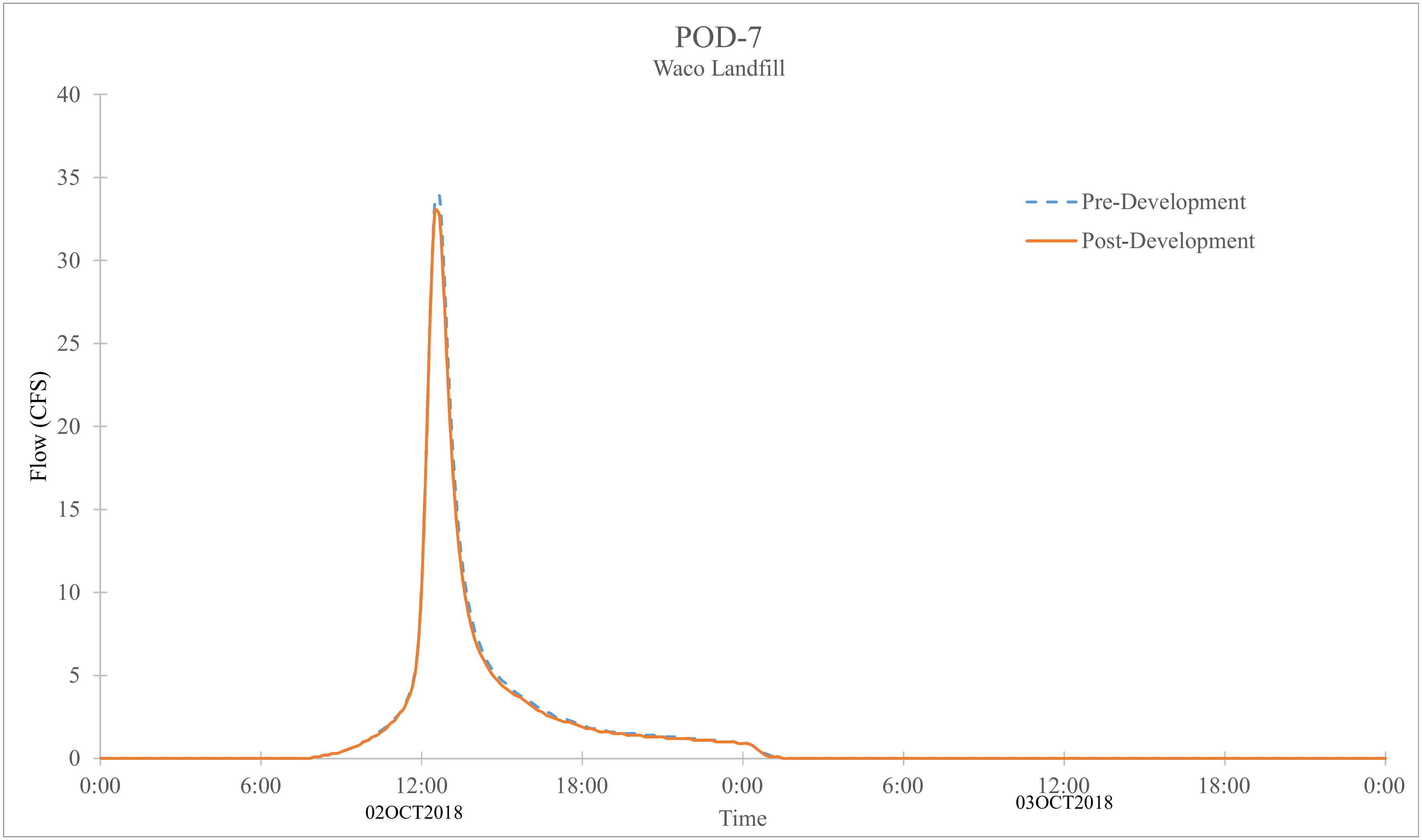


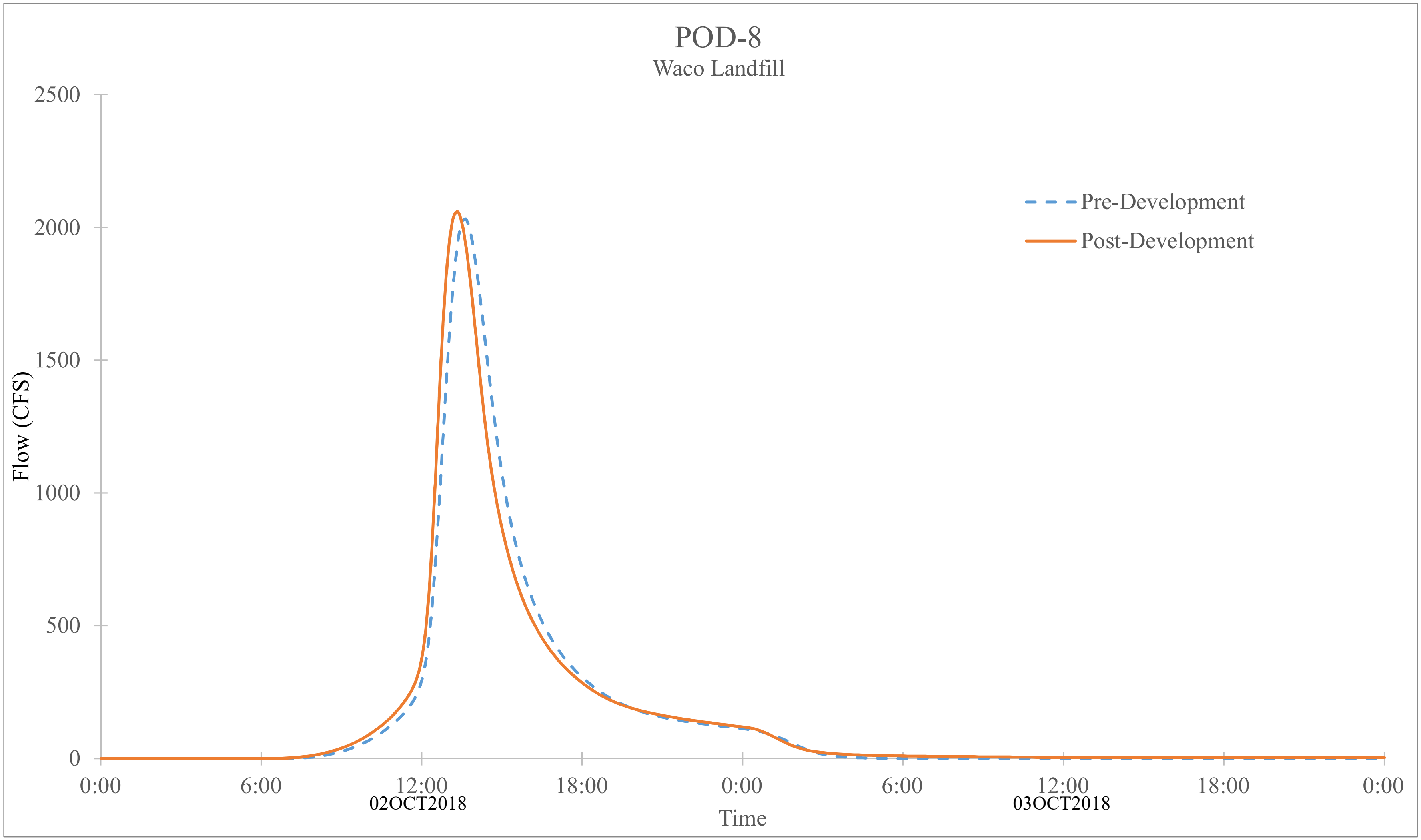
POD-4
Waco Landfill
12
10
8
6
4
2
0
Flow (CFS)
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
02OCT2018
03OCT2018
Time
Pre-Development
Post-Development

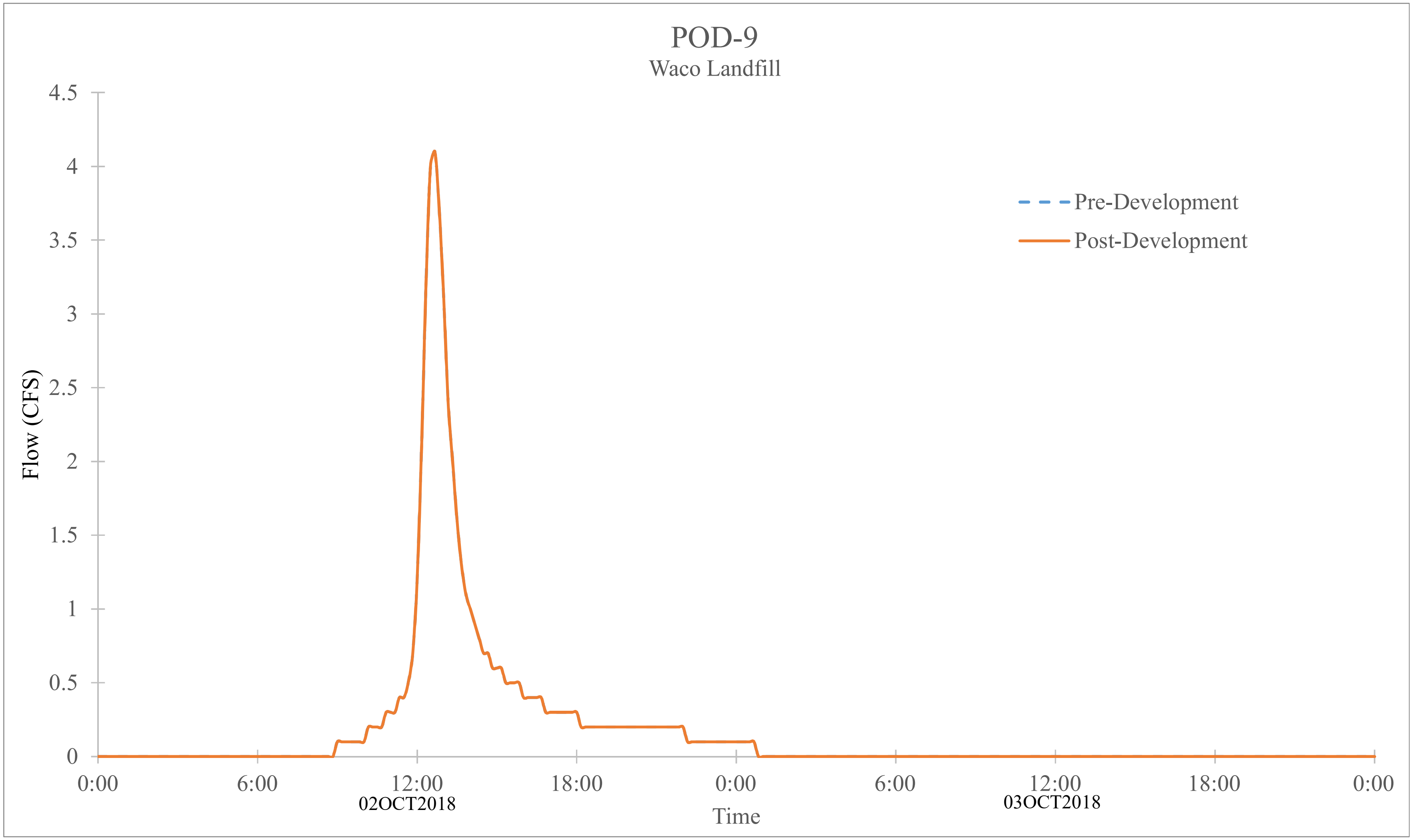

POD-5
Waco Landfill
Flow (CFS)
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
02OCT2018
Time
03OCT2018
Pre-Development
Post -Development

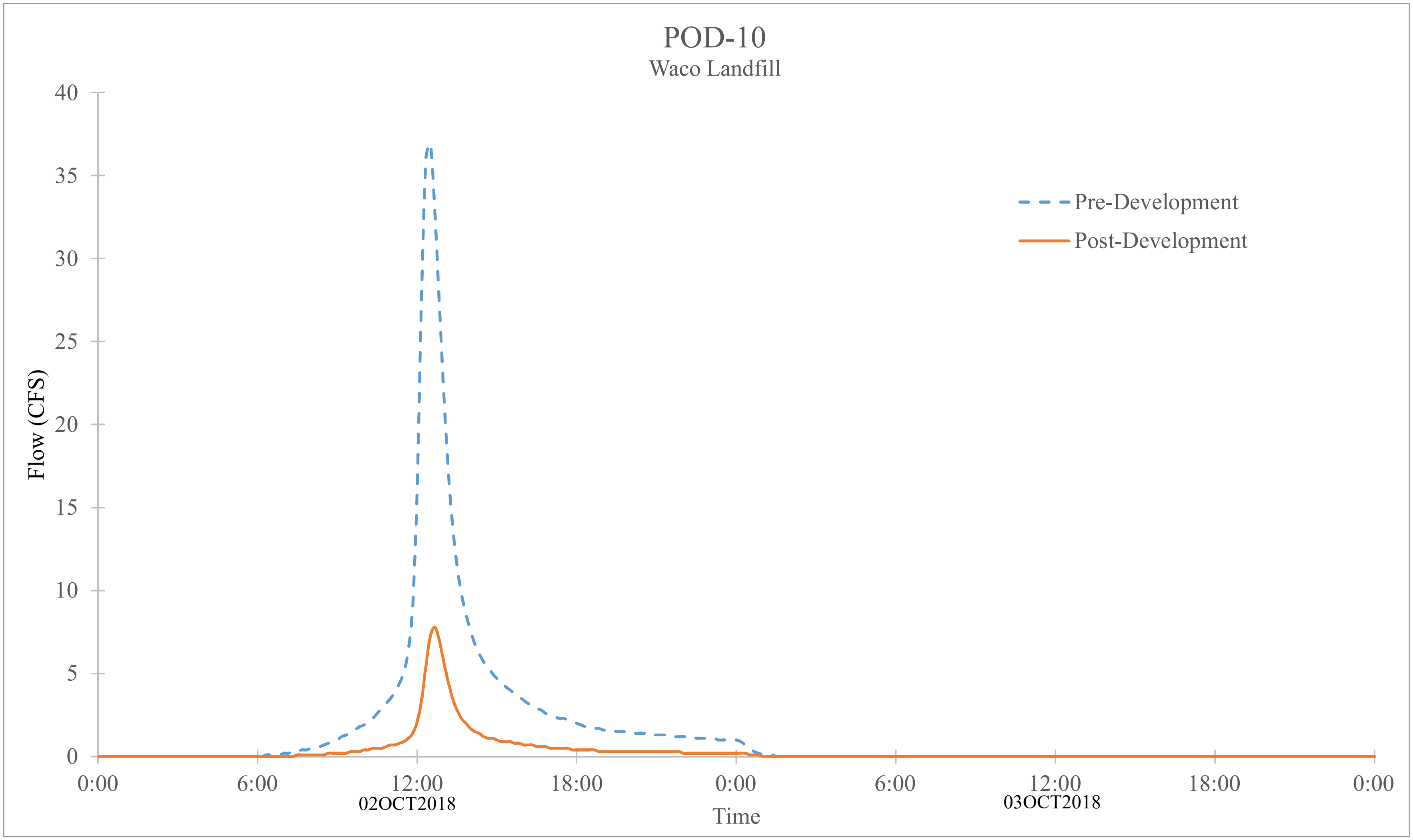


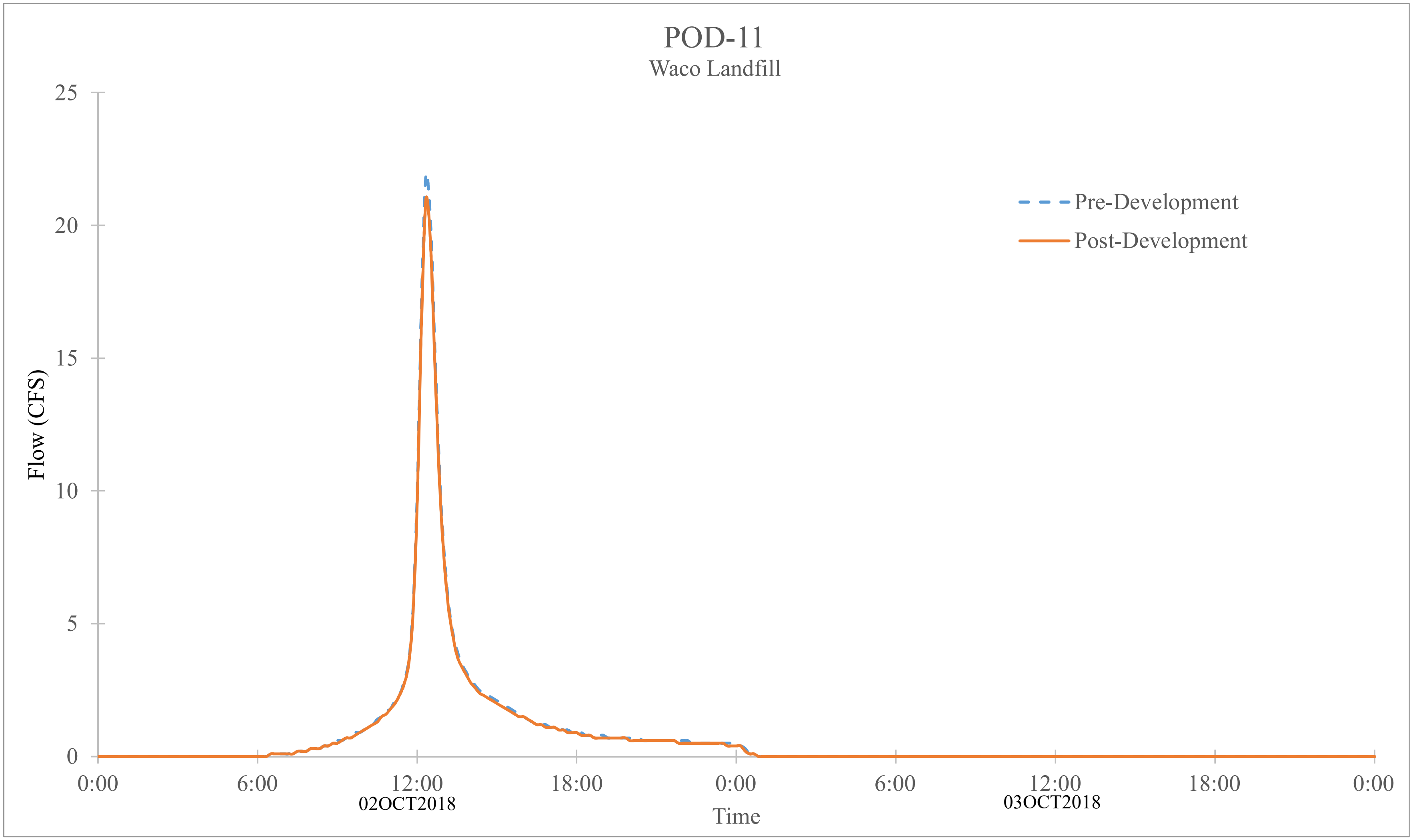
POD-6
Waco Landfill
Flow (CFS)
8
7
6
5
4
3
2
1
0
Pre
Post
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
02OCT2018
03OCT2018
Time


POD-7
Waco Landfill
Flow (CFS)
40
35
30
25
20
15
10
5
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
02OCT2018
03OCT2018
Time
Pre-Development
Post-Development


POD-8
Waco Landfill
Flow (CFS)
2500
2000
1500
1000
500
0
0:00
6:00
12:00
02OCT2018
18:00
0:00
6:00
12:00
03OCT2018
18:00
0:00
Time
Pre-Development
Post-Development


POD-9
Waco Landfill
Flow (CFS)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0:00
6:00
12:00
02OCT2018
18:00
0:00
6:00
12:00
03OCT2018
18:00
0:00
Time
Pre-Development
Post-Development


POD-10
Waco Landfill
Flow (CFS)
40
35
30
25
20
15
10
5
0
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
02OCT2018
03OCT2018
Time
Pre-Development
Post-Development



POD-11
Waco Landfill
Flow (CFS)
25
20
15
10
5
0
0:00
6:00
12:00
02OCT2018
18:00
0:00
6:00
12:00
03OCT2018
18:00
0:00
Time
Pre-Development
Post-Development

APPENDIX 6A-E

HYDRAULIC ANALYSIS

- **Overland Flow Velocity Analysis**
- **Drainage Swale Flow Analysis**
- **Downchute Flow Analysis**
- **Perimeter Channel Flow Analysis (HydroCalc Output Files)**
- **Hydraulic Analysis References**
- **Hydraulic Analysis Drawings 6A-E.1 through 6A-E.5**

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Inclusive of pages 6A-E-1 to 6A-E-77

OVERLAND FLOW VELOCITY ANALYSIS

INTERMEDIATE COVER – OVERLAND FLOW VELOCITY

CITY OF WACO LANDFILL
INTERMEDIATE COVER
OVERLAND FLOW VELOCITY

Required:

Calculate the peak velocity on intermediate sideslopes and topslopes. Compare calculated peak velocities to permissible non-erodible flow velocity for intermediate cover.

Method:

1. Determine the time of concentration (t_C) and sheet flow velocity on intermediate cover using the Manning's Kinematic Solution.
2. Determine the shallow concentrated flow velocity on intermediate cover using a derivation of Manning's Equation.
3. Compare peak velocity to permissible non-erodible velocity.

References:

1. Texas Department of Transportation, *Bridge Division Hydraulic Manual* , November 2004.
2. Natural Resouces Conservation Service, *Urban Hydrology for Small Watersheds* , *Technical Release 55* , Junes 1986.

Solution:

Calculate the expected peak overland flow velocity on the intermediate cover, using the above methods, for both Case 1 - 390-foot Intermediate Sideslope and Case 2 - 650-foot Intermediate Topslope.

Note: the sideslope length is the greatest spacing between drainage swales on intermediate cover, and the topslope length is the greatest length anticipated on intermediate topslopes prior to additional aerial fill above the first row of drainage swales on intermediate cover (see Drawing 6A-E.3).

CITY OF WACO LANDFILL
INTERMEDIATE COVER
OVERLAND FLOW VELOCITY

Case 1: 390-foot Intermediate Sideslope:

1. Determine the time of concentration (t_C) and sheet flow velocity on intermediate cover sideslopes using the Manning's Kinematic Solution.

Sheet Flow Velocity:

Sheet Flow Length = 100 ft
Slope = 0.25 ft/ft

Sheet Flow Time of Concentration Equation:

$$t_c = \frac{0.007(nL)^{0.8}}{(P_{25,24})^{0.5} S^{0.4}}$$

Where:	t_c =	sheet flow time of concentration (hr)
	n =	Manning's roughness coefficient
	L =	slope length
	$P_{25,24}$ =	25-year, 24-hour rainfall depth (in)
	S =	slope (ft/ft)

Sheet Flow Velocity Equation:

$$V = \frac{L}{60t_c}$$

Where:	V =	sheet flow velocity (fps)
	t_c =	sheet flow time of concentration (min)
	L =	sheet flow length (ft)

Calculate t_c:

n = 0.09
L = 100
$P_{25,24}$ = 7.90
S = 0.25

(**See page 6A-E-75**, 60 percent of the full surface roughness coefficient for short grass is used, consistent with a minimum of 60 percent vegetation on intermediate cover).

t_c =	0.025	hr
	1.51	min

Calculate the sheet flow velocity:

L = 100
t_c = 1.51

V =	1.10	fps

CITY OF WACO LANDFILL
INTERMEDIATE COVER
OVERLAND FLOW VELOCITY

2. Determine the shallow concentrated flow velocity on the sideslopes using a derivation of Manning's Equation.

Shallow Concentrated Flow Velocity:

Shallow Concentrated Flow Length = 300 ft
Slope = 0.25 ft/ft

Rational Method Equation:

$$Q = CiA$$

Where:		
	Q =	flow rate (cfs)
	C =	runoff coefficient
	i =	rainfall intensity (in/hr)
	A =	drainage area (ac) (assume unit width for flow area)

Intensity Equation:

$$i = b / (t_c + d)^e$$

Where:				
	i =	rainfall intensity (in/hr)		
	b =	Constant for Limestone County	=	103.56
	d =	Constant for Limestone County	=	11.0
	e =	Constant for Limestone County	=	0.806
	t_c =	time of concentration (min) (noted below)		

Time of Concentration Equation:

$$t_c = \frac{L}{V} = 1.89 \text{ min (see note below)}$$

Note: (t_c is solved through trial and error by manually adjusting the value for the time of concentration until the ratio of length to velocity and t_c to reach the peak flow rate, as calculated using the Rational Method, are equal)

Calculate peak flow rate for unit width of flow:

C =	0.77		
t_c =	1.89	min	(see note above)
i =	13.20	in/hr	
A =	0.0069	ac	(Unit width of flow, w = 1 ft. Therefore, A = L/43560)

$$\boxed{Q = 0.070 \text{ cfs}}$$

CITY OF WACO LANDFILL
INTERMEDIATE COVER
OVERLAND FLOW VELOCITY

Calculate approximate depth of flow derived from Manning's Method Equation (see attached derivation, page 6A-E-69):

$$d = \left(\frac{Qn}{1.49S^{0.5}} \right)^{0.6}$$

Q =	0.070	cfs
n =	0.025	(Manning's n for channel flow, conservative)
S =	0.25	ft/ft

d =	0.026	ft	=	0.32	in

Calculate shallow concentrated flow velocity:

$$V = \frac{Q}{A} = \frac{Q}{d}$$

V =	2.65	fps

3. Compare peak velocity to permissible non-erodible velocity.

Case 1 Conclusion:
The peak velocity on the sideslope is associated with the shallow concentrated flow component of overland flow. The calculated sideslope shallow concentrated flow velocity is less than the permissible non-erodible velocity of 3.0 ft/s on intermediate cover, as discussed in Attachment 6A, Subsection 2.2. Therefore, the expected peak velocity is acceptable on the intermediate sideslopes following placement of drainage swales at a horizontal spacing of 400 feet on a 4H:1V slope.

Case 2: 650-foot Intermediate Topslope:

1. Determine the time of concentration (t_C) and sheet flow velocity on intermediate cover topslopes using the Manning's Kinematic Solution.

Sheet Flow Velocity:

Sheet Flow Length =	100	ft
Slope =	0.05	ft/ft

Sheet Flow Time of Concentration Equation:

$$t_c = \frac{0.007(nL)^{0.8}}{(P_{25,24})^{0.5}S^{0.4}}$$ **(as described above)**

CITY OF WACO LANDFILL
INTERMEDIATE COVER
OVERLAND FLOW VELOCITY

Sheet Flow Velocity Equation:

$$V = \frac{L}{60t_c}$$ **(as described above)**

Calculate t_c:

$n =$	0.09	(**See page 6A-E-75**, 60 percent of the full surface
$L =$	100	roughness coefficient for short grass is used,
$P_{25,24} =$	7.90	consistent with a minimum of 60 percent vegetation on
$S =$	0.05	intermediate cover).

$t_c =$	0.048	hr
	2.87	min

Calculate the sheet flow velocity:

$L =$	100
$t_c =$	2.87

$V =$	0.58	fps

2. Determine the shallow concentrated flow velocity on the topslopes using a derivation of Manning's Equation.

Shallow Concentrated Flow Velocity:

Shallow Concentrated Flow Length =	550	ft
Slope =	0.05	ft/ft

Rational Method Equation:

$$Q = CiA$$ **(as described above)**

Where:

$Q =$	flow rate (cfs)
$C =$	runoff coefficient
$i =$	rainfall intensity (in/hr)
$A =$	drainage area (ac) (assume unit width for flow area)

Intensity Equation:

$$i = b / (t_c + d)^e$$ **(as described above)**

Time of Concentration Equation:

$$t_c = \frac{L}{V} = 4.90$$ min (see note below)

CITY OF WACO LANDFILL
INTERMEDIATE COVER
OVERLAND FLOW VELOCITY

Note: (t_c is solved through trial and error by manually adjusting the value for the time of concentration until the ratio of length to velocity and t_c to reach the peak flow rate, as calculated using the Rational Method, are equal)

Calculate peak flow rate for unit width of flow:

C =	0.7		
t_c =	4.90	min	(see note above)
i =	11.14	in/hr	
A =	0.0126	ac	(Unit width of flow, w = 1 ft. Therefore, A = L/43560)

Q =	0.098	cfs

Calculate approximate depth of flow derived from Manning's Method Equation (see attached derivation, page 6A-E-69):

$$d = \left(\frac{Qn}{1.49 S^{0.5}} \right)^{0.6}$$

Q =	0.098	cfs
n =	0.025	(Manning's n for channel flow, conservative)
S =	0.05	ft/ft

d =	0.053	ft	=	0.63	in

Calculate shallow concentrated flow velocity:

$$V = \frac{Q}{A} = \frac{Q}{d}$$

V =	1.87	fps

3. Compare peak velocity to permissible non-erodible velocity.

Case 2 Conclusion:
The peak velocity on the topslope is associated with the shallow concentrated flow component of overland flow. The calculated topslope shallow concentrated flow velocity is less than the permissible non-erodible velocity of 3.0 ft/s on intermediate cover, as discussed in Attachment 6A, Subsection 2.2. Therefore, the expected peak velocity is acceptable on the worst-case intermediate topslope length. No other structural controls are necessary on the topslope for this scenario.

FINAL COVER – OVERLAND FLOW VELOCITY

CITY OF WACO LANDFILL
FINAL COVER
OVERLAND FLOW VELOCITY

Required:

Calculate the peak velocity on final cover sideslopes and topslopes. Compare calculated peak velocities to permissible non-erodible flow velocity for final cover.

Method:

1. Determine the time of concentration (t_C) and sheet flow velocity on final cover using the Manning's Kinematic Solution.
2. Determine the shallow concentrated flow velocity on final cover using a derivation of Manning's Equation.
3. Compare peak velocity to permissible non-erodible velocity.

References:

1. Texas Department of Transportation, *Bridge Division Hydraulic Manual* , November 2004.
2. Natural Resouces Conservation Service, *Urban Hydrology for Small Watersheds* , *Technical Release 55* , Junes 1986.

Solution:

Calculate the expected peak overland flow velocity on the final cover, using the above methods, for both Case 1 - 130-foot Final Cover Sideslope and Case 2 - 250-foot Final Cover Topslope.

Note: The sideslope length is the greatest spacing between drainage swales on final cover, and the topslope length is the greatest flow length on the final cover topslope.

CITY OF WACO LANDFILL
FINAL COVER
OVERLAND FLOW VELOCITY

Case 1: 130-foot Final Cover Sideslope:

1. Determine the time of concentration (t_C) and sheet flow velocity on final cover sideslopes using the Manning's Kinematic Solution.

<u>Sheet Flow Velocity:</u>

Sheet Flow Length =	100	ft
Slope =	0.25	ft/ft

Sheet Flow Time of Concentration Equation:

$$t_c = \frac{0.007(nL)^{0.8}}{(P_{25,24})^{0.5}S^{0.4}}$$

Where:

t_c =	sheet flow time of concentration (hr)
n =	Manning's roughness coefficient
L =	slope length
$P_{25,24}$ =	25-year, 24-hour rainfall depth (in)
S =	slope (ft/ft)

Sheet Flow Velocity Equation:

$$V = \frac{L}{60t_c}$$

Where:

V =	sheet flow velocity (fps)
t_c =	sheet flow time of concentration (min)
L =	sheet flow length (ft)

Calculate t_c:

n =	0.15	(**See page 6A-E-75**, surface roughness for short grass)
L =	100	
$P_{25,24}$ =	7.90	
S =	0.25	

t_c =	0.038	hr
	2.27	min

Calculate the sheet flow velocity:

L =	100
t_c =	2.27

V =	0.73	fps

CITY OF WACO LANDFILL
FINAL COVER
OVERLAND FLOW VELOCITY

2. Determine the shallow concentrated flow velocity on the sideslopes using a derivation of Manning's Equation.

Shallow Concentrated Flow Velocity:

Shallow Concentrated Flow Length = 30 ft
Slope = 0.25 ft/ft

Rational Method Equation:

$$Q = CiA$$

Where:
- Q = flow rate (cfs)
- C = runoff coefficient
- i = rainfall intensity (in/hr)
- A = drainage area (ac) (assume unit width for flow area)

Intensity Equation:

$$i = b / (t_c + d)^e$$

Where:
- i = rainfall intensity (in/hr)
- b = Constant for Limestone County = 103.56
- d = Constant for Limestone County = 11.0
- e = Constant for Limestone County = 0.806
- t_c = time of concentration (min) (noted below)

Time of Concentration Equation:

$$t_c = \frac{L}{V} = 0.46 \text{ min (see note below)}$$

Note: (t_c is solved through trial and error by manually adjusting the value for the time of concentration until the ratio of length to velocity and t_c to reach the peak flow rate, as calculated using the Rational Method, are equal)

Calculate peak flow rate for unit width of flow:

C =	0.77		
t_c =	0.46	min	(see note above)
i =	14.50	in/hr	
A =	0.0007	ac	(Unit width of flow, w = 1 ft. Therefore, A = L/43560)

$$\boxed{Q = 0.008 \text{ cfs}}$$

Calculate approximate depth of flow derived from Manning's Method Equation (see attached derivation, page 6A-E-69):

$$d = \left(\frac{Qn}{1.49 S^{0.5}} \right)^{0.6}$$

Q =	0.008	cfs
n =	0.025	(Manning's n for channel flow, conservative)
S =	0.25	ft/ft

d =	0.007	ft	=	0.08	in

Calculate shallow concentrated flow velocity:

$$V = \frac{Q}{A} = \frac{Q}{d}$$

V =	1.09	fps

3. Compare peak velocity to permissible non-erodible velocity.

Case 1 Conclusion:
The peak velocity between drainage swales on the final cover sideslopes is associated with the shallow concentrated flow component of overland flow. The calculated sideslope shallow concentrated flow velocity is less than the permissible non-erodible velocity of 5.0 ft/s on final cover, as discussed in Attachment 6A, Subsection 2.2.

Case 2: 250-foot Final Topslope:

1. Determine the time of concentration (t_C) and sheet flow velocity on final cover topslopes using the Manning's Kinematic Solution.

Sheet Flow Velocity:

Sheet Flow Length =	100	ft
Slope =	0.05	ft/ft

Sheet Flow Time of Concentration Equation:

$$t_c = \frac{0.007(nL)^{0.8}}{(P_{25,24})^{0.5} S^{0.4}}$$ **(as described above)**

CITY OF WACO LANDFILL
FINAL COVER
OVERLAND FLOW VELOCITY

Sheet Flow Velocity Equation:

$$V = \frac{L}{60t_c}$$ **(as described above)**

Calculate t_c:

n =	0.15	(**See page 6A-E-75**, surface roughness for short grass)
L =	100	
$P_{25,24}$ =	7.90	
S =	0.05	

t_c =	0.072	hr
	4.32	min

Calculate the sheet flow velocity:

L =	100
t_c =	4.32

V =	0.39	fps

2. Determine the shallow concentrated flow velocity on the topslopes using a derivation of Manning's Equation.

<u>Shallow Concentrated Flow Velocity:</u>

Shallow Concentrated Flow Length =	150	ft
Slope =	0.05	ft/ft

Rational Method Equation:

$Q = CiA$ **(as described above)**

Where:
- Q = flow rate (cfs)
- C = runoff coefficient
- i = rainfall intensity (in/hr)
- A = drainage area (ac) (assume unit width for flow area)

Intensity Equation:

$i = b / (t_c + d)^e$ **(as described above)**

Time of Concentration Equation:

$$t_c = \frac{L}{V} = 2.11$$ min (see note below)

CITY OF WACO LANDFILL
FINAL COVER
OVERLAND FLOW VELOCITY

Note: (t_c is solved through trial and error by manually adjusting the value for the time of concentration until the ratio of length to velocity and t_c to reach the peak flow rate, as calculated using the Rational Method, are equal)

Calculate peak flow rate for unit width of flow:

C =	0.7		
t_c =	2.11	min	(see note above)
i =	13.01	in/hr	
A =	0.0034	ac	(Unit width of flow, w = 1 ft. Therefore, A = L/43560)

Q =	0.031	cfs

Calculate approximate depth of flow derived from Manning's Method Equation (see attached derivation, page 6A-E-69):

$$d = \left(\frac{Qn}{1.49S^{0.5}} \right)^{0.6}$$

Q =	0.031	cfs
n =	0.025	(Manning's n for channel flow, conservative)
S =	0.05	ft/ft

d =	0.026	ft	=	0.32	in

Calculate shallow concentrated flow velocity:

$$V = \frac{Q}{A} = \frac{Q}{d}$$

V =	1.18	fps

3. Compare peak velocity to permissible non-erodible velocity.

Case 2 Conclusion:

The peak velocity on the final cover topslope is associated with the shallow concentrated flow component of overland flow. The calculated topslope shallow concentrated flow velocity is less than the permissible non-erodible velocity of 5.0 ft/s on final cover, as discussed in Attachment 6A, Subsection 2.2.

DRAINAGE SWALE FLOW ANALYSIS

INTERMEDIATE COVER – DRAINAGE SWALE FLOW

CITY OF WACO LANDFILL
INTERMEDIATE COVER - DRAINAGE SWALE FLOW ANALYSIS

Required: Calculate the flow velocity and normal depth for sizing drainage swales installed on intermediate cover.

Method:

1. Determine peak discharge rate associated with the 25 - year, 24 - hour storm event for the swale contributing drainage areas, as shown on Drawings 6A-E.3 and 6A-E.4, using the Rational Method (see Subsection 2.2 of Attachment 6A).
2. Determine Mannings "n" and runoff coefficient "C" (see Pages 6A-A-25 and 6A-E-71, respectively).
3. Using the specified channel geometry, evaluate the peak velocity and flow depth using HYDROCALC program.
4. Compare the worst case flow velocity with the permissible velocity of 5 fps.

Solution: **Rational Method Calculations for Typical Swale Contributing Areas**

Drainage Area [2]	Runoff Coef. C[3,5]	Rainfall Int. I, (in/hr)[4]	Area (acres)	Peak Discharge (cfs)
SW12	0.70	8.9	4.0	25.0
SW13	0.35	8.9	2.1	6.5
Example-1	0.35	8.9	17.0	53.0
SW8	0.35	8.9	6.8	21.2
SW11	0.70	8.9	5.2	32.7
SW9	0.35	8.9	10.1	31.5
SW10	0.35	8.9	2.8	8.7
Example-2	0.70	8.9	7.3	45.5
Example-3	0.70	8.9	10.0	62.3

$$I = \frac{b}{(t_c + d)^e}$$

Where, I = Rainfall intensity, in/hr
b= 103.56

d= 11.0
e= 0.806
t_c = 10 min

(b, d, e are associated with a 25 - year, 24 - hour storm for Limestome Co., see Page 6A-E-73)

CITY OF WACO LANDFILL
INTERMEDIATE COVER - DRAINAGE SWALE FLOW ANALYSIS

Solution (Con't): **Typical Swale Summary Calculations for Greatest Peak Discharge into a Topslope and Sideslope Swale[1]**

Drainage Area [2]	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n[3]	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
SW9	31.5	0.005	0.027	2	20	0.0	1.06	2.54
Example-1	53.0	0.005	0.027	2	20	0.0	1.29	2.88
SW11	32.7	0.010	0.027	2	4	0.0	1.56	4.49
Example-2	45.5	0.010	0.027	2	4	0.0	1.76	4.87
Example-3	62.3	0.010	0.027	2	4	0.0	1.98	5.27

Conclusions:

From above drainage swale summary calculations, grass-lined topslope swales installed on intermediate cover will have peak velocities less than the permissible velocity of 5 fps. Therefore, topslope swales on installed on intermediate cover will be constructed with a minimum depth of 2.0 feet, provided the contributing area is less than or equal to 17 acres, as shown for Example-1.

Drainage swales installed on the intermediate cover sideslopes may exhibit peak velocities greater than 5 fps if the contributing area is greater than 7.3 acres (see Example 2). Therefore, sideslope swales installed on intermediate cover will be grass-lined and contructed with a minimum depth of 2.4 feet, provided the contributing area is less than or equal to 7.3 acres. Additionally, sideslope swales with contributing areas greater than 7.3 acres but less than 10 acres will be rip rap or TRM-lined and constructed with a minimum depth of 2.6 feet. Drainage swales installed on intermediate cover will be constructed with a minimum 0.5-foot of freeboard above calculated peak flow depth. See Drawing 6A.12 for drainage swale details.

Notes:

1. Calculations were performed using the HYDROCALC program developed by Dodson and Associates (Version 1.3, 1986).
2. Contributing drainage areas are depicted on Drawings 6A-E.3 and 6A-E.4.
3. Refer to Hydraulic Calculation References for Mannings "n" and runoff coefficient, C, references.
4. Rainfal Intensity (I) calculated for tc = 10 min, using equation for rainfall intensity shown above. Refer to Hydraulic Calculation References for coefficient b,d, and e references.

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	31.5
Channel Bottom Slope (ft/ft)	0.005
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	20.0
Channel Bottom Width (ft)	0.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.06
Flow Velocity (fps)	2.54
Froude Number	0.613
Velocity Head (ft)	0.1
Energy Head (ft)	1.16
Cross-Sectional Area of Flow (sq ft)	12.42
Top Width of Flow (ft)	23.38

EXAMPLE-1

```
                    TRAPEZOIDAL CHANNEL ANALYSIS
                      NORMAL DEPTH COMPUTATION

                           July 11, 2019

================================================================================
                         PROGRAM INPUT DATA
DESCRIPTION                                                               VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs)............................................             53.0
Channel Bottom Slope (ft/ft)...............................              0.005
Manning's Roughness Coefficient (n-value)..................              0.027
Channel Left Side Slope (horizontal/vertical)..............              2.0
Channel Right Side Slope (horizontal/vertical).............             20.0
Channel Bottom Width (ft)..................................              0.0

================================================================================
                        COMPUTATION RESULTS
DESCRIPTION                                                               VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)..........................................               1.29
Flow Velocity (fps)........................................               2.88
Froude Number..............................................               0.632
Velocity Head (ft).........................................               0.13
Energy Head (ft)...........................................               1.42
Cross-Sectional Area of Flow (sq ft).......................              18.39
Top Width of Flow (ft).....................................              28.44

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SW11

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)..	32.7
Channel Bottom Slope (ft/ft)................................	0.01
Manning's Roughness Coefficient (n-value)...................	0.027
Channel Left Side Slope (horizontal/vertical)...............	2.0
Channel Right Side Slope (horizontal/vertical)..............	4.0
Channel Bottom Width (ft)...................................	0.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)...	1.56
Flow Velocity (fps)...	4.49
Froude Number...	0.896
Velocity Head (ft)..	0.31
Energy Head (ft)..	1.87
Cross-Sectional Area of Flow (sq ft)........................	7.29
Top Width of Flow (ft)......................................	9.35

EXAMPLE-2

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	45.5
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	4.0
Channel Bottom Width (ft)	0.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.76
Flow Velocity (fps)	4.87
Froude Number	0.915
Velocity Head (ft)	0.37
Energy Head (ft)	2.13
Cross-Sectional Area of Flow (sq ft)	9.33
Top Width of Flow (ft)	10.58

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EXAMPLE-3

```
                         TRAPEZOIDAL CHANNEL ANALYSIS
                           NORMAL DEPTH COMPUTATION

                                July 11, 2019

================================================================================
                              PROGRAM INPUT DATA
DESCRIPTION                                                                 VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs)............................................            62.3
Channel Bottom Slope (ft/ft)...............................             0.01
Manning's Roughness Coefficient (n-value)..................             0.027
Channel Left Side Slope (horizontal/vertical)..............             2.0
Channel Right Side Slope (horizontal/vertical).............             4.0
Channel Bottom Width (ft)..................................             0.0

================================================================================
                             COMPUTATION RESULTS
DESCRIPTION                                                                 VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)..........................................              1.98
Flow Velocity (fps)........................................              5.27
Froude Number..............................................              0.933
Velocity Head (ft).........................................              0.43
Energy Head (ft)...........................................              2.42
Cross-Sectional Area of Flow (sq ft).......................             11.81
Top Width of Flow (ft).....................................             11.91

================================================================================
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FINAL COVER – DRAINAGE SWALE FLOW

CITY OF WACO LANDFILL
FINAL COVER - DRAINAGE SWALE FLOW ANALYSIS

Required: Calculate the flow velocity and normal depth for sizing drainage swales installed on final cover.

Method:
1. Determine peak discharge rate associated with the 25 - year, 24 - hour storm event for the swale contributing drainage areas, as shown on Drawing 6A-E.1, using the Rational Method (see Subsection 2.2 of Attachment 6A).
2. Determine Mannings "n" and runoff coefficient "C" (see Pages 6A-A-25 and 6A-E-71, respectively).
3. Using the specified channel geometry, evaluate the peak velocity and flow depth using HYDROCALC program.
4. Compare the worst case flow velocity with the permissible velocity of 5 fps.

Solution: **Rational Method Calculations for Typical Swale Contributing Areas**

Drainage Area [2]	Runoff Coef. C[3,5]	Rainfall Int. I, (in/hr)[4]	Area (acres)	Peak Discharge (cfs)
SW1	0.70	8.9	3.7	22.8
SW2	0.70	8.9	3.2	20.0
SW3	0.35	8.9	2.1	6.4
SW4	0.70	8.9	3.0	18.7
SW5	0.70	8.9	3.3	20.8
SW6	0.35	8.9	2.4	7.4
SW7	0.70	8.9	2.1	6.4

$$I = \frac{b}{(t_c + d)^e}$$

Where, I = Rainfall intensity, in/hr
b= 103.56
d= 11.0
e= 0.806
t_c = 10 min

(b, d, e are associated with a 25 - year, 24 - hour storm for Limestone Co., see Page 6A-E-73)

Typical Swale Summary Calculations[1]

Drainage Area [2]	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n[3]	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
SW1	22.8	0.01	0.027	2	4	0.0	1.36	4.09
SW2	20.0	0.01	0.027	2	4	0.0	1.30	3.96
SW3	6.4	0.005	0.027	2	20	0.0	0.58	1.71
SW4	18.7	0.01	0.027	2	4	0.0	1.26	3.90
SW5	20.8	0.01	0.027	2	4	0.0	1.32	4.00
SW6	7.4	0.005	0.027	2	20	0.0	0.62	1.77
SW7	6.4	0.005	0.027	2	20	0.0	0.58	1.71

Conclusions: From above drainage swale summary calculations, the greatest calculated flow velocity in a sideslope swale is 4.09 fps and in a topslope swale is 1.77 fps which are both less than the permissible velocity of 5 fps. Therefore, drainage swales installed on the final cover topslope and sideslope will be constructed with a minimum depth of 2.1 and 2.5 feet, respectively. Drainage swales will be constructed with a minimum 1-foot of freeboard above calculated peak flow depth. See Drawing 6A.19 for drainage swale details.

Notes:
1. Calculations were performed using the HYDROCALC program developed by Dodson and Associates (Version 1.3, 1986).
2. Contributing drainage areas are depicted on Drawing 6A-E.1.
3. Refer to Hydraulic Calculation References for Mannings "n" and runoff coefficient, C, references.
4. Rainfal Intensity (I) calculated for tc = 10 min, using equation for rainfall intensity shown above. Refer to Hydraulic Calculation References for coefficient b,d, and e references.

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	22.8
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	4.0
Channel Bottom Width (ft)	0.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.36
Flow Velocity (fps)	4.09
Froude Number	0.874
Velocity Head (ft)	0.26
Energy Head (ft)	1.62
Cross-Sectional Area of Flow (sq ft)	5.57
Top Width of Flow (ft)	8.18

SW2

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	20.0
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	4.0
Channel Bottom Width (ft)	0.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.3
Flow Velocity (fps)	3.96
Froude Number	0.867
Velocity Head (ft)	0.24
Energy Head (ft)	1.54
Cross-Sectional Area of Flow (sq ft)	5.05
Top Width of Flow (ft)	7.78

SW3

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

```
==============================================================================
                         PROGRAM INPUT DATA
DESCRIPTION                                                              VALUE
------------------------------------------------------------------------------
Flow Rate (cfs)...........................................             6.4
Channel Bottom Slope (ft/ft)..............................             0.005
Manning's Roughness Coefficient (n-value).................             0.027
Channel Left Side Slope (horizontal/vertical).............             2.0
Channel Right Side Slope (horizontal/vertical)............            20.0
Channel Bottom Width (ft).................................             0.0

==============================================================================
                         COMPUTATION RESULTS
DESCRIPTION                                                              VALUE
------------------------------------------------------------------------------
Normal Depth (ft)·········································              0.58
Flow Velocity (fps)·······································              1.71
Froude Number·············································              0.556
Velocity Head (ft)········································              0.05
Energy Head (ft)··········································              0.63
Cross-Sectional Area of Flow (sq ft)······················              3.75
Top Width of Flow (ft)····································              12.85

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SW4

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

```
==============================================================================
                         PROGRAM INPUT DATA
DESCRIPTION                                                             VALUE
------------------------------------------------------------------------------
Flow Rate (cfs)............................................           18.7
Channel Bottom Slope (ft/ft)...............................            0.01
Manning's Roughness Coefficient (n-value)..................            0.027
Channel Left Side Slope (horizontal/vertical)..............            2.0
Channel Right Side Slope (horizontal/vertical).............            4.0
Channel Bottom Width (ft)..................................            0.0

==============================================================================
                        COMPUTATION RESULTS
DESCRIPTION                                                             VALUE
------------------------------------------------------------------------------
Normal Depth (ft)..........................................             1.26
Flow Velocity (fps)........................................             3.9
Froude Number..............................................             0.863
Velocity Head (ft).........................................             0.24
Energy Head (ft)...........................................             1.5
Cross-Sectional Area of Flow (sq ft).......................             4.8
Top Width of Flow (ft).....................................             7.59

==============================================================================
```

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	20.8
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	4.0
Channel Bottom Width (ft)	0.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.32
Flow Velocity (fps)	4.0
Froude Number	0.869
Velocity Head (ft)	0.25
Energy Head (ft)	1.57
Cross-Sectional Area of Flow (sq ft)	5.2
Top Width of Flow (ft)	7.9

```
                    TRAPEZOIDAL CHANNEL ANALYSIS
                     NORMAL DEPTH COMPUTATION

                          July 11, 2019

================================================================================
                         PROGRAM INPUT DATA
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs).............................................              7.4
Channel Bottom Slope (ft/ft)................................              0.005
Manning's Roughness Coefficient (n-value)...................              0.027
Channel Left Side Slope (horizontal/vertical)...............              2.0
Channel Right Side Slope (horizontal/vertical)..............             20.0
Channel Bottom Width (ft)...................................              0.0

================================================================================
                        COMPUTATION RESULTS
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)...........................................               0.62
Flow Velocity (fps).........................................               1.77
Froude Number...............................................               0.561
Velocity Head (ft)..........................................               0.05
Energy Head (ft)............................................               0.67
Cross-Sectional Area of Flow (sq ft)........................               4.19
Top Width of Flow (ft)......................................              13.57

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SW7

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

```
==============================================================================
                           PROGRAM INPUT DATA
DESCRIPTION                                                               VALUE
------------------------------------------------------------------------------
Flow Rate (cfs).............................................            6.4
Channel Bottom Slope (ft/ft)................................            0.005
Manning's Roughness Coefficient (n-value)...................            0.027
Channel Left Side Slope (horizontal/vertical)...............            2.0
Channel Right Side Slope (horizontal/vertical)..............           20.0
Channel Bottom Width (ft)...................................            0.0

==============================================================================
                          COMPUTATION RESULTS
DESCRIPTION                                                               VALUE
------------------------------------------------------------------------------
Normal Depth (ft)...........................................             0.58
Flow Velocity (fps).........................................             1.71
Froude Number...............................................            0.556
Velocity Head (ft)..........................................             0.05
Energy Head (ft)............................................             0.63
Cross-Sectional Area of Flow (sq ft)........................             3.75
Top Width of Flow (ft)......................................            12.85

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```

DOWNCHUTE FLOW ANALYSIS

INTERMEDIATE COVER – DOWNCHUTE FLOW

CITY OF WACO LANDFILL
INTERMEDIATE COVER - DOWNCHUTE FLOW ANALYSIS

Required: Calculate the peak flow depth for sizing downchutes installed on **intermediate cover**.

Method:
1. Determine peak discharge rate associated with the 25 - year, 24 - hour storm event for downchute contributing drainage areas using the Rational Method (see Subsection 2.2 of Attachment 6A).
2. Determine Mannings "n" and runoff coefficient "C" (see Page 6A-A-25 and 6A-E-71, respectively).
3. Using the specified channel geometry, evaluate the peak velocity and flow depth using HYDROCALC program.

Solution:

$$I = \frac{b}{(t_c + d)^e}$$

Rational Method Calculations for Typical Swale Contributing Areas

Drainage Area [2]	Runoff Coef. $C^{3,5}$	Rainfall Int. I, (in/hr)[4]	Area (acres)	Peak Discharge (cfs)
DC3	0.70	8.9	9.0	56.2
DC4	0.70	8.9	10.5	65.2
Example DC	0.70	8.9	35.0	218.1

Where, I = Rainfall intensity, in/hr
b= 103.56
d= 11.0
e= 0.806
t_c = 10 min

(b, d, e are associated with a 25 - year, 24 - hour storm for Limestone Co., see Page 6A-E-73)

Typical Swale Summary Calculations[1]

Drainage Area [2]	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n^3	Sideslope (left)	Sideslope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
DC3	56.2	0.25	0.033	2	2	10.0	0.43	12.05
DC4	65.2	0.25	0.033	2	2	10.0	0.47	12.17
Example DC	218.1	0.25	0.033	2	2	10.0	0.95	19.31

Conclusions:

Based on the greatest contributing drainage area shown on Drawing 6A-E.5, downchutes installed on intermediate cover will be constructed 2 feet deep (assuming 1-foot of freeboard), with a 10-foot bottom width, and 2H:1V sideslopes. Gabions, rip rap, or dissipation blocks will be installed at the toe of the landfill berm with the perimeter channels to dissipate the peak velocity. Typcial details for downchutes are depcited on Drawing 6A.20.

Notes:
1. Calculations were performed using the HYDROCALC program developed by Dodson and Associates (Version 1.3, 1986).
2. Contributing drainage areas are depicted on Drawing 6A-E.5.
3. Refer to Hydraulic Calculation References for Mannings "n" and runoff coefficient, C, references.
4. Rainfal Intensity (I) calculated for tc = 10 min, using equation for rainfall intensity shown above. Refer to Hydraulic Calculation References for coefficient b,d, and e references.

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA	
DESCRIPTION	VALUE
Flow Rate (cfs)	56.2
Channel Bottom Slope (ft/ft)	0.25
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	2.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS	
DESCRIPTION	VALUE
Normal Depth (ft)	0.43
Flow Velocity (fps)	12.05
Froude Number	3.367
Velocity Head (ft)	2.26
Energy Head (ft)	2.69
Cross-Sectional Area of Flow (sq ft)	4.66
Top Width of Flow (ft)	11.72

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DC4

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	65.2
Channel Bottom Slope (ft/ft)	0.25
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	2.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.47
Flow Velocity (fps)	12.71
Froude Number	3.41
Velocity Head (ft)	2.51
Energy Head (ft)	2.98
Cross-Sectional Area of Flow (sq ft)	5.13
Top Width of Flow (ft)	11.88

FINAL COVER – DOWNCHUTE FLOW

CITY OF WACO LANDFILL
FINAL COVER - DOWNCHUTE FLOW ANALYSIS

Required: Calculate the peak flow depth for sizing downchutes installed on **final cover**.

Method:
1. Determine peak discharge rate associated with the 25 - year, 24 - hour storm event for downchute contributing drainage areas using the Rational Method (see Subsection 2.2 of Attachment 6A).
2. Determine Mannings "n" and runoff coefficient "C" (see Page 6A-A-25 and 6A-E-71, respectively).
3. Using the specified channel geometry, evaluate the peak velocity and flow depth using HYDROCALC program.

Solution:

$$I = \frac{b}{(t_c + d)^e}$$

Where, I = Rainfall intensity, in/hr

b= 103.56

d= 11.0

e= 0.806

t_c = 10 min

(b, d, e are associated with a 25 - year, 24 - hour storm for Limestone Co., see Page 6A-E-73)

Rational Method Calculations for Typical Swale Contributing Areas

	Drainage Area [2]	Runoff Coef. $C^{3,5}$	Rainfall Int. I, (in/hr)[4]	Area (acres)	Peak Discharge (cfs)
East	DC1	0.70	8.9	21.7	135.2
West	DC2	0.70	8.9	15.1	93.8

Typical Swale Summary Calculations[1]

Drainage Area [2]	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n^3	Sideslope (left)	Sideslope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
DC1	135.2	0.25	0.033	2	2	15.0	0.57	14.68
DC2	93.8	0.25	0.033	2	2	15.0	0.46	12.82

Conclusions: Based on the greatest contributing drainage areas shown on Drawing 6A-E.2, downchutes installed on final cover will be constructed 2 feet deep (assuming 1-foot of freeboard), with a 15-foot bottom width, and 2H:1V sideslopes. Gabions, rip rap, or dissipation blocks will be installed at the toe of the landfill berm with the perimeter channels to dissipate the peak velocity. Typcial details for downchutes are depcited on Drawing 6A.20.

Notes:
1. Calculations were performed using the HYDROCALC program developed by Dodson and Associates (Version 1.3, 1986).
2. Contributing drainage areas are depicted on Drawing 6A-E.2.
3. Refer to Hydraulic Calculation References for Mannings "n" and runoff coefficient, C, references.
4. Rainfal Intensity (I) calculated for tc = 10 min, using equation for rainfall intensity shown above. Refer to Hydraulic Calculation References for coefficient b,d, and e references.

DC1

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	135.2
Channel Bottom Slope (ft/ft)	0.25
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	2.0
Channel Right Side Slope (horizontal/vertical)	2.0
Channel Bottom Width (ft)	15.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.57
Flow Velocity (fps)	14.68
Froude Number	3.546
Velocity Head (ft)	3.35
Energy Head (ft)	3.92
Cross-Sectional Area of Flow (sq ft)	9.21
Top Width of Flow (ft)	17.28

DC2

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

July 11, 2019

```
================================================================================
                         PROGRAM INPUT DATA
DESCRIPTION                                                               VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs).............................................            93.8
Channel Bottom Slope (ft/ft)................................             0.25
Manning's Roughness Coefficient (n-value)...................             0.033
Channel Left Side Slope (horizontal/vertical)...............             2.0
Channel Right Side Slope (horizontal/vertical)..............             2.0
Channel Bottom Width (ft)...................................            15.0

================================================================================
                         COMPUTATION RESULTS
DESCRIPTION                                                               VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)...........................................              0.46
Flow Velocity (fps).........................................             12.82
Froude Number...............................................              3.427
Velocity Head (ft)..........................................              2.55
Energy Head (ft)............................................              3.01
Cross-Sectional Area of Flow (sq ft)........................              7.32
Top Width of Flow (ft)......................................             16.84

================================================================================
```

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PERIMETER CHANNEL FLOW ANALYSIS
(HYDROCALC OUTPUT FILES)

CHANNEL-1A1

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	11.0
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	5.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.54
Flow Velocity (fps)	3.1
Froude Number	0.832
Velocity Head (ft)	0.15
Energy Head (ft)	0.69
Cross-Sectional Area of Flow (sq ft)	3.55
Top Width of Flow (ft)	8.22

CHANNEL-1A2

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	11.0
Channel Bottom Slope (ft/ft)	0.008
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	5.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.57
Flow Velocity (fps)	2.87
Froude Number	0.75
Velocity Head (ft)	0.13
Energy Head (ft)	0.7
Cross-Sectional Area of Flow (sq ft)	3.83
Top Width of Flow (ft)	8.43

CHANNEL-1A3

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	159.3
Channel Bottom Slope (ft/ft)	0.0025
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	2.41
Flow Velocity (fps)	3.83
Froude Number	0.519
Velocity Head (ft)	0.23
Energy Head (ft)	2.64
Cross-Sectional Area of Flow (sq ft)	41.54
Top Width of Flow (ft)	24.46

CHANNEL-1A4

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	159.3
Channel Bottom Slope (ft/ft)	0.022
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.52
Flow Velocity (fps)	7.23
Froude Number	1.185
Velocity Head (ft)	0.81
Energy Head (ft)	2.33
Cross-Sectional Area of Flow (sq ft)	22.05
Top Width of Flow (ft)	19.09

CHANNEL-2A1

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	109.3
Channel Bottom Slope (ft/ft)	0.0225
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.23
Flow Velocity (fps)	6.51
Froude Number	1.166
Velocity Head (ft)	0.66
Energy Head (ft)	1.89
Cross-Sectional Area of Flow (sq ft)	16.8
Top Width of Flow (ft)	17.37

CHANNEL-2A2

```
                    TRAPEZOIDAL CHANNEL ANALYSIS
                      NORMAL DEPTH COMPUTATION

                         September 26, 2019

================================================================================
                         PROGRAM INPUT DATA
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs).............................................            109.3
Channel Bottom Slope (ft/ft)................................              0.007
Manning's Roughness Coefficient (n-value)...................              0.027
Channel Left Side Slope (horizontal/vertical)...............              3.0
Channel Right Side Slope (horizontal/vertical)..............              3.0
Channel Bottom Width (ft)...................................             10.0

================================================================================
                        COMPUTATION RESULTS
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)...........................................               1.51
Flow Velocity (fps).........................................               4.97
Froude Number...............................................               0.817
Velocity Head (ft)..........................................               0.38
Energy Head (ft)............................................               1.9
Cross-Sectional Area of Flow (sq ft)........................              21.97
Top Width of Flow (ft)......................................              19.07

================================================================================
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```

CHANNEL-2A3

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	109.3
Channel Bottom Slope (ft/ft)	0.0225
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.23
Flow Velocity (fps)	6.51
Froude Number	1.166
Velocity Head (ft)	0.66
Energy Head (ft)	1.89
Cross-Sectional Area of Flow (sq ft)	16.8
Top Width of Flow (ft)	17.37

CHANNEL-2A4

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	109.3
Channel Bottom Slope (ft/ft)	0.0025
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.99
Flow Velocity (fps)	3.45
Froude Number	0.506
Velocity Head (ft)	0.18
Energy Head (ft)	2.17
Cross-Sectional Area of Flow (sq ft)	31.68
Top Width of Flow (ft)	21.91

CHANNEL-2A5

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	253.7
Channel Bottom Slope (ft/ft)	0.0025
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	3.04
Flow Velocity (fps)	4.36
Froude Number	0.535
Velocity Head (ft)	0.29
Energy Head (ft)	3.34
Cross-Sectional Area of Flow (sq ft)	58.25
Top Width of Flow (ft)	28.27

CHANNEL-3A1

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	125.4
Channel Bottom Slope (ft/ft)	0.0025
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	2.13
Flow Velocity (fps)	3.59
Froude Number	0.511
Velocity Head (ft)	0.2
Energy Head (ft)	2.33
Cross-Sectional Area of Flow (sq ft)	34.96
Top Width of Flow (ft)	22.79

CHANNEL-4A1

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	13.9
Channel Bottom Slope (ft/ft)	0.0025
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	5.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.89
Flow Velocity (fps)	2.05
Froude Number	0.444
Velocity Head (ft)	0.07
Energy Head (ft)	0.95
Cross-Sectional Area of Flow (sq ft)	6.8
Top Width of Flow (ft)	10.32

CHANNEL-4A2

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	13.9
Channel Bottom Slope (ft/ft)	0.03
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	5.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.45
Flow Velocity (fps)	4.87
Froude Number	1.408
Velocity Head (ft)	0.37
Energy Head (ft)	0.82
Cross-Sectional Area of Flow (sq ft)	2.86
Top Width of Flow (ft)	7.7

CHANNEL-4A3

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	93.0
Channel Bottom Slope (ft/ft)	0.015
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.26
Flow Velocity (fps)	5.38
Froude Number	0.955
Velocity Head (ft)	0.45
Energy Head (ft)	1.71
Cross-Sectional Area of Flow (sq ft)	17.29
Top Width of Flow (ft)	17.54

CHANNEL-4A4

```
                    TRAPEZOIDAL CHANNEL ANALYSIS
                      NORMAL DEPTH COMPUTATION

                         September 26, 2019

================================================================================
                          PROGRAM INPUT DATA
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs)............................................              93.0
Channel Bottom Slope (ft/ft)...............................               0.006
Manning's Roughness Coefficient (n-value)..................               0.027
Channel Left Side Slope (horizontal/vertical)..............               3.0
Channel Right Side Slope (horizontal/vertical).............               3.0
Channel Bottom Width (ft)..................................              10.0

================================================================================
                         COMPUTATION RESULTS
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)..........................................                1.44
Flow Velocity (fps)........................................                4.49
Froude Number..............................................                0.752
Velocity Head (ft).........................................                0.31
Energy Head (ft)...........................................                1.76
Cross-Sectional Area of Flow (sq ft).......................               20.71
Top Width of Flow (ft).....................................               18.67

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CHANNEL-4A5

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	93.0
Channel Bottom Slope (ft/ft)	0.0025
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.82
Flow Velocity (fps)	3.29
Froude Number	0.5
Velocity Head (ft)	0.17
Energy Head (ft)	1.99
Cross-Sectional Area of Flow (sq ft)	28.23
Top Width of Flow (ft)	20.95

CHANNEL-4B1

```
                         TRAPEZOIDAL CHANNEL ANALYSIS
                           NORMAL DEPTH COMPUTATION

                              September 26, 2019

================================================================================
                              PROGRAM INPUT DATA
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs).............................................             9.7
Channel Bottom Slope (ft/ft)................................             0.006
Manning's Roughness Coefficient (n-value)...................             0.027
Channel Left Side Slope (horizontal/vertical)...............             3.0
Channel Right Side Slope (horizontal/vertical)..............             3.0
Channel Bottom Width (ft)...................................             5.0

================================================================================
                             COMPUTATION RESULTS
DESCRIPTION                                                                VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)...........................................              0.58
Flow Velocity (fps).........................................              2.5
Froude Number...............................................              0.651
Velocity Head (ft)..........................................              0.1
Energy Head (ft)............................................              0.67
Cross-Sectional Area of Flow (sq ft)........................              3.88
Top Width of Flow (ft)......................................              8.46

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```

CHANNEL-4B2

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	9.7
Channel Bottom Slope (ft/ft)	0.019
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	5.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.42
Flow Velocity (fps)	3.71
Froude Number	1.11
Velocity Head (ft)	0.21
Energy Head (ft)	0.63
Cross-Sectional Area of Flow (sq ft)	2.61
Top Width of Flow (ft)	7.51

CHANNEL-4B3

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA	
DESCRIPTION	VALUE
Flow Rate (cfs)	71.6
Channel Bottom Slope (ft/ft)	0.007
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS	
DESCRIPTION	VALUE
Normal Depth (ft)	1.2
Flow Velocity (fps)	4.38
Froude Number	0.793
Velocity Head (ft)	0.3
Energy Head (ft)	1.5
Cross-Sectional Area of Flow (sq ft)	16.34
Top Width of Flow (ft)	17.21

CHANNEL-4B4

```
                    TRAPEZOIDAL CHANNEL ANALYSIS
                      NORMAL DEPTH COMPUTATION

                         September 26, 2019

================================================================================
                         PROGRAM INPUT DATA
DESCRIPTION                                                              VALUE
--------------------------------------------------------------------------------
Flow Rate (cfs)............................................            71.6
Channel Bottom Slope (ft/ft)...............................             0.01
Manning's Roughness Coefficient (n-value)..................             0.027
Channel Left Side Slope (horizontal/vertical)..............             3.0
Channel Right Side Slope (horizontal/vertical).............             3.0
Channel Bottom Width (ft)..................................            10.0

================================================================================
                        COMPUTATION RESULTS
DESCRIPTION                                                              VALUE
--------------------------------------------------------------------------------
Normal Depth (ft)..........................................              1.09
Flow Velocity (fps)........................................              4.95
Froude Number..............................................              0.934
Velocity Head (ft).........................................              0.38
Energy Head (ft)...........................................              1.47
Cross-Sectional Area of Flow (sq ft).......................             14.45
Top Width of Flow (ft).....................................             16.54

================================================================================
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CHANNEL-4B5

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	71.6
Channel Bottom Slope (ft/ft)	0.0065
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.23
Flow Velocity (fps)	4.27
Froude Number	0.766
Velocity Head (ft)	0.28
Energy Head (ft)	1.51
Cross-Sectional Area of Flow (sq ft)	16.77
Top Width of Flow (ft)	17.36

CHANNEL-4B6

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	71.6
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	1.09
Flow Velocity (fps)	4.95
Froude Number	0.934
Velocity Head (ft)	0.38
Energy Head (ft)	1.47
Cross-Sectional Area of Flow (sq ft)	14.45
Top Width of Flow (ft)	16.54

HYDROCALC Hydraulics for Windows, Version 2.0.1,
Dodson & Associates, Inc., 5629 FM 1960 West, Suite 314, Houston, TX 77069
Email:software@dodson-hydro.com,

CHANNEL-4B7

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	215.4
Channel Bottom Slope (ft/ft)	0.01
Manning's Roughness Coefficient (n-value)	0.033
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	10.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	2.19
Flow Velocity (fps)	5.95
Froude Number	0.838
Velocity Head (ft)	0.55
Energy Head (ft)	2.74
Cross-Sectional Area of Flow (sq ft)	36.2
Top Width of Flow (ft)	23.12

CHANNEL-4B8

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

September 26, 2019

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	215.4
Channel Bottom Slope (ft/ft)	0.0025
Manning's Roughness Coefficient (n-value)	0.027
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	11.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	2.72
Flow Velocity (fps)	4.14
Froude Number	0.529
Velocity Head (ft)	0.27
Energy Head (ft)	2.98
Cross-Sectional Area of Flow (sq ft)	52.02
Top Width of Flow (ft)	27.3

HYDRAULIC ANALYSIS REFERENCES

Hydraulic Design Manual

Revised July 2016

Procedure for using the Rational Method

The rational formula estimates the peak rate of runoff at a specific location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time of concentration. The rational formula is:

$$Q = \frac{CIA}{Z}$$

Equation 4-20.

Where*:*

Q = maximum rate of runoff (cfs or m^3/sec.)

C = runoff coefficient

I = average rainfall intensity (in./hr. or mm/hr.)

A = drainage area (ac or ha)

Z = conversion factor, 1 for English, 360 for metric

Rainfall Intensity

The rainfall intensity (I) is the average rainfall rate in in./hr. for a specific rainfall duration and a selected frequency. The duration is assumed to be equal to the time of concentration. For drainage areas in Texas, you may compute the rainfall intensity using Equation 4-21, which is known as a rainfall intensity-duration-frequency (IDF) relationship (power-law model).

$$I = \frac{b}{(t_c + d)^e}$$

Equation 4-21.

Where:

I = design rainfall intensity (in./hr.)

tc = time of concentration (min) as discussed in Section 11

e, b, d = coefficients for specific frequencies listed by county in the EBDLKUP-2015v2.1.xlsx spreadsheet lookup tool (developed by Cleveland et al. 2015). These coefficients are based on rainfall frequency-duration data contained in the Atlas of Depth-Duration Frequency (DDF) of Precipitation of Annual Maxima for Texas (TxDOT 5-1301-01-1). Also see video/tutorial on the use of the EBDLKUP-2015v2.1.xlsx spreadsheet tool.

Table 4-10: Runoff Coefficients for Urban Watersheds

Type of drainage area	Runoff coefficient
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.30-0.70
Residential:	
Single-family areas	0.30-0.50
Multi-units, detached	0.40-0.60
Multi-units, attached	0.60-0.75
Suburban	0.35-0.40
Apartment dwelling areas	0.30-0.70
Industrial:	
Light areas	0.30-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.30-0.40
Railroad yards	0.30-0.40
Unimproved areas:	
Sand or sandy loam soil, 0-3%	0.15-0.20
Sand or sandy loam soil, 3-5%	0.20-0.25
Black or loessial soil, 0-3%	0.18-0.25
Black or loessial soil, 3-5%	0.25-0.30
Black or loessial soil, > 5%	0.70-0.80
Deep sand area	0.05-0.15
Steep grassed slopes	0.70
Lawns:	
Sandy soil, flat 2%	0.05-0.10
Sandy soil, average 2-7%	0.10-0.15
Sandy soil, steep 7%	0.15-0.20
Heavy soil, flat 2%	0.13-0.17
Heavy soil, average 2-7%	0.18-0.22

Table 4-10: Runoff Coefficients for Urban Watersheds

Type of drainage area	Runoff coefficient
Heavy soil, steep 7%	0.25-0.35
Streets:	
Asphaltic	0.85-0.95
Concrete	0.90-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.95
Roofs	0.75-0.95

Rural and Mixed-Use Watershed

Table 4-11 shows an alternate, systematic approach for developing the runoff coefficient. This table applies to rural watersheds only, addressing the watershed as a series of aspects. For each of four aspects, the designer makes a systematic assignment of a runoff coefficient "component." Using Equation 4-22, the four assigned components are added to form an overall runoff coefficient for the specific watershed segment.

The runoff coefficient for rural watersheds is given by:

$$C = C_r + C_i + C_v + C_s$$

Equation 4-22.

Where*:*

C = runoff coefficient for rural watershed

C_r = component of coefficient accounting for watershed relief

C_i = component of coefficient accounting for soil infiltration

C_v = component of coefficient accounting for vegetal cover

C_s = component of coefficient accounting for surface type

The designer selects the most appropriate values for C_r, C_i, C_v, and C_s from Table 4-11.

Sideslopes: C= 0.7

Topslopes: C= 0.35

EBDLKUP-2015v2.1.xlsx

Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on United States Geological Survey (USGS) Scientific Investigations Report 2004–5041
"Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas"

1. Select English or SI Units

English

2. Select or Enter a County

Limestone

3. Enter a Time of Conc. Select Units

10 min

Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)
e	0.8198	0.8095	0.8055	0.8059	0.806	0.8037
b (in.)	57.21	72.88	84.61	103.56	121.05	138.12
d (min)	10.48	10.62	10.54	11.00	11.31	11.37
Intensity (in./hr)	4.81	6.29	7.42	8.90	10.28	11.79

(Spreadsheet Release Date: August 31, 2015; data table reshuffle by Asquith July 14, 2016)

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Conservation
Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

To show bookmarks which navigate through the document.

Click the show/hide navigation pane button, and then

click the bookmarks tab. It will navigate you to the contents,

chapters, rainfall maps, and printable forms.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Final Cover: n= 0.15

Intermediate Cover: n= 0.09
(60% of the full surface roughness coefficient for short grass is used)

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \quad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Design Hydrology and Sedimentology for Small Catchments

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Paris San Diego San Francisco Singapore Sydney Tokyo

where the value of I is

Retardance	I
A	10.000
B	7.643
C	5.601
D	4.436
E	2.876

This relationship can be used in computer programs to make hydraulic computations for vegetated waterways. The relationships should not be used outside the range of the curves shown in Fig. 4.14.

The graphs of Fig. 4.15 are solutions to Manning's equation using the curves in Fig. 4.14. They can be used as a design aid for solving Manning's equation for all retardance classes.

Example Problem 4.11 Vegetated channel 1

Design a channel to carry 25 cfs on a 4% slope. Use a parabolic channel. The soil is easily eroded, and the grass may be mowed to 2.5 in. or it may be uncut.

Solution: Select Bermuda grass. Bermuda grass is in retardance B if unmowed and retardance D if mowed. The permissible velocity is selected from Table 4.5 as 6 fps. First design for the mowed condition

$$A = Q/v = 25/6 = 4.17 \text{ ft}^2.$$

Table 4.4 Guide to Selection of Vegetal Retardance[a]

Stand	Length of vegetation (in.)	Retardance class
Good	>30	A
	11–24	B
	6–10	C
	2–6	D
	<2	E
Fair	>30	B
	11–24	C
	6–10	D
	2–6	D
	<2	E

[a]Soil Conservation Service (1979) engineering field manual.

Table 4.5 Permissible velocities for Vegetated Channels (Ree, 1949)

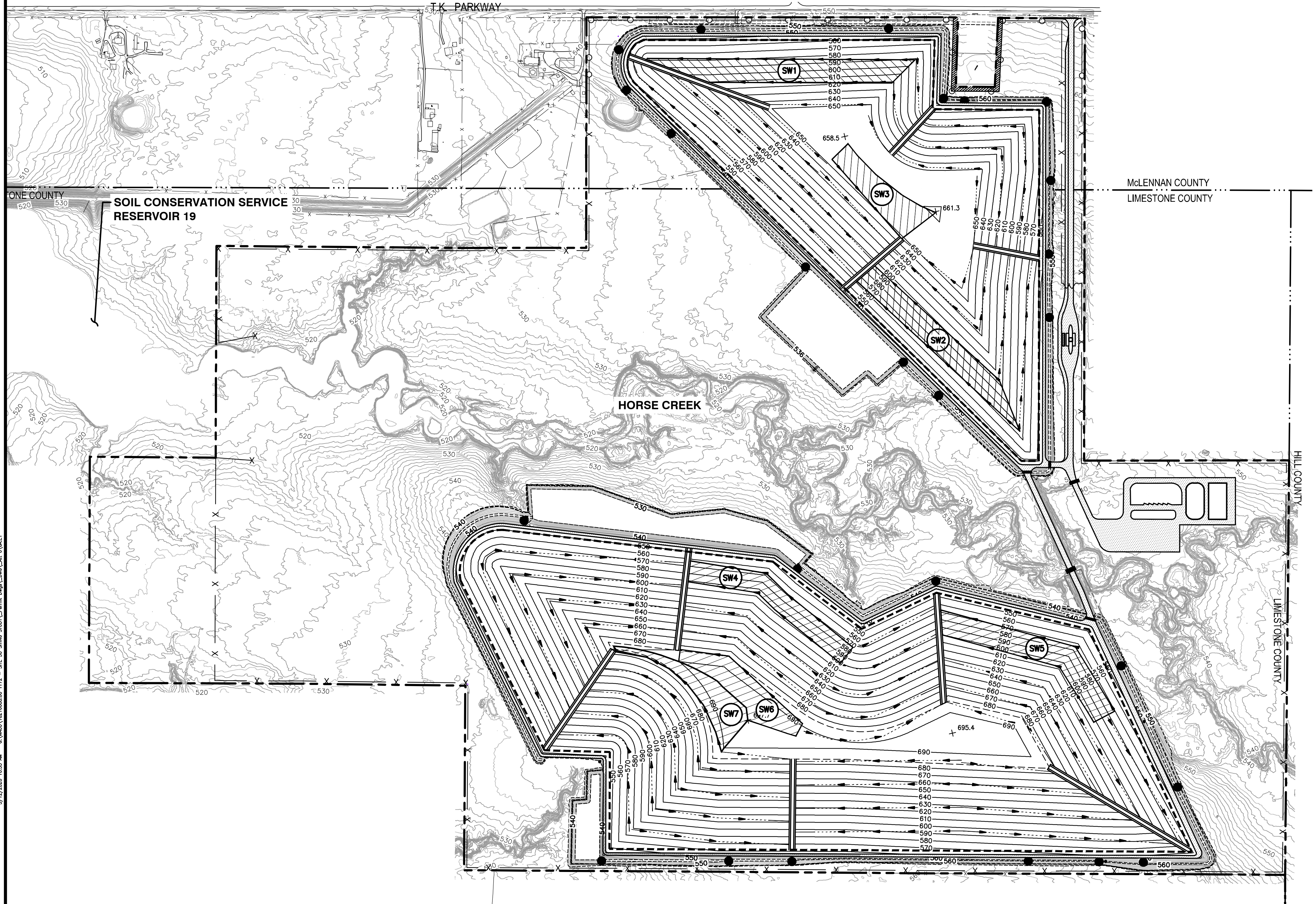
	Permissible velocity (fps)					
	Erosion-resistant soils (% slope)			Easily eroded soils (% slope)		
Cover	0–5	5–10	Over 10	0–5	5–10	Over 10
Bermuda grass	8	7	6	6	5	4
Buffalo grass Kentucky bluegrass Smooth brome Blue grama Tall fescue	7	6	5	5	4	3
Lespedeza sericea Weeping lovegrass Kudzu Alfalfa Crabgrass	3.5	NR[a]	NR	2.5	NR	NR
Grass mixture	5	4	NR	4	3	NR
Annuals for temporary protection	3.5	NR	NR	2.5	NR	NR

[a]Not recommended.

Final Cover Swales
Intermediate Cover Swales
(grass lined)

DRAWINGS

6A-E.1 through 6A-E.5



0 300 600
SCALE IN FEET

LEGEND

- EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- PERMIT BOUNDARY
- LIMITS OF WASTE
- SECTOR BOUNDARY
- COUNTY LINE
- EXISTING FENCE (SCREENED)
- FINAL COVER CONTOURS
- PROPOSED PERIMETER FENCE
- PROPOSED 8' PRIVACY FENCE
- ACCESS ROAD
- DRAINAGE SWALES
- DOWNCHUTES
- CHANNEL SECTION
- DRAINGE SWALE CONTRIBUTING AREA

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. DRAINAGE SWALES INSTALLED ON FINAL COVER WILL HAVE A MAXIMUM SPACING OF 130 HORIZONTAL FEET ON A 4H:1V SIDESLOPE CONSISTENT WITH ATTACHMENT 6A, SUBSECTION 6.5.

STATE OF TEXAS
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5/13/2020

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REV	DATE	DESCRIPTION	BY

DRAWING TITLE: FINAL COVER - DRAINAGE SWALE AREAS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BC/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

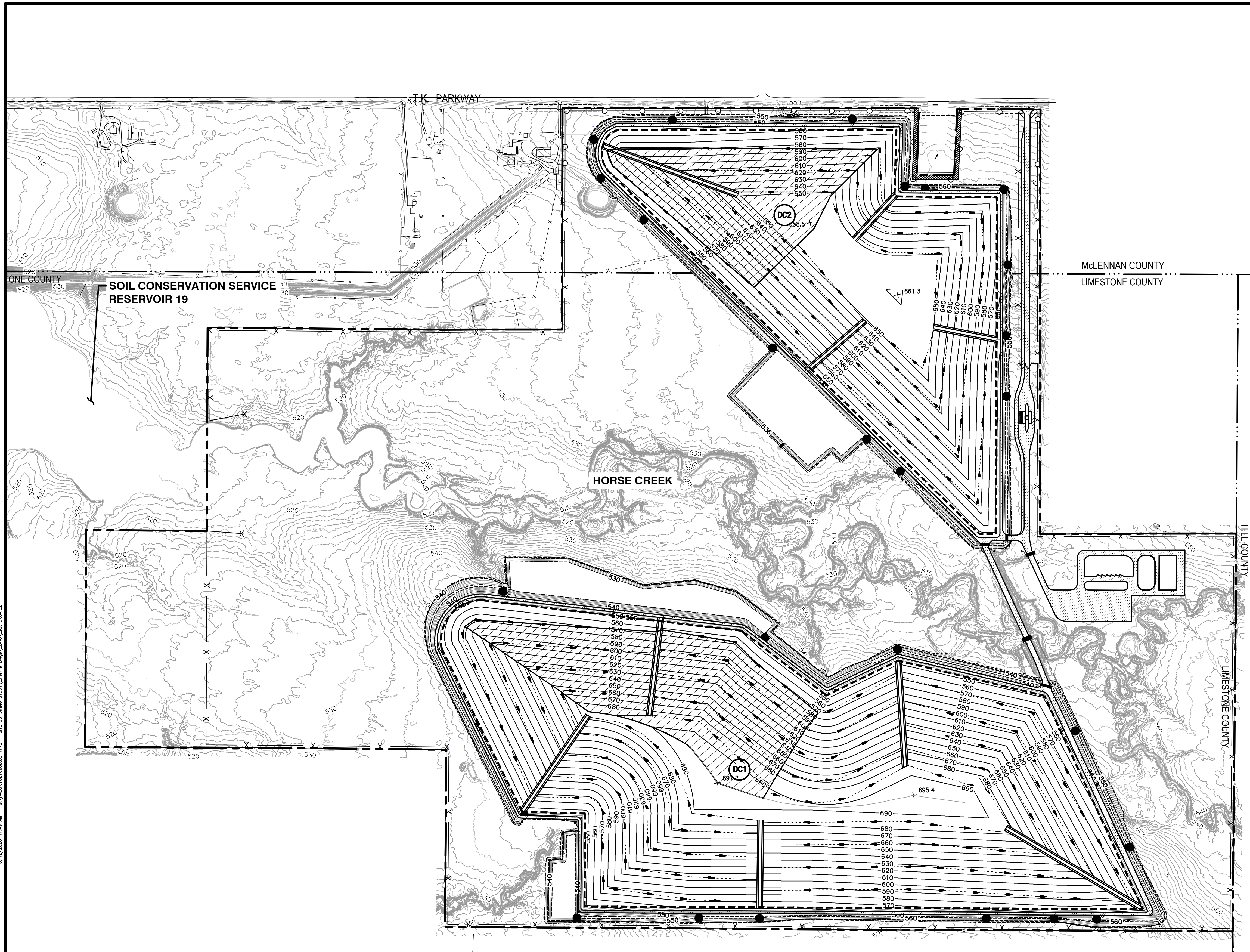
CADD FILE: 6A.E1

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.

6A-E.1



LEGEND

- EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- PERMIT BOUNDARY
- LIMITS OF WASTE
- SECTOR BOUNDARY
- COUNTY LINE
- EXISTING FENCE (SCREENED)
- FINAL COVER CONTOURS
- PROPOSED PERIMETER FENCE
- PROPOSED 8' PRIVACY FENCE
- ACCESS ROAD
- DRAINAGE SWALES
- DOWNCHUTES
- CHANNEL SECTION
- DOWNCHUTE DRAINAGE AREA

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.

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PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

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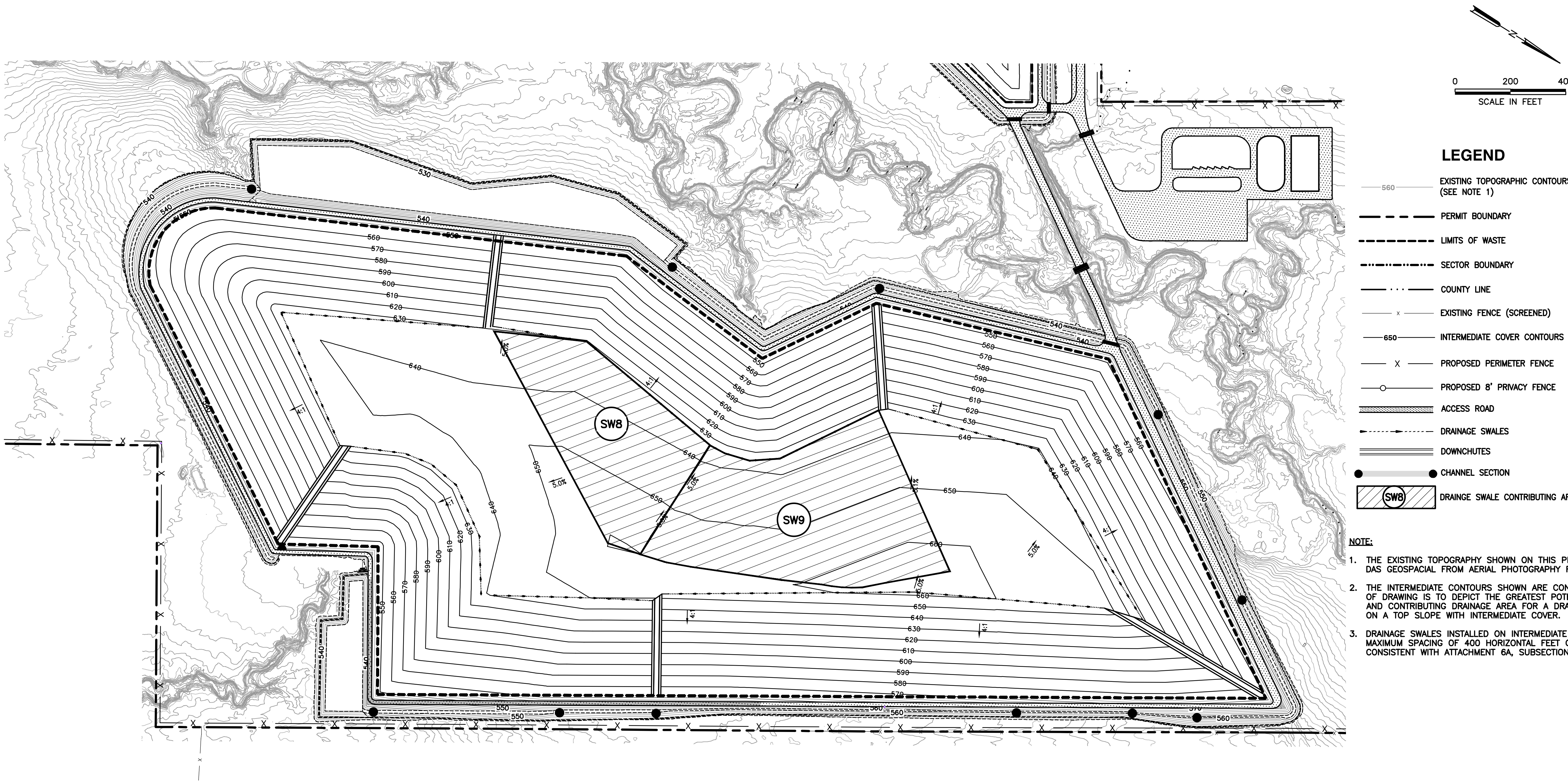
CADD FILE: 6A.E2

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. **6A-E.2**



LEGEND

560	EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
	PERMIT BOUNDARY
	LIMITS OF WASTE
	SECTOR BOUNDARY
	COUNTY LINE
x	EXISTING FENCE (SCREENED)
650	INTERMEDIATE COVER CONTOURS
X	PROPOSED PERIMETER FENCE
	PROPOSED 8' PRIVACY FENCE
	ACCESS ROAD
	DRAINAGE SWALES
	DOWNCHUTES
	CHANNEL SECTION
SW8	DRAINGE SWALE CONTRIBUTING AREA

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. THE INTERMEDIATE CONTOURS SHOWN ARE CONCEPTUAL, THE INTENT OF DRAWING IS TO DEPICT THE GREATEST POTENTIAL FLOW LENGTH AND CONTRIBUTING DRAINAGE AREA FOR A DRAINAGE SWALE INSTALLED ON A TOP SLOPE WITH INTERMEDIATE COVER.
3. DRAINAGE SWALES INSTALLED ON INTERMEDIATE COVER WILL HAVE A MAXIMUM SPACING OF 400 HORIZONTAL FEET ON A 4H:1V SIDESLOPE, CONSISTENT WITH ATTACHMENT 6A, SUBSECTION 6.4

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DRAWING TITLE: INTERMEDIATE COVER - TYPICAL SWALE/DOWNCHUTE LAYOUT - I

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

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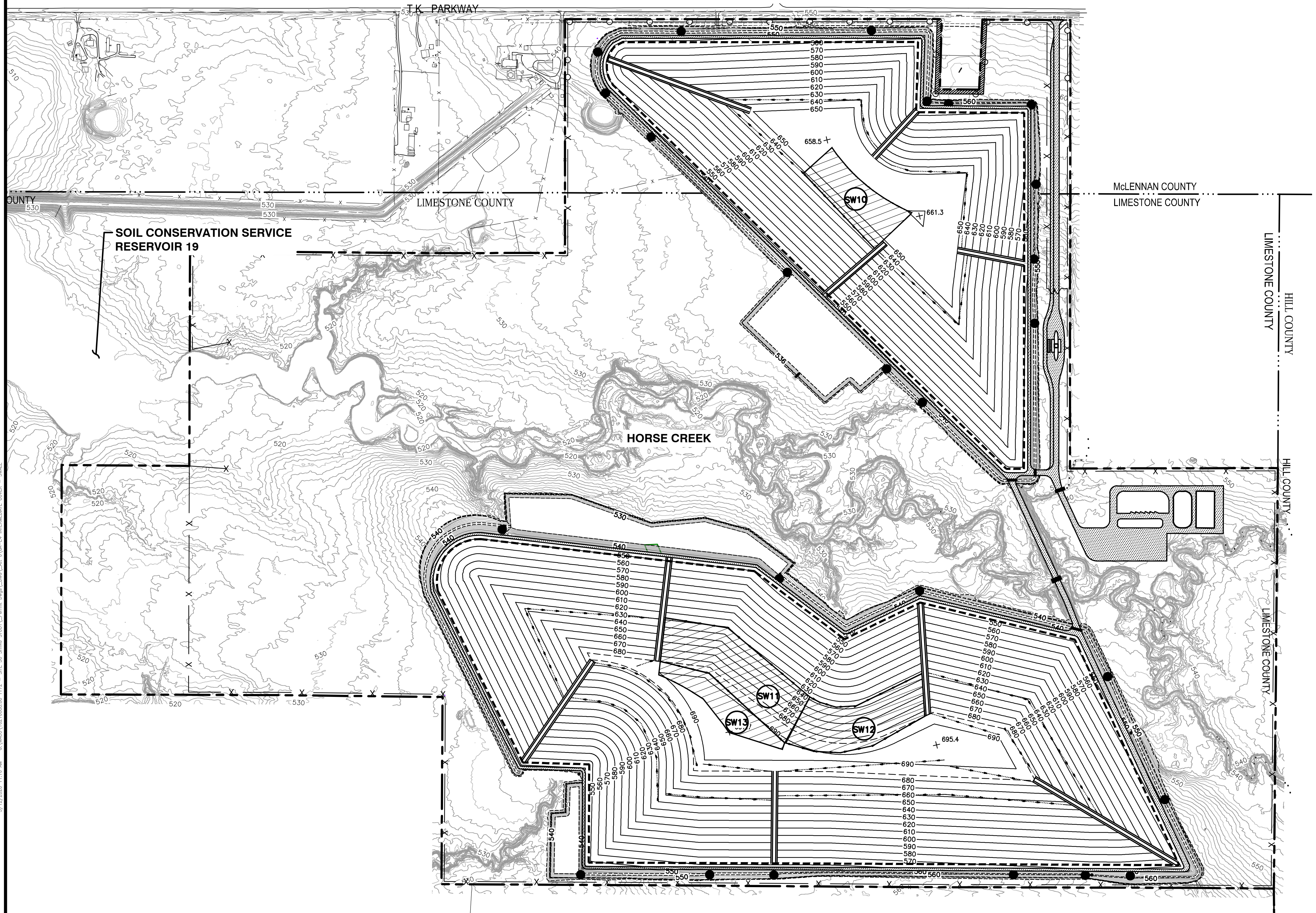
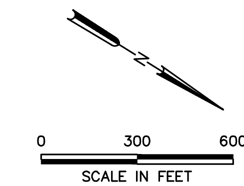
CADD FILE: 6A-E3 INTERMEDIATE COVER - SWALE

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A-E.3





LEGEND

- EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- PERMIT BOUNDARY
- LIMITS OF WASTE
- SECTOR BOUNDARY
- COUNTY LINE
- EXISTING FENCE (SCREENED)
- INTERMEDIATE COVER CONTOURS
- PROPOSED PERIMETER FENCE
- PROPOSED 8' PRIVACY FENCE
- ACCESS ROAD
- DRAINAGE SWALES
- DOWNCHUTES
- CHANNEL SECTION
- DRAINGE SWALE CONTRIBUTING AREA

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. THE INTERMEDIATE CONTOURS SHOWN ARE CONCEPTUAL. THE INTENT OF DRAWING IS TO DEPICT THE GREATEST POTENTIAL FLOW LENGTH AND CONTRIBUTING DRAINAGE AREA FOR A DRAINAGE SWALE INSTALLED ON A TOP SLOPE WITH INTERMEDIATE COVER.
3. DRAINAGE SWALES INSTALLED ON INTERMEDIATE COVER WILL HAVE A MAXIMUM SPACING OF 400 HORIZONTAL FEET ON A 4H:1V SIDESLOPE, CONSISTENT WITH ATTACHMENT 6A, SUBSECTION 6.4

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DRAWING TITLE: INTERMEDIATE COVER - TYPICAL SWALE/DOWNCHUTE LAYOUT - II

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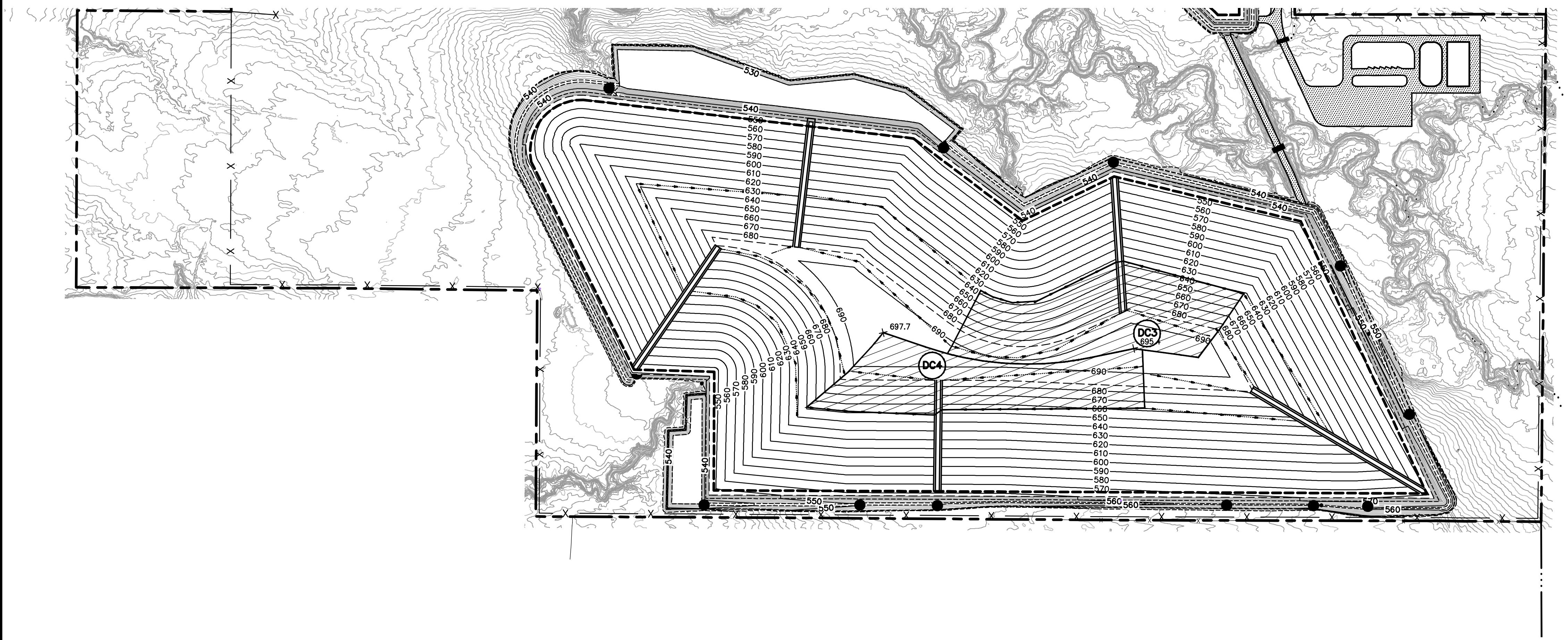
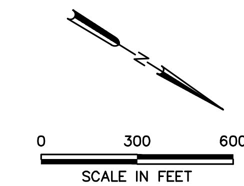
DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6A-E.4





LEGEND

560	EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
	PERMIT BOUNDARY
	LIMITS OF WASTE
	SECTOR BOUNDARY
	COUNTY LINE
x	EXISTING FENCE (SCREENED)
650	INTERMEDIATE COVER CONTOURS
X	PROPOSED PERIMETER FENCE
	PROPOSED 8' PRIVACY FENCE
	ACCESS ROAD
	DRAINAGE SWALES
	DOWNCHUTES
	CHANNEL SECTION
DC3	DOWNCHUTE DRAINAGE AREA

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM AERIAL PHOTOGRAPHY FLOWN JULY 03, 2018.
2. THE INTERMEDIATE CONTOURS SHOWN ARE CONCEPTUAL. THE INTENT OF DRAWING IS TO DEPICT THE GREATEST POTENTIAL FLOW LENGTH AND CONTRIBUTING DRAINAGE AREA FOR A DRAINAGE SWALE INSTALLED ON A TOP SLOPE WITH INTERMEDIATE COVER.

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5/13/2020

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DRAWING TITLE: INTERMEDIATE COVER - DOWNCHUTE AREAS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

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CADD FILE: 6A-E5 INTERMEDIATE COVER - DOWNCHUTE

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. **6A-E.5**

APPENDIX 6A-F

SOIL LOSS ANALYSIS

STATE OF TEXAS
JAMES ROY MURRAY III
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PROFESSIONAL ENGINEER
5/13/2020

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6A-F-1 to 6A-F-23

INTERMEDIATE COVER – SOIL LOSS ANALYSIS

CITY OF WACO LANDFILL
INTERMEDIATE COVER - SOIL LOSS ANALYSIS

Required: Determine expected soil loss for the landfill topslope and sideslope with intermediate cover consistent with 30 TAC §330.305(d)(2).

Method: Expected soil loss is calculated using the Universal Soil Loss Equation (USLE)/Revised Universal Soil Loss Equation (RUSLE). The annual soil loss calculated for intermediate cover conditions is compared to the permissible soil loss of 50 tons/acre/year, as referenced from the TCEQ's "Surface Water Drainage and Erosional Stability Guidance for Municipal Solid Waste Landfill", dated May, 2018.

References:

1. SCS National Engineering Handbook, *Section 3 - Sedimentation, Chapter 3 - Erosion*.
2. TNRCC, Use of the USLE in Final Cover/Configuration Design, 1993.
3. USDA, *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), 1997.*
4. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Limestone County, Texas.*
5. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Hill County*, Texas.
6. Reference: USDA, *Predicting Rainfall Erosion Losses, A Guide to Conservation Planning*, Agriculture Handbook Number 537, 1978.
7. TCEQ, *Surface Water Drainage and Erosional Stability Guidance for Municipal Solid Waste Landfill, May 2018.*

Solution:

1. Soil loss equation: A = RKLSCP

Where:
- A = Soil Loss (tons/ac/yr)
- R = Rainfall/Runoff Erosivity actor
- K = Soil Erodibility Factor
- L = Slope Length Factor
- S = Slope Steepness Factor
- C = Cover Management Factor
- P = Support Practice Factor

The rainfall factor, R, is a product of rainfall energy and maximum 30-min intensity.
Average annual R values for Eastern United States is presented in Figure 2-1 of USDA 1997.
Values of the R Factor (see page 6A-F-9), the R factor for the Site is:

R = 305

The soil erodibility, K, factor represents the resistance of a soil surface to erosion as a function of the soil's physical and chemical properties. As shown in soil surveys for Limestone County and McLennan County for the applicable on-site soils (see page 6A-F-14), the weighted average K factor for the area is:

K = 0.350

CITY OF WACO LANDFILL
INTERMEDIATE COVER - SOIL LOSS ANALYSIS

Solution (Cont.): The effect of topography on soil erosion are determined by the slope length factor, L, and slope steepness factor, S. The slopes of interest are represented by either of the following: (1) topslope above and sideslope below the first drainage swale placed on intermediate cover or (2) sideslope area between consecutive drainage swales on intermediate cover.

Topslope Conditions			Sideslope Conditions		
slope =	5	%	slope =	25	%
length, l =	650	ft	length, l =	400	ft

Topographic factor, combined slope length and slope steepness factors LS, is based on a moderate rill/interill erosion ratio (**see page** 6A-F-19).

Topslope, LS = 1.37 Sideslope, LS = 10.65

The cover and cropping management factor, C, represents the percentage of soil loss that would occur if the surface were partially protected by some combination of cover and management practices. Use of Table 2 - Factor C for Permanent Pasture, Range, and Idle Land (**see page** 6A-F-21) for 60% ground cover yields the following C value.

C = 0.042

The erosion control practice factor, P, measures the effect of control practices that reduce the erosion potential of the runoff by influencing drainage patterns, runoff concentration, and runoff velocity. Use of Table 3, for Countouring, Countouring, Stripcropping and Terracing (**see page** 6A-F-22), the P factor is determined to be:

P = 0.90

2. Soil loss calculations:

Slope Condition	R	K	LS	C	P	A (tons/ac/yr)
5% slope 650 ft length	305	0.35	1.37	0.042	0.90	5.5
25% slope 400 ft length	305	0.35	10.65	0.042	0.90	43.0

Conclusions:

From review of the annual soil loss on topslopes and sideslopes with intermediate cover, a value of less than 50 tons/acre/year is achieved for both topslopes and sideslopes, consistent with TCEQ's guidance document for addressing erosional stability during all phases of landfill operation. Sideslope swales will be installed on intermediate cover, as specified in Attachment 6A, Section 6 to reduce erosion from intermediate cover. Specifications for installation, inspection, and maintenance of intermediate cover and sideslope swales are also described in Attachment 6A, Section 6.

FINAL COVER – SOIL LOSS ANALYSIS

Prep By: BG
Date: 11/26/2018

CITY OF WACO LANDFILL
FINAL COVER - SOIL LOSS ANALYSIS

Required: Determine expected soil loss for the landfill topslope and sideslope with final cover consistent with 30 TAC §330.305(d)(2).

Method: Expected soil loss is calculated using the Universal Soil Loss Equation (USLE)/Revised Universal Soil Loss Equation (RUSLE). The annual soil loss calculated for final cover conditions is compared to the permissible soil loss of 3 tons/acre/year, as referenced from the TCEQ's "Surface Water Drainage and Erosional Stability Guidance for Municipal Solid Waste Landfill", dated May, 2018.

References:

1. SCS National Engineering Handbook, *Section 3 - Sedimentation, Chapter 3 - Erosion*.
2. TNRCC, Use of the USLE in Final Cover/Configuration Design, 1993.
2. USDA, *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), 1997.*
3. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Limestone County, Texas.*
3. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Hill County*, Texas.
4. Reference: USDA, *Predicting Rainfall Erosion Losses, A Guide to Conservation Planning*, Agriculture Handbook Number 537, 1978.
5. TCEQ, *Surface Water Drainage and Erosional Stability Guidance for Municipal Solid Waste Landfill, May 2018.*

Solution:

1. Soil loss equation: A = RKLSCP

Where:

A =	Soil Loss (tons/ac/yr)
R =	Rainfall/Runoff Erosivity actor
K =	Soil Erodibility Factor
L =	Slope Length Factor
S =	Slope Steepness Factor
C =	Cover Management Factor
P =	Support Practice Factor

The rainfall factor, R, is a product of rainfall energy and maximum 30-min intensity.
Average annual R values for Eastern United States is presented in Figure 2-1 of USDA 1997.
Values of the R Factor (**see page** 6A-F-9), the R factor for the Site is:

R = 305

The soil erodibility, K, factor represents the resistance of a soil surface to erosion as a function of the soil's physical and chemical properties. As shown in soil surveys for Limestone County and McLennan County for the applicable on-site soils (**see page** 6A-F-14), the weighted average K factor for the area is:

K = 0.350

Solution (Cont.): The effect of topography on soil erosion are determined by the slope length factor, L, and slope steepness factor, S. The slopes of interest are represented by either of the following: (1) topslope above and sideslope below the first drainage swale placed on final cover or (2) sideslope area between consecutive drainage swales on final cover.

Topslope Conditions			Sideslope Conditions		
slope =	5	%	slope =	25	%
length, l =	250	ft	length, l =	130	ft

Topographic factor, combined slope length and slope steepness factors LS, is based on a low rill/interill erosion ratio (see page 6A-F-20).

Topslope, LS = 0.78 Sideslope, LS = 4.68

The cover and cropping management factor, C, represents the percentage of soil loss that would occur if the surface were partially protected by some combination of cover and management practices. Using of Table 2 - Factor C for Permanent Pasture, Range, and Idle Land (see page 6A-F-21) for 90% ground cover yields the following C value.

C = 0.006

The erosion control practice factor, P, measures the effect of control practices that reduce the erosion potential of the runoff by influencing drainage patterns, runoff concentration, and runoff velocity. Use of Table 3, for Countouring, Countouring, Stripcropping and Terracing (see page 6A-F-22), the P factor is determined to be:

P = 0.90

2. Soil loss calculations:

Slope Condition	R	K	LS	C	P	A (tons/ac/yr)
5% slope 250 ft length	305	0.35	0.780	0.006	0.90	0.45
25% slope 130 ft length	305	0.35	4.680	0.006	0.90	2.70

Conclusions:

From review of the annual soil loss, a value of less than 3 tons/acre/year is achieved, consistent with TCEQ's guidance document for addressing erosional stability during all phases of landfill operation.

SOIL LOSS ANALYSIS REFERENCES

Prep By: BG
Date: 11/26/2018

CITY OF WACO LANDFILL
R Factor

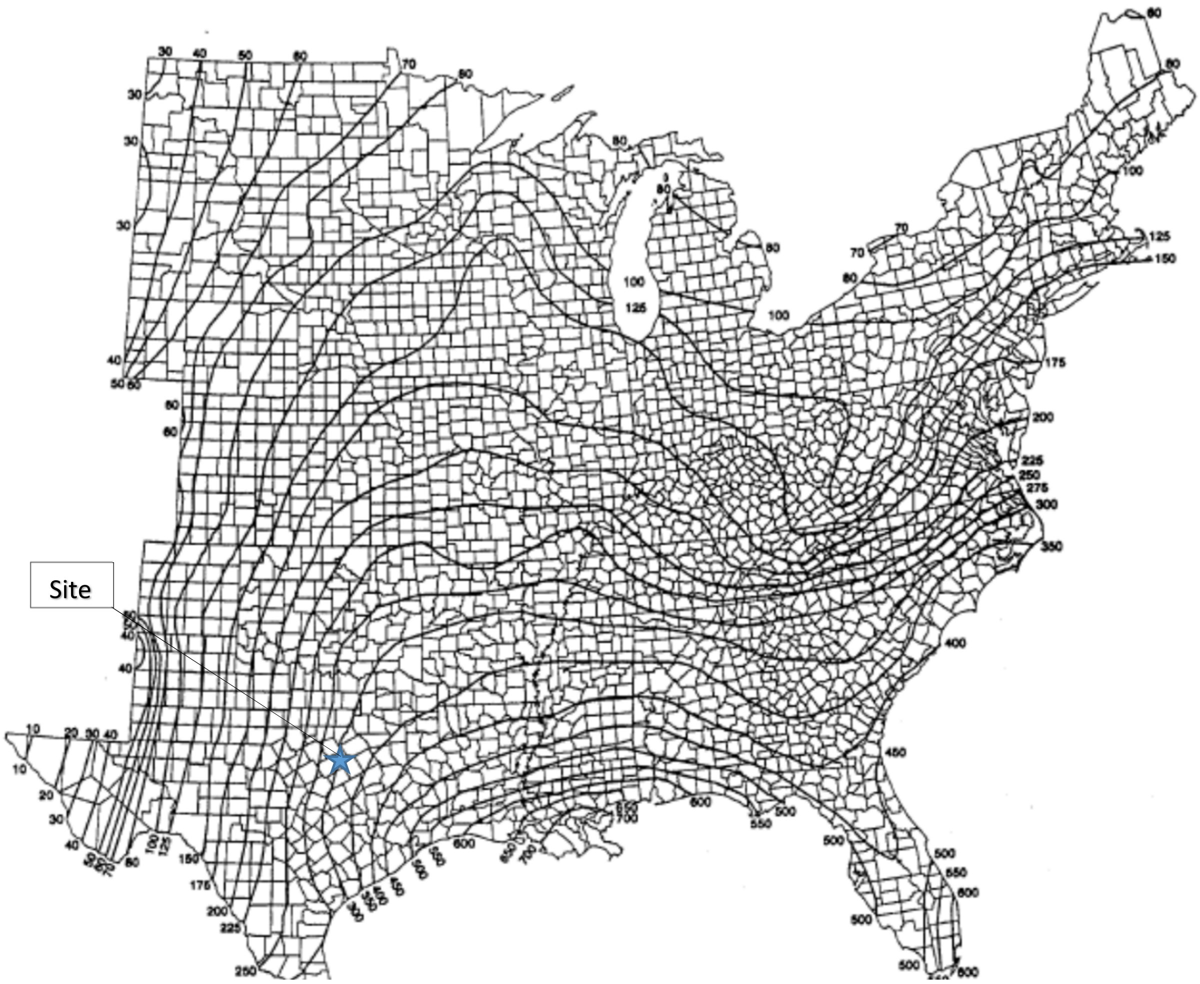


Figure 1. Isoerodent Map of Average Annual Rainfall Runoff Erosivity Factor, R.

Reference: USDA, Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), Agricultural Research Service, Agriculture Handbook Number 703, 1997.

K Factors for Site Soils
(Table from Limestone County Soil Survey, USDA, NRCS, September 1997

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
AxA: Axtell	0-9	7-18	1.40-1.60	0.6-2.0	0.11-0.15	5.1-6.5	<2	Low	0.43	5	3	.5-1
	9-32	35-55	1.35-1.60	<0.06	0.07-0.16	4.5-7.3	<2	High	0.37			
	32-60	27-50	1.50-1.70	<0.06	0.07-0.16	6.6-8.4	<2	High	0.37			
	60-80	25-50	1.50-1.70	0.2-0.6	0.07-0.12	5.6-8.4	<2	High	0.37			
AxB: Axtell	0-8	7-18	1.40-1.60	0.6-2.0	0.11-0.15	5.1-6.5	<2	Low	0.43	5	3	.5-1
	8-21	35-55	1.35-1.60	<0.06	0.07-0.16	4.5-5.5	<2	High	0.37			
	21-53	27-50	1.50-1.70	<0.06	0.07-0.16	6.6-8.4	<2	High	0.37			
	53-80	25-50	1.50-1.70	0.2-0.6	0.07-0.12	5.6-8.4	<2	High	0.37			
BnA: Branyon	0-6	40-60	1.15-1.45	<0.06	0.12-0.18	7.4-8.4	<2	Very high	0.32	5	4	2-4
	6-62	40-60	1.20-1.45	<0.06	0.12-0.18	7.4-8.4	<4	Very high	0.32			
	62-80	40-60	1.20-1.35	<0.06	0.12-0.18	7.9-8.4	<4	Very high	0.32			
BuA: Burleson	0-18	40-60	1.35-1.50	<0.06	0.12-0.18	5.6-8.4	<2	Very high	0.32	5	4	1-3
	18-42	40-60	1.40-1.55	<0.06	0.12-0.18	5.6-8.4	<4	Very high	0.32			
	42-80	35-60	1.40-1.55	<0.06	0.12-0.18	7.4-8.4	<4	Very high	0.32			
CrA: Crockett	0-6	5-20	1.50-1.60	0.6-2.0	0.11-0.20	5.6-7.8	<2	Low	0.43	4-3	5	.5-2
	6-12	40-55	1.35-1.60	<0.06	0.08-0.14	5.6-7.3	<4	High	0.32			
	12-40	35-55	1.40-1.65	<0.06	0.08-0.14	6.1-8.4	<4	High	0.32			
	40-56	20-50	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	Moderate	0.32			
	56-80	30-60	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	High	0.32			
CrB: Crockett	0-5	5-20	1.50-1.60	0.6-2.0	0.11-0.20	5.6-7.8	<2	Low	0.43	4-3	5	.5-2
	5-16	40-55	1.35-1.60	<0.06	0.08-0.14	5.6-7.3	<4	High	0.32			
	16-47	35-55	1.40-1.65	<0.06	0.08-0.14	6.1-8.4	<4	High	0.32			
	47-54	20-50	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	Moderate	0.32			
	54-80	30-60	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	High	0.32			
CrC2: Crockett	0-3	5-20	1.50-1.60	0.6-2.0	0.11-0.20	5.6-7.8	<2	Low	0.43	4-3	5	.5-2
	3-13	40-55	1.35-1.60	<0.06	0.08-0.14	5.6-7.3	<4	High	0.32			
	13-33	35-55	1.40-1.65	<0.06	0.08-0.14	6.1-8.4	<4	High	0.32			
	33-45	20-50	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	Moderate	0.32			
	45-80	30-60	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	High	0.32			
EgB: Edge	0-9	5-12	1.25-1.55	0.6-2.0	0.14-0.18	4.5-7.3	<2	Low	0.43	4	3	.5-1
	9-26	40-55	1.36-1.55	<0.06	0.11-0.19	4.5-6.5	<2	High	0.32			
	26-38	27-45	1.45-1.65	0.06-0.2	0.10-0.16	4.5-6.5	<2	Moderate	0.32			
	38-51	10-40	1.40-1.69	0.2-0.6	0.10-0.16	4.5-7.8	<2	Moderate	0.37			
	51-80	10-45	1.50-1.75	0.06-0.2	0.11-0.18	5.1-8.4	<2	Moderate	0.37			
EgC2: Edge	0-3	5-12	1.25-1.55	0.6-2.0	0.14-0.18	4.5-7.3	<2	Low	0.43	4	3	.5-1
	3-13	40-55	1.36-1.55	<0.06	0.11-0.19	4.5-6.5	<2	High	0.32			
	13-31	27-45	1.45-1.65	0.06-0.2	0.10-0.16	4.5-6.5	<2	Moderate	0.32			
	31-60	10-40	1.40-1.69	0.2-0.6	0.10-0.16	4.5-7.8	<2	Moderate	0.37			
	60-80	10-45	1.50-1.75	0.06-0.2	0.11-0.18	5.1-8.4	<2	Moderate	0.37			
EgD: Edge	0-9	5-12	1.25-1.55	0.6-2.0	0.14-0.18	4.5-7.3	<2	Low	0.43	4	3	.5-1
	9-25	40-55	1.36-1.55	<0.06	0.11-0.19	4.5-6.5	<2	High	0.32			
	25-49	27-45	1.45-1.65	0.06-0.2	0.10-0.16	4.5-6.5	<2	Moderate	0.32			
	49-53	10-40	1.40-1.69	0.2-0.6	0.10-0.16	4.5-7.8	<2	Moderate	0.37			
	53-80	10-45	1.50-1.75	0.06-0.2	0.11-0.18	5.1-8.4	<2	Moderate	0.37			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
EhC3*:												
Edge	0-3	5-12	1.25-1.55	0.6-2.0	0.14-0.18	4.5-7.3	<2	Low	0.43	4	3	.5-1
	3-25	40-55	1.36-1.55	<0.06	0.11-0.19	4.5-6.5	<2	High	0.32			
	25-32	27-45	1.45-1.65	0.06-0.2	0.10-0.16	4.5-6.5	<2	Moderate	0.32			
	32-42	10-40	1.40-1.69	0.2-0.6	0.10-0.16	4.5-7.8	<2	Moderate	0.37			
	42-80	10-45	1.50-1.75	0.06-0.2	0.11-0.18	5.1-8.4	<2	Moderate	0.37			
Gullied land	---	---	---	---	---	---	---	----------	----	---	---	---
EsC2 Ellis	0-6	40-50	1.35-1.55	<0.06	0.12-0.18	6.1-8.4	<2	High	0.32	3	4	1-3
	6-40	40-60	1.35-1.55	<0.06	0.12-0.18	6.1-8.4	<2	High	0.32			
	40-80	40-60	1.40-1.65	<0.06	0.10-0.15	6.6-8.4	<2	High	0.32			
EsE2 Ellis	0-6	40-50	1.35-1.55	<0.06	0.12-0.18	6.1-8.4	<2	High	0.32	3	4	1-3
	6-37	40-60	1.35-1.55	<0.06	0.12-0.18	6.1-8.4	<2	High	0.32			
	37-80	40-60	1.40-1.65	<0.06	0.10-0.15	6.6-8.4	<2	High	0.32			
FeD2 Ferris	0-4	40-65	1.40-1.50	<0.06	0.15-0.18	7.9-8.4	<2	Very high	0.32	4-3	4	.5-2
	4-45	40-65	1.40-1.50	<0.06	0.12-0.18	7.9-8.4	<2	Very high	0.32			
	45-80	40-75	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	<2	High	0.32			
FhC2*:												
Ferris	0-4	40-65	1.40-1.50	<0.06	0.15-0.18	7.9-8.4	<2	Very high	0.32	4-3	4	.5-2
	4-43	40-65	1.40-1.50	<0.06	0.12-0.18	7.9-8.4	<2	Very high	0.32			
	43-80	40-75	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	<2	High	0.32			
Heiden	0-20	40-60	1.30-1.50	<0.06	0.15-0.20	7.9-8.4	<2	Very high	0.32	5	4	1-4
	20-35	40-60	1.35-1.55	<0.06	0.14-0.18	7.9-8.4	<2	Very high	0.32			
	35-60	40-60	1.40-1.60	<0.06	0.12-0.18	7.9-8.4	<2	Very high	0.32			
	60-80	40-60	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	<2	Very high	0.32			
GfB Gasil	0-16	5-12	1.50-1.60	6.0-20	0.07-0.11	6.1-7.8	<2	Low	0.20	5	2	.5-1
	16-80	15-35	1.40-1.60	0.6-2.0	0.12-0.19	5.1-6.5	<2	Low	0.32			
GsA Groesbeck	0-15	4-10	1.35-1.45	2.0-6.0	0.07-0.12	6.1-7.3	<2	Low	0.32	2	2	1-3
	15-29	18-25	1.35-1.60	0.6-2.0	0.10-0.15	6.1-7.8	<2	Low	0.28			
	29-32	15-25	1.35-1.65	0.6-2.0	0.10-0.15	7.4-8.4	<2	Low	0.28			
	32-80	---	---	0.2-2.0	---	---	---	----------	----			
GsC Groesbeck	0-16	4-10	1.35-1.45	2.0-6.0	0.07-0.12	6.1-7.3	<2	Low	0.32	2	2	1-3
	16-26	18-25	1.35-1.60	0.6-2.0	0.10-0.15	6.1-7.8	<2	Low	0.28			
	26-30	15-25	1.35-1.65	0.6-2.0	0.10-0.15	7.4-8.4	<2	Low	0.28			
	30-60	---	---	0.2-2.0	---	---	---	----------	----			
HeB Heiden	0-18	40-60	1.30-1.50	<0.06	0.15-0.20	7.9-8.4	<2	Very high	0.32	5	4	1-4
	18-56	40-60	1.35-1.55	<0.06	0.14-0.18	7.9-8.4	<2	Very high	0.32			
	56-65	40-60	1.40-1.60	<0.06	0.12-0.18	7.9-8.4	<2	Very high	0.32			
	65-80	40-60	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	<2	Very high	0.32			
HoB Houston Black	0-21	50-60	1.20-1.40	<0.06	0.15-0.20	7.4-8.4	<2	Very high	0.32	5	4	1-5
	21-56	50-60	1.25-1.50	<0.06	0.12-0.18	7.4-8.4	<2	Very high	0.32			
	56-80	45-65	1.30-1.55	<0.06	0.10-0.16	7.4-8.4	<4	Very high	0.32			
Kc Kaufman	0-5	50-86	1.20-1.45	<0.06	0.12-0.18	5.6-8.4	<2	Very high	0.32	5	4	1-4
	5-45	60-86	1.25-1.45	<0.06	0.12-0.18	5.6-8.4	<2	Very high	0.32			
	45-80	60-86	1.25-1.45	<0.06	0.12-0.18	5.6-8.4	<2	Very high	0.32			
Kd Kaufman	0-6	50-86	1.20-1.45	<0.06	0.12-0.18	5.6-8.4	<2	Very high	0.32	5	4	1-4
	6-40	60-86	1.25-1.45	<0.06	0.12-0.18	5.6-8.4	<2	Very high	0.32			
	40-80	60-86	1.25-1.45	<0.06	0.12-0.18	5.6-8.4	<2	Very high	0.32			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
LaE2 Lamar	0-3	27-35	1.25-1.40	0.6-2.0	0.12-0.15	6.6-8.4	<2	Moderate	0.32	5	4L	1-3
	3-27	20-35	1.30-1.50	0.6-2.0	0.12-0.15	7.9-8.4	<2	Moderate	0.32			
	27-80	20-35	1.35-1.60	0.6-2.0	0.12-0.15	7.9-8.4	<2	Moderate	0.32			
LrB*:												
Lavender	0-7	3-8	1.35-1.45	2.0-6.0	0.07-0.12	5.6-7.3	<2	Low	0.32	2	2	.5-2
	7-13	8-12	1.35-1.45	2.0-6.0	0.08-0.13	5.6-7.8	<2	Low	0.32			
	13-31	18-34	1.35-1.55	0.6-2.0	0.10-0.15	5.6-7.8	<2	Low	0.28			
	31-60	---	---	0.2-2.0	---	---	---	---	---			
Rock outcrop	---	---	---	---	---	---	---	---	---	---	---	---
LsB Leson	0-6	40-60	1.30-1.45	<0.06	0.12-0.18	6.1-8.4	<2	High	0.32	5	4	1-4
	6-33	40-60	1.30-1.50	<0.06	0.12-0.18	6.1-8.4	<2	High	0.32			
	33-57	40-60	1.35-1.55	<0.06	0.12-0.18	6.6-8.4	<2	High	0.32			
	57-80	40-65	1.40-1.65	<0.06	0.12-0.16	7.4-8.4	<4	High	0.32			
LuA Lufkin	0-10	5-18	1.35-1.65	0.6-2.0	0.11-0.18	5.1-6.5	<2	Low	0.43	5	3	.5-2
	10-66	35-45	1.40-1.60	<0.06	0.12-0.18	4.5-7.8	<4	Very high	0.32			
	66-80	20-40	1.40-1.68	<0.06	0.10-0.14	6.1-8.4	<4	High	0.37			
LxA*:												
Lufkin	0-7	5-18	1.35-1.65	0.6-2.0	0.11-0.18	5.1-6.5	<2	Low	0.43	5	3	.5-2
	7-60	35-45	1.40-1.60	<0.06	0.12-0.18	4.5-7.8	<4	Very high	0.32			
	60-80	20-40	1.40-1.68	<0.06	0.10-0.14	6.1-8.4	<4	High	0.37			
Rader	0-6	4-15	1.30-1.50	2.0-6.0	0.10-0.18	4.5-6.5	<2	Low	0.37	5	3	.5-2
	6-18	4-15	1.35-1.55	2.0-6.0	0.10-0.18	4.5-6.5	<2	Low	0.37			
	18-27	18-30	1.40-1.60	0.2-0.6	0.12-0.18	4.5-5.5	<2	Moderate	0.32			
	27-40	35-50	1.45-1.65	<0.06	0.12-0.18	4.5-6.5	<2	High	0.32			
	40-80	24-45	1.45-1.65	0.06-0.2	0.12-0.18	4.5-8.4	<4	Moderate	0.32			
MaA Mabank	0-6	10-25	1.50-1.65	0.6-2.0	0.11-0.15	5.6-7.3	<2	Low	0.43	5	3	1-2
	6-37	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-8.4	<2	High	0.32			
	37-80	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-8.4	2-8	High	0.32			
Na Nahatche	0-15	18-27	1.10-1.30	0.6-2.0	0.13-0.20	5.6-7.8	<2	Moderate	0.28	5	6	1-3
	15-60	18-35	1.20-1.50	0.6-2.0	0.12-0.20	5.6-7.8	<2	Moderate	0.28			
	60-80	18-35	1.30-1.60	0.6-2.0	0.12-0.18	5.6-7.8	<2	Moderate	0.28			
NoB Normangee	0-6	27-35	1.50-1.60	0.06-0.2	0.15-0.20	5.6-7.3	<2	Moderate	0.37	4	6	.5-2
	6-51	35-55	1.55-1.65	<0.06	0.12-0.18	5.6-8.4	2-8	High	0.32			
	51-80	35-55	1.60-1.70	<0.06	0.12-0.18	6.1-8.4	2-8	High	0.32			
NrD2 Normangee	0-3	27-35	1.50-1.60	0.06-0.2	0.10-0.14	5.6-7.3	<2	Low	0.28	4	8	.5-2
	3-43	35-55	1.55-1.65	<0.06	0.12-0.18	5.6-8.4	2-8	High	0.32			
	43-80	35-55	1.60-1.70	<0.06	0.12-0.18	6.1-8.4	2-8	High	0.32			
OgB Oglesby	0-18	40-50	1.25-1.45	0.06-0.2	0.13-0.18	6.6-7.8	<2	High	0.32	1	4	1-3
	18-24	---	---	0.06-2.0	---	---	---	---	---			
Ot Oletha	0-6	40-50	1.25-1.45	<0.06	0.14-0.19	5.1-7.3	<2	High	0.32	5	4	1-3
	6-16	18-35	1.35-1.60	0.2-0.6	0.15-0.18	4.5-5.5	<2	Moderate	0.32			
	16-25	24-35	1.35-1.60	0.2-2.0	0.15-0.18	6.6-8.4	<2	Moderate	0.32			
	25-33	25-35	1.35-1.60	0.2-2.0	0.15-0.18	6.6-8.4	<2	Moderate	0.32			
	33-44	25-35	1.35-1.60	0.2-2.0	0.15-0.18	6.6-8.4	<2	Moderate	0.32			
	44-80	15-35	1.40-1.60	0.2-2.0	0.15-0.18	6.1-7.8	<2	Moderate	0.32			
PaC Padina	0-4	2-10	1.20-1.50	6.0-20	0.07-0.11	5.6-7.3	<2	Low	0.17	5	2	.5-1
	4-47	2-10	1.20-1.50	6.0-20	0.05-0.08	5.6-7.3	<2	Low	0.17			
	47-80	18-35	1.40-1.60	0.6-2.0	0.14-0.18	5.1-6.5	<2	Low	0.24			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
PaE-------------- Padina	0-11	2-10	1.20-1.50	6.0-20	0.07-0.11	5.6-7.3	<2	Low--------	0.17	5	2	.5-1
	11-46	2-10	1.20-1.50	6.0-20	0.05-0.08	5.6-7.3	<2	Low--------	0.17			
	46-80	18-35	1.40-1.60	0.6-2.0	0.14-0.18	5.1-6.5	<2	Low--------	0.24			
PeB-------------- Personville	0-18	3-10	1.35-1.45	2.0-6.0	0.07-0.12	6.1-7.3	<2	Low--------	0.24	3	2	.5-2
	18-47	18-25	1.35-1.55	0.6-2.0	0.10-0.15	5.1-6.5	<2	Low--------	0.17			
	47-60	---	---	0.2-2.0	---	---	---	-----------	----			
Pr*-------------- Pits, quarries	---	---	---	---	---	---	---	-----------	----	---	---	---
Ps*-------------- Pits, sand	---	---	---	---	---	---	---	-----------	----	---	---	---
RaA-------------- Rader	0-12	4-15	1.30-1.50	2.0-6.0	0.10-0.18	4.5-6.5	<2	Low--------	0.37	5	3	.5-2
	12-19	4-15	1.35-1.55	2.0-6.0	0.10-0.18	4.5-6.5	<2	Low--------	0.37			
	19-25	18-30	1.40-1.60	0.2-0.6	0.12-0.18	4.5-5.5	<2	Moderate	0.32			
	25-63	35-50	1.45-1.65	<0.06	0.12-0.18	4.5-6.5	<2	High-------	0.32			
	63-80	24-45	1.45-1.65	0.06-0.2	0.12-0.18	4.5-8.4	<4	Moderate	0.32			
RoA-------------- Robco	0-16	2-10	1.40-1.60	6.0-20	0.04-0.10	5.1-6.5	<2	Low--------	0.24	5	2	.5-1
	16-25	2-10	1.40-1.60	6.0-20	0.04-0.10	5.1-6.5	<2	Low--------	0.24			
	25-27	27-35	1.50-1.65	0.2-0.6	0.12-0.18	4.5-6.0	<2	Moderate	0.32			
	27-60	20-35	1.55-1.70	0.06-0.2	0.12-0.18	4.5-6.0	<2	High-------	0.37			
	60-80	25-45	1.55-1.70	0.06-0.2	0.10-0.18	4.5-7.3	<2	Moderate	0.37			
SaB-------------- Silawa	0-7	10-20	1.35-1.55	2.0-6.0	0.10-0.15	5.1-6.5	<2	Low--------	0.24	5-4	3	.5-2
	7-44	18-35	1.35-1.60	0.6-2.0	0.12-0.17	4.5-6.0	<2	Low--------	0.32			
	44-58	12-30	1.40-1.65	2.0-6.0	0.08-0.15	4.5-6.0	<2	Low--------	0.32			
	58-80	2-15	1.40-1.70	6.0-20	0.05-0.11	4.5-6.5	<2	Low--------	0.20			
SaD-------------- Silawa	0-5	10-20	1.35-1.55	2.0-6.0	0.10-0.15	5.1-6.5	<2	Low--------	0.24	5-4	3	.5-2
	5-35	18-35	1.35-1.60	0.6-2.0	0.12-0.17	4.5-6.0	<2	Low--------	0.32			
	35-41	12-30	1.40-1.65	2.0-6.0	0.08-0.15	4.5-6.0	<2	Low--------	0.32			
	41-80	2-15	1.40-1.70	6.0-20	0.05-0.11	4.5-6.5	<2	Low--------	0.20			
SsB-------------- Silstid	0-5	3-12	1.40-1.60	6.0-20	0.05-0.10	5.6-7.3	<2	Low--------	0.17	5	2	.5-1
	5-27	3-12	1.40-1.60	6.0-20	0.05-0.10	5.6-7.3	<2	Low--------	0.17			
	27-60	18-32	1.50-1.70	0.6-2.0	0.10-0.16	5.1-6.5	<2	Low--------	0.24			
	60-80	18-32	1.50-1.70	0.6-2.0	0.10-0.16	5.1-6.5	<2	Low--------	0.24			
SsD-------------- Silstid	0-8	3-12	1.40-1.60	6.0-20	0.05-0.10	5.6-7.3	<2	Low--------	0.17	5	2	.5-1
	8-24	3-12	1.40-1.60	6.0-20	0.05-0.10	5.6-7.3	<2	Low--------	0.17			
	24-52	18-32	1.50-1.70	0.6-2.0	0.10-0.16	5.1-6.5	<2	Low--------	0.24			
	52-80	18-32	1.50-1.70	0.6-2.0	0.10-0.16	5.1-6.5	<2	Low--------	0.24			
StA-------------- Styx	0-15	3-15	1.40-1.60	2.0-6.0	0.05-0.10	5.1-7.3	<2	Low--------	0.17	5	2	.5-2
	15-27	3-15	1.40-1.60	2.0-6.0	0.05-0.10	5.1-7.3	<2	Low--------	0.17			
	27-80	25-35	1.30-1.65	0.6-2.0	0.12-0.16	4.5-6.5	<2	Low--------	0.24			
TaA-------------- Tabor	0-12	8-20	1.50-1.60	0.6-2.0	0.11-0.15	5.1-6.5	<2	Low--------	0.43	5	3	.5-1
	12-55	40-55	1.35-1.55	<0.06	0.09-0.12	4.5-7.3	<2	High-------	0.32			
	55-80	25-45	1.45-1.65	<0.06	0.14-0.18	5.1-8.4	<2	High-------	0.32			
Tc--------------- Tinn	0-12	40-60	1.40-1.50	0.06-0.2	0.15-0.20	7.4-8.4	<2	Very high	0.32	5	4	1-4
	12-60	40-60	1.40-1.50	<0.06	0.13-0.18	7.4-8.4	<2	Very high	0.32			
	60-80	40-60	1.40-1.50	<0.06	0.13-0.18	7.4-8.4	<2	Very high	0.32			
To--------------- Tinn	0-18	40-60	1.40-1.50	0.06-0.2	0.15-0.20	7.4-8.4	<2	Very high	0.32	5	4	1-4
	18-60	40-60	1.40-1.50	<0.06	0.13-0.18	7.4-8.4	<2	Very high	0.32			
	60-80	40-60	1.40-1.50	<0.06	0.13-0.18	7.4-8.4	<2	Very high	0.32			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Uh---------------- Uhland	0-7	10-20	1.25-1.40	0.6-2.0	0.10-0.16	5.6-7.8	<2	Low--------	0.37	5	3	.5-2
	7-80	10-18	1.25-1.55	0.6-2.0	0.10-0.16	5.6-7.8	<2	Low--------	0.37			
Wa---------------- Whitesboro	0-26	12-20	1.25-1.40	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low--------	0.28	5	5	1-3
	26-55	22-35	1.30-1.45	0.6-2.0	0.13-0.18	6.1-8.4	<2	Moderate	0.28			
	55-80	22-35	1.30-1.55	0.6-2.0	0.13-0.18	6.1-8.4	<2	Moderate	0.28			
Wf---------------- Whitesboro	0-26	12-20	1.25-1.40	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low--------	0.28	5	5	1-3
	26-58	22-35	1.30-1.45	0.6-2.0	0.13-0.18	6.1-8.4	<2	Moderate	0.28			
	58-80	22-35	1.30-1.55	0.6-2.0	0.13-0.18	6.1-8.4	<2	Moderate	0.28			
WnA--------------- Wilson	0-7	27-35	1.35-1.50	0.2-0.6	0.10-0.17	5.6-7.3	<0	Moderate	0.43	5	6	.5-2
	7-56	35-50	1.50-1.60	<0.06	0.12-0.15	5.6-8.4	<4	High------	0.37			
	56-80	35-60	1.50-1.60	<0.06	0.12-0.15	6.6-8.4	2-8	High------	0.37			
WxA*:												
Wilson----------	0-8	18-27	1.35-1.45	0.2-0.6	0.10-0.17	5.6-7.3	<2	Low--------	0.43	5	5	.5-2
	8-45	35-50	1.50-1.60	<0.06	0.12-0.15	5.6-8.4	<4	High-------	0.37			
	45-80	35-60	1.50-1.60	<0.06	0.12-0.15	6.6-8.4	2-8	High-------	0.37			
Bremond----------	0-6	10-18	1.45-1.60	0.6-2.0	0.11-0.20	5.1-7.3	<2	Low--------	0.43	5	5	1-2
	6-14	40-50	1.35-1.50	<0.06	0.14-0.18	5.6-7.3	<2	High-------	0.32			
	14-46	30-50	1.40-1.65	<0.06	0.15-0.18	6.1-8.4	<2	High-------	0.32			
	46-80	27-50	1.40-1.65	<0.06	0.15-0.18	6.6-8.4	2-8	High-------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

East Area: (app. 110 acres)
AxB 29.3% 0.37
FeD2 7.6% 0.32
FhC2 8.1% 0.32
HeB 17.8% 0.32
WnA 37.2% 0.37

West Area: (app. 75 acres)
AxB 13.5% 0.37
CrB 21.1% 0.32
FhC2 1.3% 0.32
HeB 0.6% 0.32
WnA 54.5% 0.37
HeC 9% 0.32 (from McLennan County Survey)

Weighted Average K: 0.35

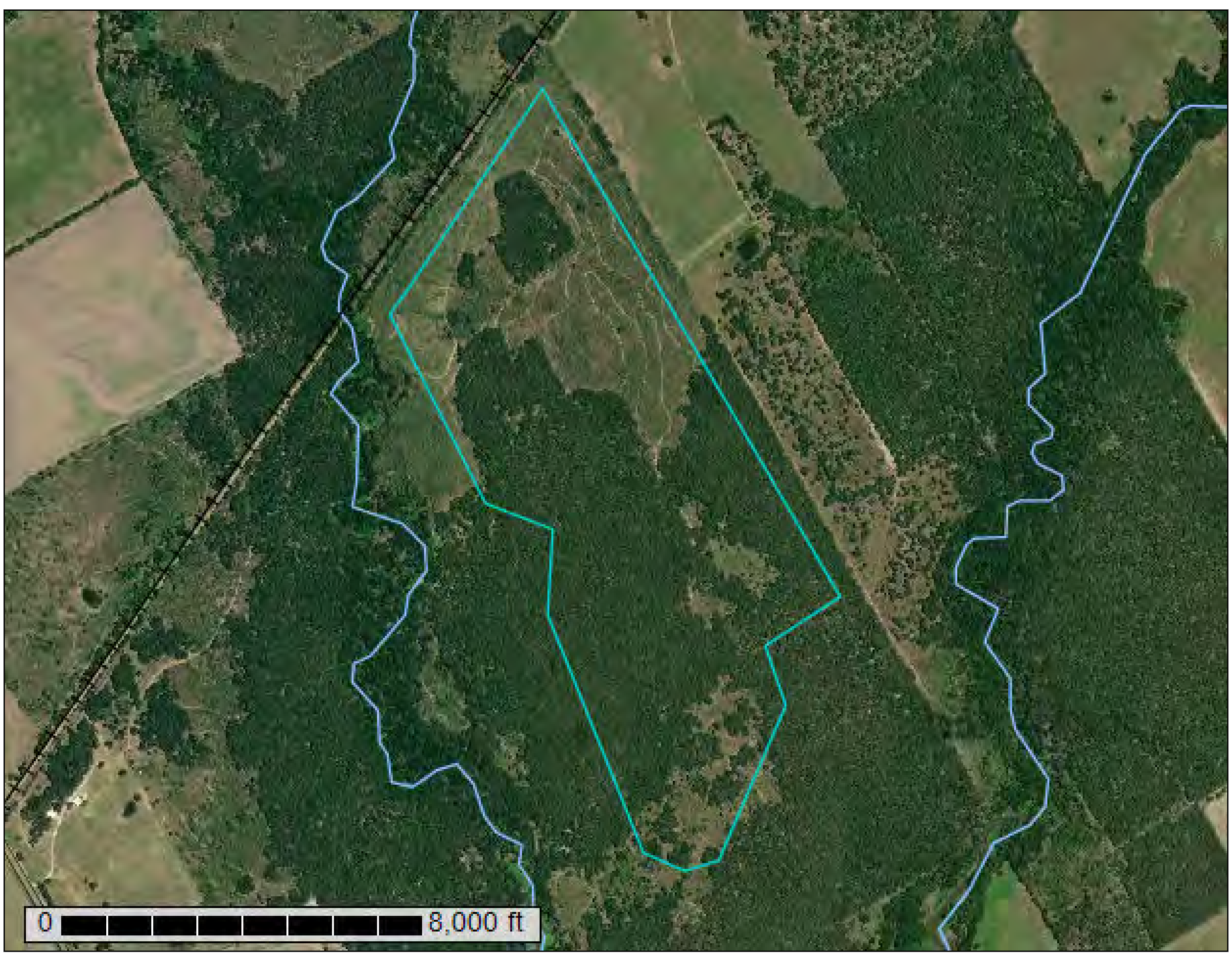
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

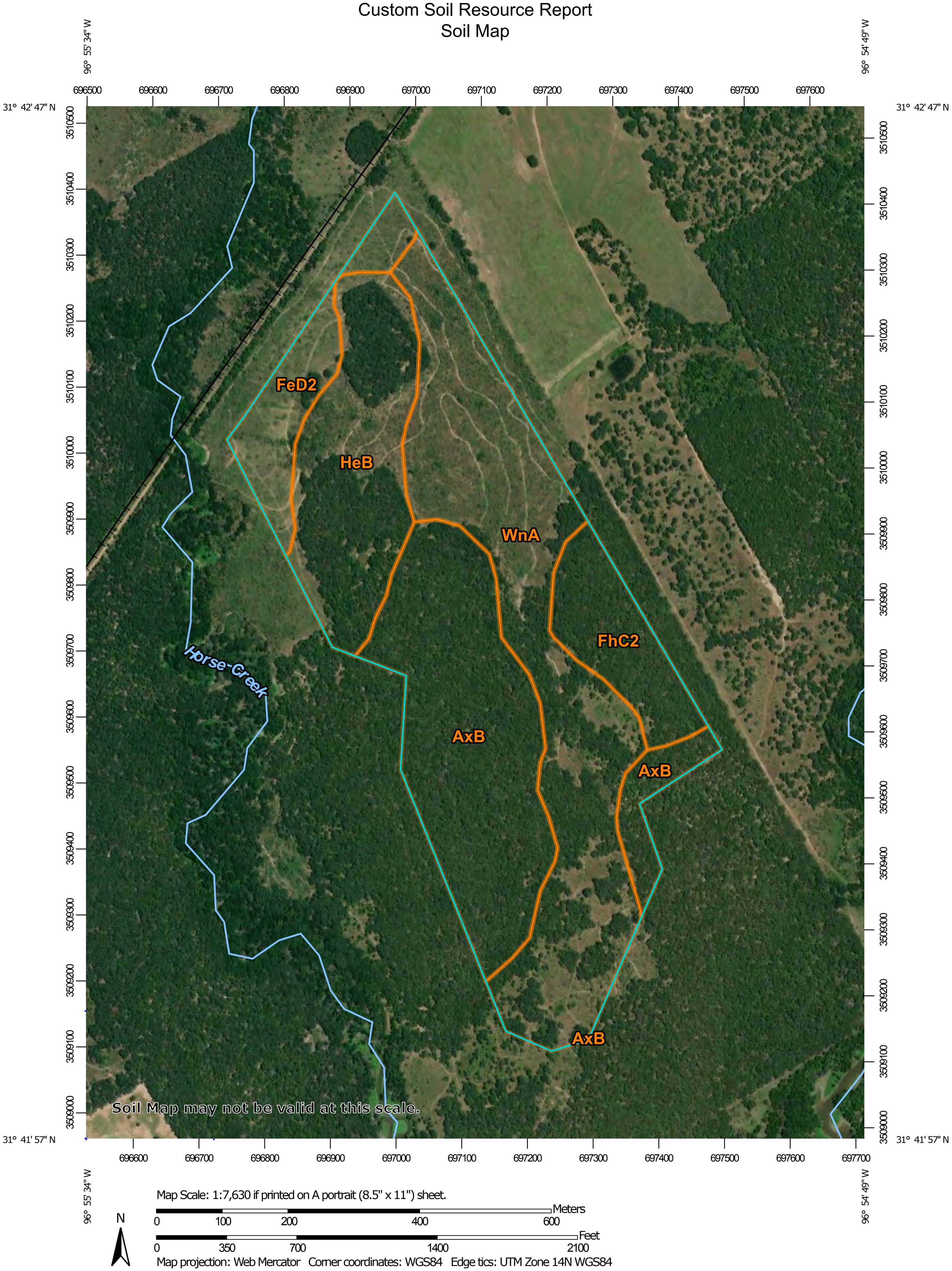
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Limestone County, Texas



November 19, 2018

Soil Map



FeD2
HeB
WnA
FhC2
AxB
AxB
AxB
Horse Creek
Soil Map may not be valid at this scale.
96° 55' 34" W
96° 54' 49" W
31° 42' 47" N
31° 41' 57" N
Map Scale: 1:7,630 if printed on A portrait (8.5" x 11") sheet.
Meters
0 100 200 400 600
Feet
0 350 700 1400 2100
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

United States Department of Agriculture

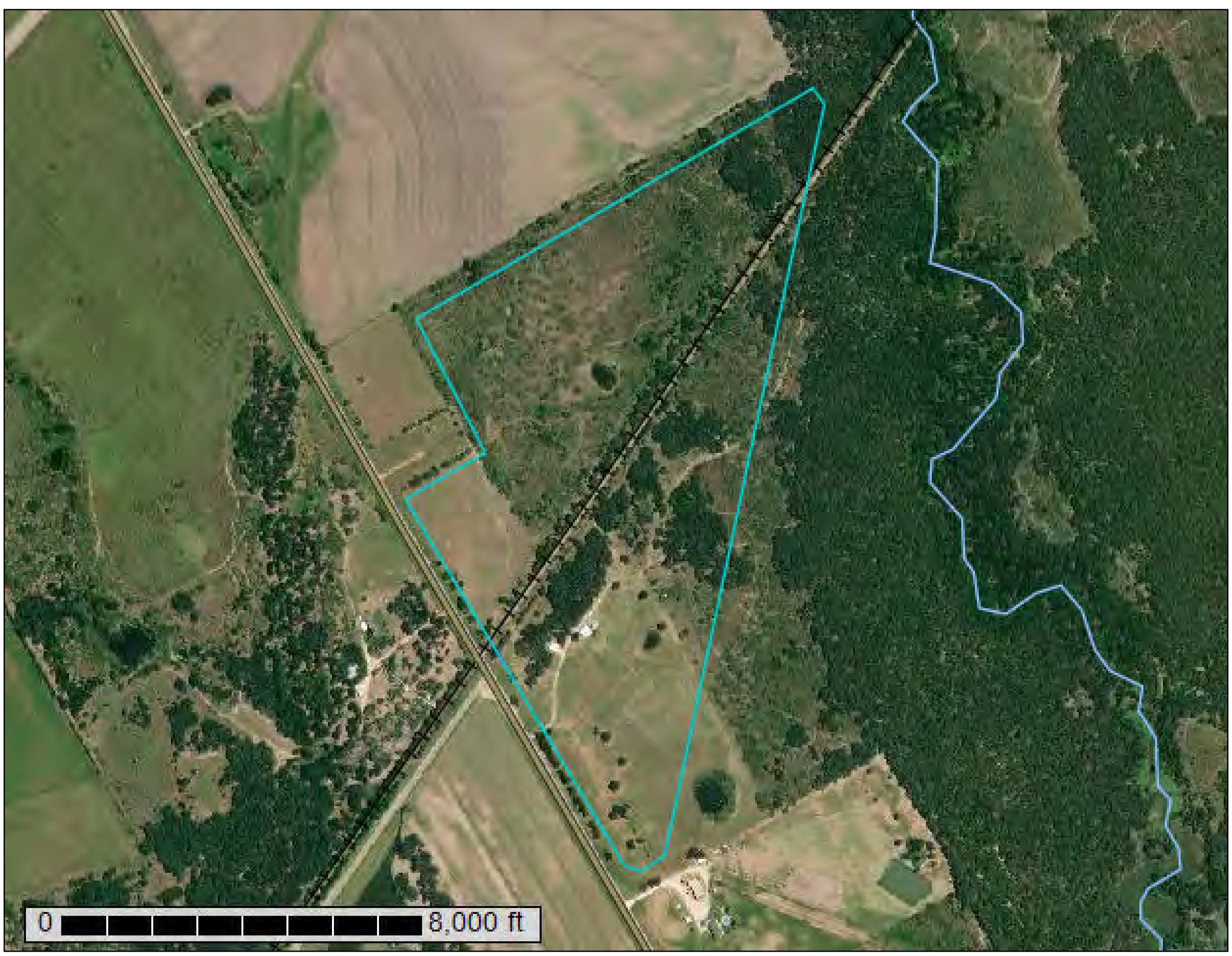
NRCS

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 Limestone County, Texas, and McLennan County, Texas

West Area



Custom Soil Resource Report
Soil Map

Map Scale: 1:6,100 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 250, 500, 1000, 1500

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

Table 4-2.
Values for topographic factor, LS, for moderate ratio of rill to interrill erosion.[1]

Slope (%)	Horizontal slope length (ft)																
	3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
0.5	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10
1.0	0.11	0.11	0.11	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.17	0.18	0.19	0.20	0.20
2.0	0.17	0.17	0.17	0.17	0.17	0.19	0.22	0.25	0.27	0.29	0.31	0.33	0.35	0.37	0.41	0.44	0.47
3.0	0.22	0.22	0.22	0.22	0.22	0.25	0.32	0.36	0.39	0.44	0.48	0.52	0.55	0.60	0.68	0.75	0.80
4.0	0.26	0.26	0.26	0.26	0.26	0.31	0.40	0.47	0.52	0.60	0.67	0.72	0.77	0.86	0.99	1.10	1.19
5.0	0.30	0.30	0.30	0.30	0.30	0.37	0.49	0.58	0.65	0.76	0.85	0.93	1.01	1.13	1.33	1.49	1.63
6.0	0.34	0.34	0.34	0.34	0.34	0.43	0.58	0.69	0.78	0.93	1.05	1.16	1.25	1.42	1.69	1.91	2.11
8.0	0.42	0.42	0.42	0.42	0.42	0.53	0.74	0.91	1.04	1.26	1.45	1.62	1.77	2.03	2.47	2.83	3.15
10.0	0.46	0.48	0.50	0.51	0.52	0.67	0.97	1.19	1.38	1.71	1.98	2.22	2.44	2.84	3.50	4.06	4.56
12.0	0.47	0.53	0.58	0.61	0.64	0.84	1.23	1.53	1.79	2.23	2.61	2.95	3.26	3.81	4.75	5.56	6.28
14.0	0.48	0.58	0.65	0.70	0.75	1.00	1.48	1.86	2.19	2.76	3.25	3.69	4.09	4.82	6.07	7.15	8.11
16.0	0.49	0.63	0.72	0.79	0.85	1.15	1.73	2.20	2.60	3.30	3.90	4.45	4.95	5.86	7.43	8.79	10.02
20.0	0.52	0.71	0.85	0.96	1.06	1.45	2.22	2.85	3.40	4.36	5.21	5.97	6.68	7.97	10.23	12.20	13.99
25.0	0.56	0.80	1.00	1.16	1.30	1.81	2.82	3.65	4.39	5.69	6.83	7.88	8.86	10.65	13.80	16.58	19.13
30.0	0.59	0.89	1.13	1.34	1.53	2.15	3.39	4.42	5.34	6.98	8.43	9.76	11.01	13.30	17.37	20.99	24.31
40.0	0.65	1.05	1.38	1.68	1.95	2.77	4.45	5.87	7.14	9.43	11.47	13.37	15.14	18.43	24.32	29.60	34.48
50.0	0.71	1.18	1.59	1.97	2.32	3.32	5.40	7.17	8.78	11.66	14.26	16.67	18.94	23.17	30.78	37.65	44.02
60.0	0.76	1.30	1.78	2.23	2.65	3.81	6.24	8.33	10.23	13.65	16.76	19.64	22.36	27.45	36.63	44.96	52.70

[1]Such as for row-cropped agricultural and other moderately consolidated soil conditions with little-to-moderate cover (not applicable to thawing soil)

Reference: USDA, Predicting Soil Erosion by Water: A guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), Agricultural Research Service, Agriculture Handbook Number 703, 1997.

Table 4-1.
Values for topographic factor, LS, for low ratio of rill to interrill erosion.[1]

Slope (%)	Horizontal slope length (ft) <3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.5	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
1.0	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.17
2.0	0.20	0.20	0.20	0.20	0.20	0.21	0.23	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.33	0.34	0.35
3.0	0.26	0.26	0.26	0.26	0.26	0.29	0.33	0.36	0.38	0.40	0.43	0.44	0.46	0.48	0.52	0.55	0.57
4.0	0.33	0.33	0.33	0.33	0.33	0.36	0.43	0.46	0.50	0.54	0.58	0.61	0.63	0.67	0.74	0.78	0.82
5.0	0.38	0.38	0.38	0.38	0.38	0.44	0.52	0.57	0.62	0.68	0.73	0.78	0.81	0.87	0.97	1.04	1.10
6.0	0.44	0.44	0.44	0.44	0.44	0.50	0.61	0.68	0.74	0.83	0.90	0.95	1.00	1.08	1.21	1.31	1.40
8.0	0.54	0.54	0.54	0.54	0.54	0.64	0.79	0.90	0.99	1.12	1.23	1.32	1.40	1.53	1.74	1.91	2.05
10.0	0.60	0.63	0.65	0.66	0.68	0.81	1.03	1.19	1.31	1.51	1.67	1.80	1.92	2.13	2.45	2.71	2.93
12.0	0.61	0.70	0.75	0.80	0.83	1.01	1.31	1.52	1.69	1.97	2.20	2.39	2.56	2.85	3.32	3.70	4.02
14.0	0.63	0.76	0.85	0.92	0.98	1.20	1.58	1.85	2.08	2.44	2.73	2.99	3.21	3.60	4.23	4.74	5.18
16.0	0.65	0.82	0.94	1.04	1.12	1.38	1.85	2.18	2.46	2.91	3.28	3.60	3.88	4.37	5.17	5.82	6.39
20.0	0.68	0.93	1.11	1.26	1.39	1.74	2.37	2.84	3.22	3.85	4.38	4.83	5.24	5.95	7.13	8.10	8.94
25.0	0.73	1.05	1.30	1.51	1.70	2.17	3.00	3.63	4.16	5.03	5.76	6.39	6.96	7.97	9.65	11.04	12.26
30.0	0.77	1.16	1.48	1.75	2.00	2.57	3.60	4.40	5.06	6.18	7.11	7.94	8.68	9.99	12.19	14.04	15.66
40.0	0.85	1.36	1.79	2.17	2.53	3.30	4.73	5.84	6.78	8.37	9.71	10.91	11.99	13.92	17.19	19.96	22.41
50.0	0.91	1.52	2.06	2.54	3.00	3.95	5.74	7.14	8.33	10.37	12.11	13.65	15.06	17.59	21.88	25.55	28.82
60.0	0.97	1.67	2.29	2.86	3.41	4.52	6.63	8.29	9.72	12.16	14.26	16.13	17.84	20.92	26.17	30.68	34.71

[1]Such as for rangeland and other consolidated soil conditions with cover (applicable to thawing soil where both interrill and rill erosion are significant).

Reference: USDA, Predicting Soil Erosion by Water: A guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), Agricultural Research Service, Agriculture Handbook Number 703, 1997.

TABLE 10.—*Factor* C *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
			Percent ground cover					
Type and height[2]	Percent cover[3]	Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

Use 0.006 for final cover

Use for intermediate cover

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Reference: USDA, Predicting Rainfall Erosion Losses, A Guide to Conservation Planning, Agriculture Handbook Number 537, 1978.

Table 3 P Factors for Contouring, Contour Stripcropping and Terracing

Land Slope	P values	
%	Contouring†	Terracing†
2.0 to 7	0.50	0.50
8.0 to 12	0.60	0.60
13.0 to 18	0.80	0.80
19.0 to 24	0.90	0.90

(This table appeared in SCS (5), p.9)

† Contouring and terracing columns are suitable for MSWLF cover. Contour stripcropping is not suitable for the type of vegetative cover normally practiced at municipal landfills.

Table 4 Guide for Assigning Soil Loss Tolerance Values (T) to Solid Having Different Rooting Depths

Rooting Depth	Soil Loss Tolerance Values Annual Soil Loss - (Tons/Acre)
Inches	Non-Renewable Soil a/
10 - 20	1
20 - 40	2
40 - 50	3
50 - 60	4
60 +	< 5

(This table appears in SCS (6) p.4)

a/ Soils with unfavorable substrata such as rock or soft rock that cannot be renewed by economical means. Most of the MSWLF covers with constructed, or recompacted clay cap and/or flexible membrane should use this performance criteria.

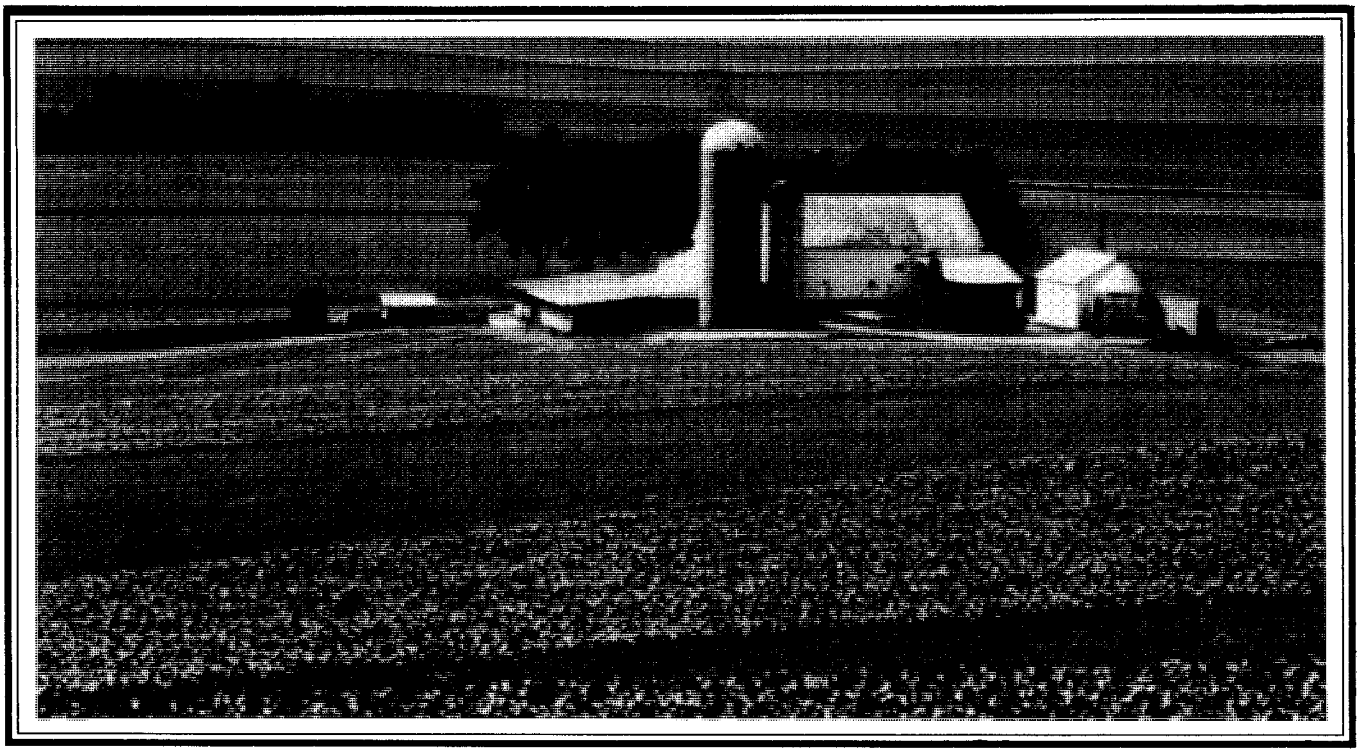
USDA

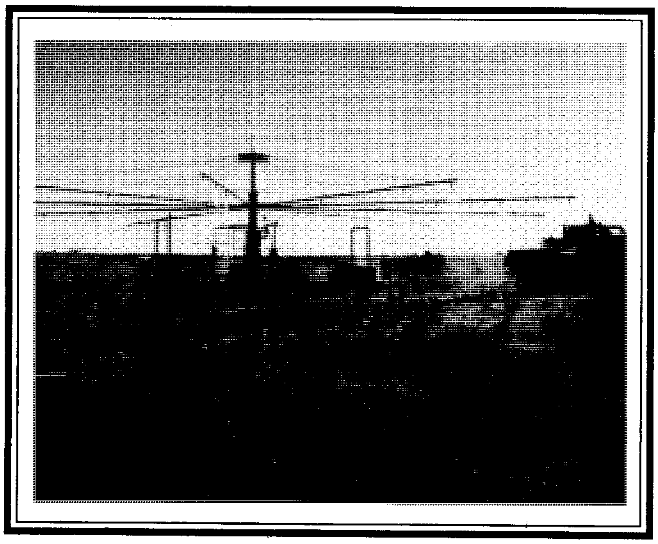
United States Department of Agriculture

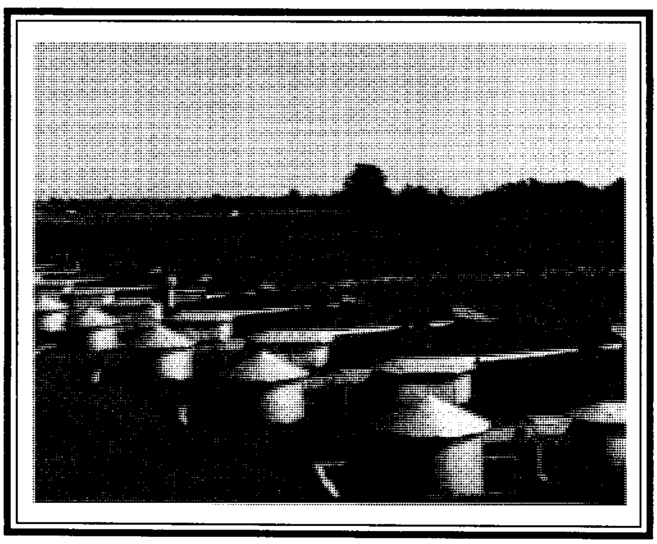
Agricultural Research Service

Agriculture Handbook Number 703

Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE)







6A-F-23

SCS ENGINEERS

APPENDIX 6A-G

EROSION AND SEDIMENTATION CONTROL INSPECTION AND MAINTENANCE FORM

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6A-G-1 to 6A-G-2

CITY OF WACO LANDFILL
EROSION AND SEDIMENTATION CONTROL
INSPECTION AND MAINTENANCE FORM

Date: ___________ Time: _________ Inspector: _________________

Signature

The erosion and sedimentation inspection and subsequent landfill cover and BMP maintenance will be completed by a landfill employee at a minimum of daily for active daily cover areas, weekly for inactive daily cover areas, weekly for intermediate cover, and monthly for final cover. Daily inspections will be noted in the cover log. Weekly and monthly inspections will be noted on this form (or an alternate form). Inspections will include inspection of the respective cover and installed non-structural and structural controls. At a minimum the following items will be inspected:

INSPECTION ITEMS	OBSERVATIONS	COMMENTS *(See Note 1)*	ACTION *(See Note 2)*
Erosion of daily cover			
Erosion of intermediate cover			
Erosion of final cover			
Condition of vegetation on intermediate cover			
Condition of vegetation on final cover			
Erosion/sedimentation of down-gradient perimeter drainage channel or basin			
Erosion/sedimentation at down-gradient offsite discharge outlets			
Sedimentation of water bodies on-site or on property adjacent to Landfill.			

Note 1: Comments will include suggested maintenance or other follow-up actions, which may entail application of Best Management Practices (BMPs). BMPs include: Drainage Swales and Downchutes, Seeding and Sodding, Mulching, Check Dams, Silt Fences, Compost/Straw Filter Berms or Socks, Vegetative Buffers or Filter Strips, etc.

Note 2: Maintenance of landfill cover, non-structural and structural BMPs, perimeter drainage system, etc. will be initiated within 5 days of detection, weather permitting. The date that the maintenance was performed will also be noted on this form under "Action".

CITY OF WACO LANDFILL
TCEQ PERMIT NO. MSW-2400
McLENNAN AND LIMESTONE COUNTIES, TEXAS

PART III
SITE DEVELOPMENT PLAN
ATTACHMENT 6B
FLOODPLAIN EVALUATION

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, TX 76710

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

Prepared by:

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Bedford, Texas 76021
817/571-2288

Revision 0 – April 2020
SCS Project No. 16216088.00

TABLE OF CONTENTS

SECTION **PAGE**

SCS Engineers
TBPE Reg. # F-3407

1 INTRODUCTION

This Floodplain Evaluation was prepared as a part of the landfill permit application for the City of Waco Landfill (landfill) to be located in McLennan and Limestone Counties, Texas. This evaluation has been prepared consistent with 30 TAC §330.61(m)(1), by delineating the 100-year floodplain, as provided on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map, in relation to the permit boundary. As demonstrated in this attachment, although the floodplain crosses the landfill permit boundary, no waste disposal or construction are proposed during landfill development within the 100-year floodplain.

An additional study of the 100-year flood was performed. The findings of this 100-year flood study identify the 100-year flood level and 100-year flood limits and demonstrate that the landfill and perimeter drainage system will not be impacted by the 100-year flood.

2 FLOODPLAIN DELINEATION

2.1 FLOODPLAIN EVALUATION

A review of the FEMA Flood Insurance Rate Maps, Limestone County, Panel No. 48293C0125C (September 16, 2011) and McLennan County, Panel No. 48309C0250C (September 26, 2008), indicate that the proposed permit boundary encroaches the 100-year floodplain of Horse Creek. In accordance with §330.63(c)(2)(B), an excerpt from the FEMA Flood Insurance Rate Map, which depicts the 100-year floodplain in relation to the limits of waste and permit boundary, is provided on Drawing 6B.1. As shown on this drawing, the limits of waste are not located in the 100-year floodplain.

In accordance with the Flood Insurance Rate Map, the floodplain for this area of Limestone County has been designated as a "Special Flood Hazard Area - Zone A". A Zone A areas are defined by FEMA as "Areas with a 1 percent annual probability of flooding and a 26 percent probability of flooding over the life of a 30-year period. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones".

The delineated floodplain has also been depicted on Drawing 6B.3 and drawings provided in Attachment 6A – Surface Water Drainage Plan, including Drawing 6A.3 – Drainage Structure Plan, which present the landfill at final closure. As shown on this drawing neither the waste disposal limits nor drainage features will be located within the 100-year floodplain and there will be no construction in the floodplain.

Additionally, the landfill has been designed with a perimeter berm above existing grade, above the 100-year flood level and outside of the 100-year flood limits and 100-year floodplain. No construction, structures, or other items that might impair the adequacy for safe passage of these or any other internal or external flood waters are proposed. Therefore, the landfill and perimeter drainage system will not be impacted by the 100-year floodplain or the 100-year flood.

2.2 100-YEAR FLOOD STUDY

Since the floodplain for the project area has been designated as Zone A (no base flood elevations in the FEMA Flood Insurance Rate Map), an additional flood study was performed to determine the flooding levels and limits of the 100-year storm event and confirm that the proposed landfill and perimeter drainage system will not be impacted by a 100-year storm event. This 100-year flood study is presented in this section.

2.2.1 Methodology

2.2.1.1 Hydrologic Analysis Methods

This subsection describes the hydrologic methodology used for the 100-year flood study. The peak flow rates and total discharge volumes of the upstream drainage areas were estimated to evaluate the impacts of the 100-year event to the proposed landfill area. The hydrologic conditions of the on-site and off-site (upstream) watershed subbasins (drainage areas) were modeled for a 100-year, 24-hour storm event using the U.S. Army Corp of Engineers', Hydrologic Engineering Center's - Hydrologic Modeling System, Version 4.0 computer software (referred to as HEC-HMS). HEC-HMS was used to develop hydrographs for the drainage areas for computation of the peak flow rates and total discharge volumes, which will be used for the 100-year flood boundary estimation. When modeling the on-site watershed subbasins, both pre- and post-development conditions were used. The pre-development on-site and off-site watershed subbasins and surrounding drainage features modeled using HEC-HMS are provided on Drawing 6B.2. Post-development on-site conditions and watershed subbasins are provided on Drawing 6A.2. The hypothetical precipitation distribution, which is one of the HEC-HMS input parameters, used in this analysis was derived from the National Weather Service, Technical Paper No. 40 (TP-40). A Type III storm event with a return period of 100 years and duration of 24 hours was used for the hydrologic modeling. This storm event is associated with approximately 9.9 inches of precipitation, which was assumed to be evenly distributed across the entire watershed for the return period. A figure presenting the source of the precipitation data used in the model is included in Appendix 6B.A.

Further description of HEC-HMS computer program and other HEC-HMS input parameters are provided in Appendix 6A. HEC-HMS input parameters used in the 100-year flood study are summarized in a table included in Appendix 6B.A, and Reservoir 19 Outlet structure (Elevation-Area-Discharge Relationship) is provided in Appendix 6A-A. Drainage areas included in the flood studies are provided on Drawings 6A.2 and 6B.2.

2.2.1.2 Hydraulic Analysis Methods

This section describes the methodology used for evaluating hydraulic parameters, including water surface elevation, geometry and peak flow velocities for Packwood Creek and Horse Creek for a 100-year storm event. Water surface elevations were estimated for five and eleven cross sections for Packwood Creek and Horse Creek, respectively. These water elevations were then used to estimate the boundary of the 100-year flood. The locations of the analyzed cross sections are presented in Drawing 6B.3.

In order to estimate the 100-year flood boundary, the U.S. Army Corp of Engineers', Hydrologic Engineering Center's - River Analysis System, Version 5.0.4 computer software (referred to as HEC-RAS) was used. HEC-RAS is a software that performs one-dimensional steady flow hydraulics, one and two dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling. One dimensional steady flow hydraulics, which is based on the one-dimensional energy equation, was used for this 100-year flood study.

Input parameters for the HEC-RAS model include cross sectional data (locations and geometries of the cross sections) and the peak flow rates for the cross sections that were estimated using HEC-HMS as explained in the previous section. Cross sections analyzed for Packwood Creek and Horse Creek are shown in Drawing 6B.3. The pre-development peak flow rates were either the same or higher than the post-development peak flowrates, as shown in Table 6B.1; therefore, the pre-development flowrates were input into the HEC-RAS model.

TABLE 6B.1
COMPARISON OF PRE- AND POST-DEVELOPMENT CONDITIONS
PEAK DISCHARGE RATE

Location: POD-A1

Condition	Peak Discharge Rate (cfs)
Pre-development	2579.1
Post-development	2467.0
Percent Change	-4.3

Location: POD-A2

Condition	Peak Discharge Rate (cfs)
Pre-development	3224.2
Post-development	2943.1
Percent Change	-8.7

Location: B/POD-B

Condition	Peak Discharge Rate (cfs)
Pre-development	4233.4
Post-development	4112.9
Percent Change	-2.8

As part of this permit application, the construction of an access road with four 8 ft by 8 ft concrete box culverts is proposed. These culverts, which will be located between Cross Sections 6 and 5 of Horse Creek, are included in the HEC-RAS model. Using this input information, HEC-RAS provides minimum channel elevations, water surface elevations, flow velocities, flow areas, and top channel widths.

2.2.2 Computations using HEC-HMS

HEC-HMS input file is included in Appendix 6B.B. HEC-HMS output files for each drainage area and a summary of estimated peak discharges, which are used in HEC-RAS analysis, are provided in Appendix 6B.C.

2.2.3 Computations using HEC-RAS

HEC-RAS output file summary is presented in Appendix 6B.D. Using the water surface elevations (flooding levels) corresponding to the analyzed cross sections, the limit of 100-year flood is delineated. Figure 6B.3 shows this delineation of the 100-year flood.

2.2.4 Findings of the 100-year Flood Study

As shown on Drawing 6B.3 the waste disposal limits are not located within the flooding limits of the 100-year flood study. Additionally, the landfill has been designed with a perimeter berm above existing grade, above the 100-year flood level and outside of the 100-year flood limits and 100-year floodplain.

No construction, structures, or other items that might impair the adequacy for safe passage of these or any other internal or external flood waters are proposed.

The landfill will not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, nor result in washout of solid waste so as to pose a hazard to human health and the environment.

2.3 REGULATORY COMPLIANCE WITH FLOODPLAIN REQUIREMENTS

This subsection confirms compliance of the proposed permit application with the various floodplain requirements set forth in 30 TAC 330.

2.3.1 Description of Floodplain [TAC §330.61(m)(1)]

The delineated floodplain from the FEMA Flood Insurance Rate Map of Limestone County, Texas has been depicted on Drawing 6B.1 and drawings provided in Attachment 6A – Surface Water Drainage Plan, including Drawing 6A.3 – Drainage Structure Plan. As shown on these drawings neither the waste disposal limits nor drainage features will be located within the 100-year floodplain.

The site will not require any levees or other improvements to provide protection from the 100-year floodplain. Therefore, the requirements of 30 TAC §301, Subchapter C, relating to Approval of Levees and Other Improvements are not applicable.

2.3.2 Freeboard Requirement [TAC §330.307(a) and (b)]

The proposed landfill has been designed with a perimeter berm above existing grade, above the 100-year flood level and outside of the 100-year flood limits and 100-year floodplain. The site will not require any levees or other improvements to provide protection from the 100-year floodplain or 100-year flooding event.

2.3.3 Flood Control and Analysis [TAC §330.547(a)

As shown on Drawings 6B.1 and 6B.3, no solid waste disposal operations are proposed in the 100-year floodplain. As shown on Drawing 6B.1, no 100-year floodways are shown within the proposed permit boundaries. No solid waste disposal operations will be in areas that are located in a 100-year floodway as defined by the Federal Emergency Management Agency.

2.3.4 Floodplains [TAC §330.547]

2.3.4.1 Restriction of 100-year Flood

The municipal solid waste management units are not located in a 100-year floodplain.

Development of the proposed landfill will not cause restriction in the flow of the 100-year flood.

2.3.4.2 Reduction of Temporary Storage within Floodplain

The municipal solid waste management units are not located in a 100-year floodplain.

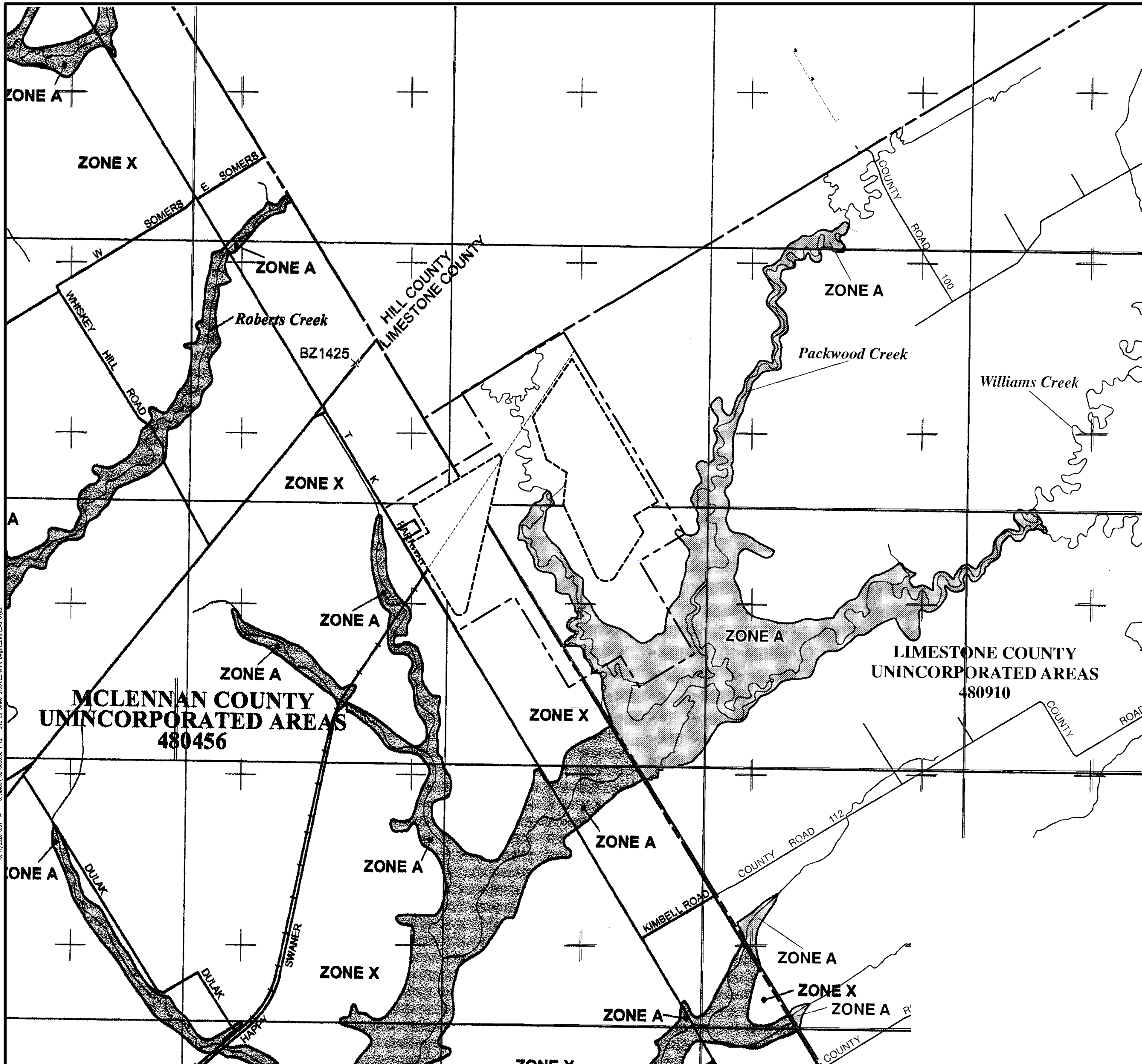
2.3.4.3 Washout of Solid Waste

The municipal solid waste management units are not located in a 100-year floodplain.

Development of the proposed landfill will not result in washout of solid waste so as to pose a hazard to human health and the environment.

DRAWINGS

- Drawing 6B.1: FEMA Floodplain Map
- Drawing 6B.2: Flood Study Drainage Areas
- Drawing 6B.3: Proposed Limit of 100-year Flood Study



0 1000 2000
SCALE IN FEET

LEGEND

— — — PERMIT BOUNDARY

- - - - - LIMITS OF WASTE

ZONE A SPECIAL FLOOD HAZARD AREA

ZONE X OTHER SPECIAL FLOOD HAZARD AREA

NOTES:

1. THESE MAPS MAY NOT INCLUDE ALL SPECIAL FLOOD HAZARD AREAS IN THE COMMUNITY. AFTER A MORE DETAILED STUDY, THE SPECIAL FLOOD HAZARD AREAS SHOWN ON THESE MAPS MAY BE MODIFIED, AND OTHER AREAS ADDED.
2. ZONE A: AREAS WITH A 1% ANNUAL CHANCE OF FLOODING AND A 26% CHANCE OF FLOODING OVER THE LIFE OF A 30–YEAR MORTGAGE. BECAUSE DETAILED ANALYSES ARE NOT PERFORMED FOR SUCH AREAS; NO DEPTHS OR BASE FLOOD ELEVATIONS ARE SHOWN WITHIN THESE ZONES.
3. ZONE X: AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOODPLAIN.

BASE MAP SOURCES
FIRM

FLOOD INSURANCE RATE MAP LIMESTONE COUNTY,
TEXAS INCORPORATED AREA COMMUNITY –
PANEL 125 OF 625
MAP NUMBER: 48293C0125C
EFFECTIVE DATE: SEPTEMBER 16, 2011
U.S. DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT

FLOOD INSURANCE RATE MAP MCLENNAN COUNTY,
TEXAS INCORPORATED AREA COMMUNITY –
PANEL 250 OF 750
MAP NUMBER: 48309C0250C
EFFECTIVE DATE: SEPTEMBER 26, 2008
U.S. DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: FEMA FLOODPLAIN MAP

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

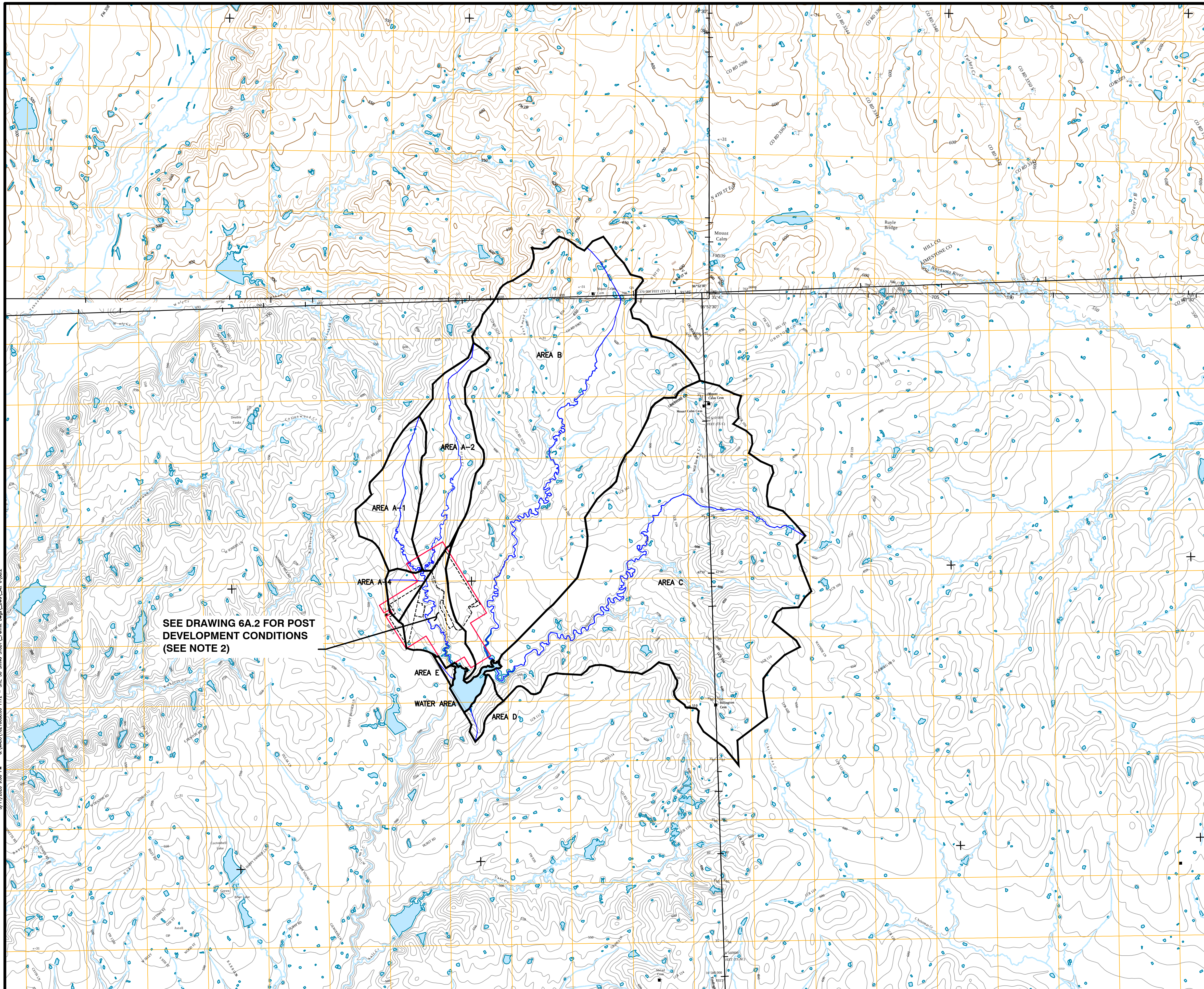
PROJ. NO. 16216088.00 | DSN. BY: RRK | DWN. BY: JLJ | CHK. BY: KDY | Q/A RVW BY: KDY | APP. BY: RRK

CADD FILE: 6B.1

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6B.1



0 0.5 1
SCALE IN MILES

LEGEND

- DRAINAGE AREA BOUNDARY
- ASSUMED CHANNEL LENGTH
- PERMIT BOUNDARY
- LIMITS OF WASTE

NOTE:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPACIAL FROM USGS MAP AXTELL, TEXAS (1956).
2. SEE DRAWING 6A.2 FOR THE POST DEVELOPMENT WATERSHED BASINS AND INPUT PARAMETERS USED IN THE POST-DEVELOPMENT FLOOD STUDY.

JAMES ROY MURRAY III
73860
LICENSED PROFESSIONAL ENGINEER
5/13/2020

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: FLOOD STUDY DRAINAGE AREAS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

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1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

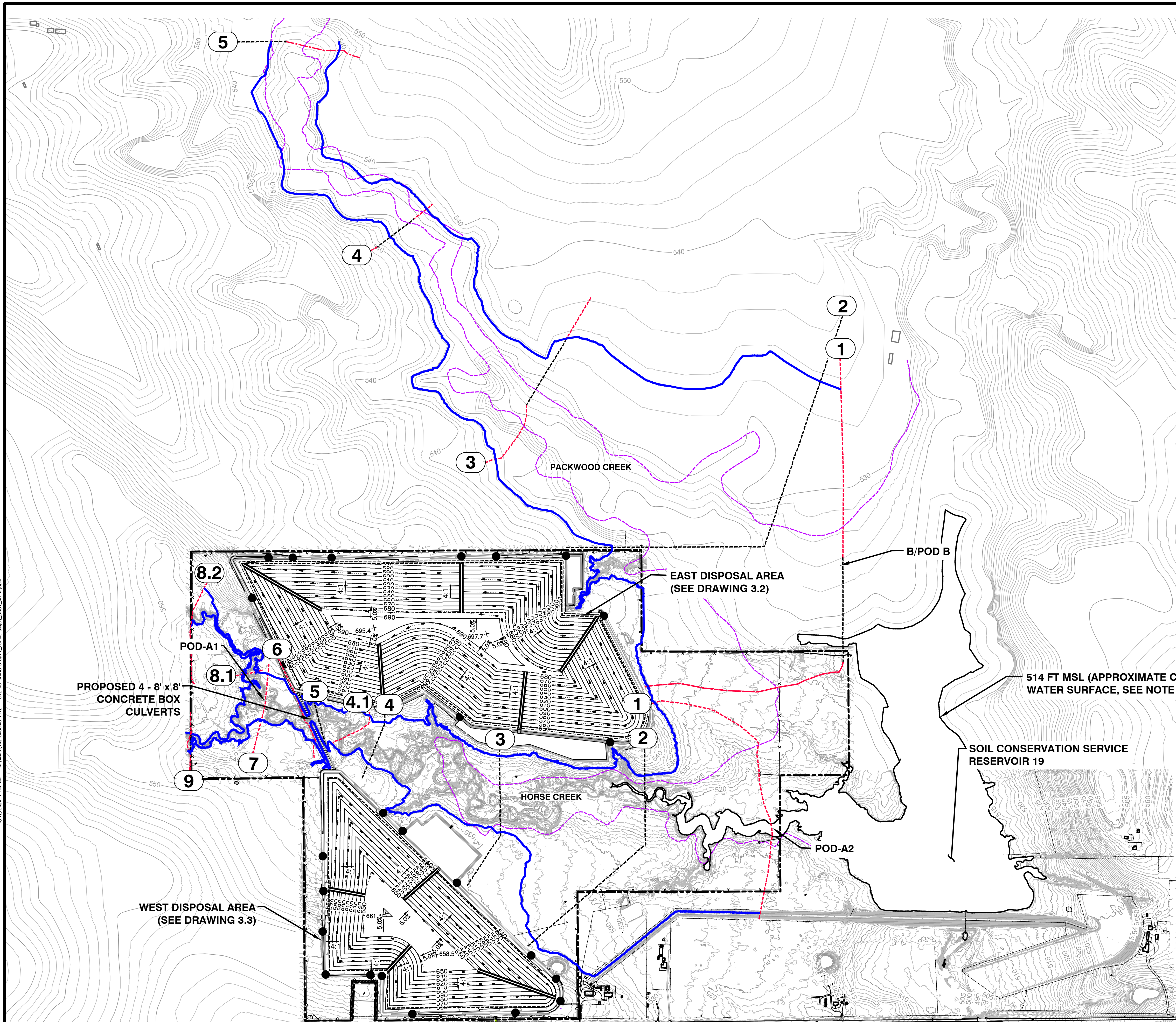
PROJ. NO. 16216088.00 | DWN. BY: NR | Q/A RVW BY: RRK
DSN. BY: BG/RRK | CHK. BY: BJD | APP. BY: RRK

CADD FILE: 6B.2

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6B.2



0 500 1000
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 4 SURVEYED CROSS–SECTIONALS
- 7 TOPOGRAPHY CROSS–SECTIONALS
- CURRENT 100–YEAR FEMA FLOOD PLAIN (NOTE 2)
- PROPOSED LIMITS OF 100–YEAR FLOOD

NOTE:

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF 2016 AND 2018 SURVEYS.

   2016 TOPOGRAPHIC SURVEY FROM U.S. GEOLOGICAL SURVEY.

   2018 TOPOGRAPHIC SURVEY FROM AERIAL PHOTOGRAPHY PERFORMED BY UNITED GEO TECHNOLOGIES, INC. ON JULY 03, 2018.

2. 100–YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48293C0125C, DATED SEPTEMBER 16, 2011. FOR ADDITIONAL INFORMATION, SEE DRAWING 6B1.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
PROPOSED LIMIT OF 100-YEAR FLOOD STUDY

PROJECT TITLE
CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT
CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6B.3

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO.
6B.3

APPENDIX 6B-A

HEC-HMS INPUT PARAMETERS

- Subbasin Input Parameters
- Precipitation Data

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6B-A-1 to 6B-A-10

SUBBASIN INPUT PARAMETERS

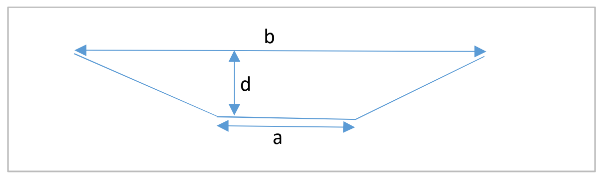
Pre-Development Conditions

CITY OF WACO
HEC-HMS VELOCITY METHOD INPUT PARAMETERS
NATURAL CONDITIONS

2-yr, 24-hr Rainfall Depth = 4.25 inches

Discharge Study Point	Area (acres)	Area (sq miles)	CN	Sheet Flow Length (ft)	Sheet Flow Surface Description	Sheet Flow Slope (ft/ft)	Sheet Flow Manning n	Shallow Concentrated Flow Length (ft)	Shallow Concentrated Flow Surface Description	Shallow Concentrated Flow Slope (ft/ft)	Shallow Concentrated Flow Avg. Velocity (ft/s)	Open Channel Flow Length (ft)	Open Channel Flow Surface Description	Open Channel Flow Slope (ft/ft)	Open Channel Flow Manning n	Cross-sectional Area (ft^2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Avg. Velocity (ft/s)	Sheet Flow T_c (min)	Shallow Concentrated Flow T_c (min)	Channel Flow T_c (min)	Total T_c (min)	Total Lag Time (min)
A-1	425.0	0.664	80.0	300	Grass	0.011	0.15	1,080	Grass	0.021	1.01	10,953	Grass	0.007	0.026	43.7	29	1.48	6.10	26.0	17.8	29.9	73.8	44.3
A-2	617.8	0.965	79.5	300	Grass	0.027	0.15	2,324	Grass	0.013	0.79	15,934	Grass	0.006	0.026	77.8	88	0.89	3.95	18.2	49.0	67.2	134.3	80.6
A-3	292.8	0.457	73.9	300	Grass	0.023	0.15	2,469	Grass	0.017	0.92	7,364	Grass	0.002	0.026	46.6	26	1.79	3.55	19.3	45.0	34.6	98.8	59.3
A-4	90.0	0.141	78.2	300	Grass	0.007	0.15	1,422	Grass	0.013	0.80	1,109	Grass	0.009	0.026	17.9	20	0.90	5.05	30.8	29.6	3.7	64.1	38.5
B	3861.2	6.033	78.3	300	Grass	0.021	0.15	9,736	Grass	0.009	0.67	28,029	Grass	0.002	0.026	185.9	46	4.04	6.98	20.1	243.2	66.9	330.2	198.1
C	4004.3	6.257	78.3	300	Grass	0.007	0.15	7,141	Grass	0.011	0.73	27,793	Grass	0.002	0.026	227.8	54	4.22	7.23	31.2	163.5	64.1	258.8	155.3
D	71.1	0.111	81.5	300	Grass	0.017	0.15	1,510	Grass	0.026	1.12	-	-	-	-	-	-	-	-	21.6	22.4	-	44.0	26.4
E	49.0	0.077	78.3	300	Grass	0.025	0.15	2,660	Grass	0.005	0.50	-	-	-	-	-	-	-	-	18.7	88.1	-	106.8	64.1
Reservoir 19	67.6	0.106	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0

Channel Section:



	a (ft)	d (ft)	left slope (%)	right slope (%)	b (ft)	Area (ft^2)	Wetted P (ft)
A-1 Channel Section:	15	2.0	33.0	25.0	28.9	43.7	29.43
A-2 Channel Section:	42	1.2	7.7	4.0	87.6	77.8	87.65
A-3 Channel Section:	5	3.2	22.5	50.0	25.0	46.6	26.04
A-4 Channel Section:	8	1.3	26.5	19.9	19.5	17.9	19.76
B Channel Section:	6	7.6	50.0	35.0	42.9	185.9	46.00
C Channel Section:	12	7.2	33.3	40.0	51.5	227.8	54.01

SUBBASIN INPUT PARAMETERS

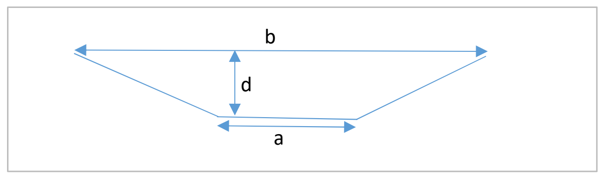
Post-Development Conditions

CITY OF WACO
HEC-HMS VELOCITY METHOD INPUT PARAMETERS
100-YEAR FLOOD STUDY
NATURAL CONDITIONS

2-yr, 24-hr Rainfall Depth = 4.25 inches

Discharge Study Point	Area		CN	Sheet Flow				Shallow Concentrated Flow				Open Channel Flow								Time of Concentration (T_c)				
	(acres)	(sq miles)		Length (ft)	Surface Description	Slope (ft/ft)	Manning n	Length (ft)	Surface Description	Slope (ft/ft)	Avg. Velocity (ft/s)	Length (ft)	Surface Description	Slope (ft/ft)	Manning n	Cross-sectional Area (ft^2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Avg. Velocity (ft/s)	Sheet Flow T_c (min)	Shallow Concentrated Flow T_c (min)	Channel Flow T_c (min)	Total T_c (min)	Total Lag Time (min)
A-1	425.0	0.664	80.0	300	Grass	0.011	0.15	1,080	Grass	0.021	1.01	10,953	Grass	0.007	0.026	43.7	29	1.48	6.10	26.0	17.8	29.9	73.8	44.3
A-2	617.8	0.965	79.5	300	Grass	0.027	0.15	2,324	Grass	0.013	0.79	15,934	Grass	0.006	0.026	77.8	88	0.89	3.95	18.2	49.0	67.2	134.3	80.6
A-4	50.6	0.079	78.2	300	Grass	0.007	0.15	1,528	Grass	0.013	0.80	-	-	-	-	-	-	-	-	30.8	31.8	-	62.6	37.6
B	3729.5	5.827	78.3	300	Grass	0.021	0.15	9,736	Grass	0.009	0.67	28,029	Grass	0.002	0.026	185.9	46	4.04	6.98	20.1	243.2	66.9	330.2	198.1
C	4004.3	6.257	78.3	300	Grass	0.007	0.15	7,141	Grass	0.011	0.73	27,793	Grass	0.002	0.026	227.8	54	4.22	7.23	31.2	163.5	64.1	258.8	155.3
D	71.1	0.111	81.5	300	Grass	0.017	0.15	1,510	Grass	0.026	1.12	-	-	-	-	-	-	-	-	21.6	22.4	-	44.0	26.4
E	14.7	0.023	78.3	300	Grass	0.025	0.15	1,184	Grass	0.012	0.75	-	-	-	-	-	-	-	-	18.7	26.2	-	44.9	26.9
Reservoir 19	67.6	0.106	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0

Channel Section:



	a (ft)	d (ft)	left slope (%)	right slope (%)	b (ft)	Area (ft^2)	Wetted P (ft)
A-1 Channel Section:	15	2.0	33.0	25.0	28.9	43.7	29.43
A-2 Channel Section:	42	1.2	7.7	4.0	87.6	77.8	87.65
B Channel Section:	6	7.6	50.0	35.0	42.9	185.9	46.00
C Channel Section:	12	7.2	33.3	40.0	51.5	227.8	54.01

CITY OF WACO LANDFILL
KINEMATIC WAVE INPUT PARAMETERS
100 YEAR FLOOD STUDY
- POST-DEVELOPMENT CONDITIONS -

Discharge Study Point	Contributing Drainage Areas	Drainage Plane			Collector							Main Channel					Area (sq. mi.)	Curve Number (CN)	SCS Method				
		Length (ft)	Slope (ft/ft)	Roughness	Area (sq. mil.)	No. of Collectors	Length (ft)	Slope (ft/ft)	Manning's Coefficient	Width (ft)	Sideslope xH:1V	Length (ft)	Slope (ft/ft)	Manning's Coefficient	Width (ft)	Sideslope xH:1V			Stream Length (ft)	Slope (ft/ft)	Manning n	Sheet Flow T_c (min)	Lag Time (min)
POD-1	DA-1A	130	0.25	0.15	0.00395	9	847	0.01	0.027	0	3	536	0.25	0.033	15	2	0.0355	85.0	-	-	-	-	-
	DA-1B	189	0.05	0.15	-	-		-	-	-	-	906	0.01	0.027	0	3	0.0055	85.0	-	-	-	-	-
	*DA-1C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0042	85.0	179	0.0100	0.15	17.87	11
	*DA-1D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0023	85.0	138	0.0100	0.15	14.52	9
	**DA-1E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0019	85.0	179	0.2500	0.15	4.92	5
POD-8	DA-2A	130	0.25	0.15	0.00353	8	757	0.01	0.027	0	3	950	0.25	0.033	15	2	0.0282	85.0	-	-	-	-	-
	DA-2B	117	0.05	0.15	-	-	-	-	-	-	-	496	0.01	0.027	0	3	0.0030	85.0	-	-	-	-	-
	DA-3A	130	0.25	0.15	0.00373	10	799	0.01	0.027	0	3	634	0.25	0.033	15	2	0.0373	85.0	-	-	-	-	-
	DA-3B	179	0.05	0.15	-	-	-	-	-	-	-	808	0.01	0.027	0	3	0.0040	85.0	-	-	-	-	-
	DA-3C	130	0.25	0.15	0.00421	10	903	0.01	0.027	0	3	568	0.25	0.033	15	2	0.0421	85.0	-	-	-	-	-
	DA-3D	161	0.05	0.15	-	-	-	-	-	-	-	822	0.01	0.027	0	3	0.0040	85.0	-	-	-	-	-
	DA-3E	130	0.25	0.15	0.00376	9	807	0.01	0.027	0	3	693	0.25	0.033	15	2	0.0339	85.0	-	-	-	-	-
	DA-3F	181	0.05	0.15	-	-	-	-	-	-	-	866	0.01	0.027	0	3	0.0027	85.0	-	-	-	-	-
	DA-4A	130	0.25	0.15	0.00375	8	804	0.01	0.027	0	3	438	0.25	0.033	15	2	0.0300	85.0	-	-	-	-	-
	DA-4B	236	0.05	0.15	-	-	-	-	-	-	-	566	0.01	0.027	0	3	0.0050	85.0	-	-	-	-	-
	DA-4C	130	0.25	0.15	0.00324	6	694	0.01	0.027	0	3	387	0.25	0.033	15	2	0.0194	85.0	-	-	-	-	-
	DA-4D	218	0.05	0.15	-	-	-	-	-	-	-	368	0.01	0.027	0	3	0.0027	85.0	-	-	-	-	-
	*DA-4E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0047	85.0	104	0.0100	0.15	11.54	7
	DA-5A	130	0.25	0.15	0.00484	7	1038	0.01	0.027	0	3	844	0.25	0.033	15	2	0.0379	85.0	-	-	-	-	-
	DA-5B	176	0.05	0.15	-	-	-	-	-	-	-	554	0.01	0.027	0	3	0.0036	85.0	-	-	-	-	-
	DA-5C	130	0.25	0.15	0.00199	5	427	0.01	0.027	0	3	370	0.25	0.033	15	2	0.0099	85.0	-	-	-	-	-
	DA-5D	242	0.05	0.15	-	-	-	-	-	-	-	491	0.01	0.027	0	3	0.0048	85.0	-	-	-	-	-
	*DA-5E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0033	85.0	96	0.0100	0.15	10.87	7

Total Area = **0.33 sq. miles**
Waste Diposal Total Area = **207 acres**

Note:
1. *, Drainage areas indicated with an asterisk, include areas modeled using the Velocity method, as described in Attachment 6A, Section 2.2.
1. **, Drainage area DA-1E indicated with two asterisks, open channel was included into lag time calculation.

Open Channel Flow								
Surface Description	Length (feet)	Slope (ft/ft) (ft/ft)	Manning n	Cross-sectional Area (ft2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Avg. Velocity (ft/s)	Channel Flow T_c (min)
Grass	1006	0.013	0.027	5.8	9.0	0.6	4.6	4

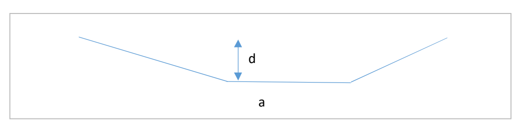
	a (ft)	d (ft)	left slope (%)	right slope (%)	Area (ft2)	Wetted P (ft)
DA-1E	2.85	1.0	32.0	37.0	5.8	9.0

CITY OF WACO LANDFILL
VELOCITY METHOD INPUT PARAMETERS
100 YEAR FLOOD STUDY
-POST-DEVELOPMENT CONDITIONS -

2-yr, 24-hr Rainfall Depth = 4.25 imches

Discharge Study Point	Contributing Drainage Areas	Area (sq. mi.)	Curve Number (CN)	Sheet Flow				Shallow Concentrated Flow				Open Channel Flow								Time of Concentration (Tc)				Total Lag Time
				Surface Description	Length	Slope	Manning n	Surface Description	Length	Slope	Avg. Velocity	Surface Description	Length	Slope (ft/ft)	Manning n	Cross-sectional Area	Wetted Perimeter	Hydraulic Radius	Avg. Velocity	Sheet Flow T_c	Shallow Concentrated Flow T_c	Channel Flow T_c	Total T_c	
					(feet)	(ft/ft)			(feet)	(ft/ft)	(ft/s)		(feet)	(ft/ft)		(ft2)	(ft)	(ft)	(ft/s)	(min)	(min)	(min)	(min)	(min)
POD-1	PRE-1R	0.0149	74.7	Grass	262	0.021	0.15	-	-	-	-	Grass	472	0.028	0.027	5.8	9.0	0.6	6.9	18	-	1	19	11
	OS-5	0.0131	80.0	Grass	300	0.008	0.15	Grass	2149	0.010	0.7	-	-	-	-	-	-	-	-	29	51	-	81	48
	EDA East	0.0030	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
POD-2	PRE-2R	0.0086	73.0	Grass	300	0.009	0.15	-	-	-	-	-	-	-	-	-	-	-	-	28	-	-	28	17
POD-3 & 4	PRE-3R	0.0207	73.0	Grass	300	0.014	0.15	Grass	1045	0.014	0.8	-	-	-	-	-	-	-	-	24	21	-	45	27
	PRE-4R	0.0056	73.0	Grass	300	0.013	0.15	Grass	172	0.017	0.9	-	-	-	-	-	-	-	-	24	3	-	27	16
POD-5 & 6	PRE-5R	0.0352	73.0	Grass	300	0.017	0.15	Grass	1287	0.017	0.9	Grass	760	0.013	0.027	5.1	10.5	0.5	3.8	22	24	3	49	29
	PRE-6R	0.0043	73.0	Grass	300	0.007	0.15	Grass	458	0.009	0.7	-	-	-	-	-	-	-	-	31	12	-	43	26
POD-7	PRE-7R	0.0223	73.0	Grass	300	0.028	0.15	Grass	1375	0.010	0.7	-	-	-	-	-	-	-	-	18	33	-	51	30
POD-8	PRE-8ABR	0.0847	73.8	Grass	300	0.005	0.15	Grass	-	-	-	Grass	3100	0.001	0.027	22.7	15.3	1.5	2.3	36	-	23	59	35
	PRE-8CR	0.1898	73.1	-	-	-	-	Grass	613	0.018	0.9	Grass	8832	0.001	0.027	40.6	24.3	1.7	2.9	-	11	51	62	37
	PRE-8DR	0.0312	73.7	Grass	300	0.010	0.15	Grass	1466	0.012	0.8	-	-	-	-	-	-	-	-	27	32	-	59	35
	OS-1	1.5800	79.7	Grass	300	0.013	0.15	Grass	2460	0.013	0.8	Grass	11834	0.006	0.027	137.1	110.4	1.2	5.1	24	52	39	115	69
	OS-2	0.0580	80.0	Grass	300	0.017	0.15	Grass	1133	0.016	0.9	Grass	920	0.011	0.027	6.8	9.3	0.7	4.6	22	22	3	47	28
	OS-3	0.0233	80.0	Grass	300	0.005	0.15	Grass	611	0.015	0.8	-	-	-	-	-	-	-	-	37	12	-	49	29
	EDA WEST	0.0120	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	WDA	0.0100	99.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
POD-9	PRE-9R	0.0029	73.0	Grass	300	0.002	0.15	Grass	164	0.004	0.5	-	-	-	-	-	-	-	-	48	6	-	54	33
POD-10	PRE-10AR	0.0016	80.0	Grass	300	0.014	0.15	Grass	678	0.008	0.6	-	-	-	-	-	-	-	-	23	18	-	42	25
	PRE-10BR	0.0029	80.0	Grass	300	0.007	0.15	Grass	946	0.009	0.7	-	-	-	-	-	-	-	-	32	23	-	55	33
POD-11	PRE-11R	0.0100	80.0	Grass	300	0.015	0.15	Grass	516	0.021	1.0	-	-	-	-	-	-	-	-	23	9	-	31	19

Channel Section:



Total Area = 2.14 sq. miles
Total Area = 1372 acres
Permit Property Total Area = 292 acres

	a (ft)	d (ft)	left slope (%)	right slope (%)	Area (ft2)	Wetted P (ft)	2-year, 24 hour		
PRE-1R Channel Section:	2.85	1.0	32.0	37.0	5.8	9.0	Q2yr :	16.9	cfs
PRE-5R Channel Section:	3.19	0.8	15.5	31.0	5.1	10.5	Q2yr:	16.2	cfs
PRE-8ABR Channel Section:	2.75	2.5	54.0	32.0	22.7	15.3	Q2 yr:	44.2	cfs
PRE-8CR Channel Section:	4.65	2.9	22.5	50.0	40.6	24.3	Q2 yr:	94.5	cfs
OS-1 Channel Section:	42.00	1.8	7.7	4.0	137.1	110.4	Q2 yr:	710.3	cfs
OS-2 Channel Section:	0.75	1.6	27.1	85.1	6.8	9.3	Q2 yr:	44.6	cfs

Note:
1. Drainage Areas Pre-10A, Pre-10B, and Pre-11 were not included in the HEC-HMS Model due to the following: (1) these areas will not be disturbed during development of the landfill; and (2) these areas due not contribute run-on/runoff to the post-development perimeter drainage

Methodology:

Reference: United States Department of Agriculture. Hydrology National Engineering Handbook, Part 630 (May 2010). Chapter 15, Time of Concentration.

Sheet Flow T_c

$$T_t = \frac{0.007(nl)^{0.8}}{(P_2)^{0.5}S^{0.4}} \text{(ep. 15-8)}$$

where:
T_t = travel time, h
n = Manning's roughness coefficient (0.15, short-grass prairie)
l = sheet flow length, ft
P_2 = 2-year, 24-hour rainfall, in (4.25 inches)
S = slope of land surface, ft/ft

Shallow Concentrated Flow T_c

$$V = 6.962\,(s)^{0.5}$$

where:
V = Average velocity, ft/s
s = slope of the hydraulic grade line, ft/ft

(Table 15-3 for Short-grass pasture flow type)

Channel Flow T_c

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \text{(eq. 15-10)}$$

where:
V = Average velocity, ft/s
r = hydraulic radius, ft
$= \frac{a}{P_w}$
a = cross-sectional flow area, ft2
P_w = Wetted perimeter, ft
s = slope of the hydraulic grade line, ft/ft
n = Manning's n value for open channel flow (0.027, grass)

Lag time

$$V = 0.6\,T_c \quad \text{(eq. 15-3)}$$

where:
L = lag, h
T_c = time of concentration, h

PRECIPITATION DATA

Design Hydrology and Sedimentology for Small Catchments

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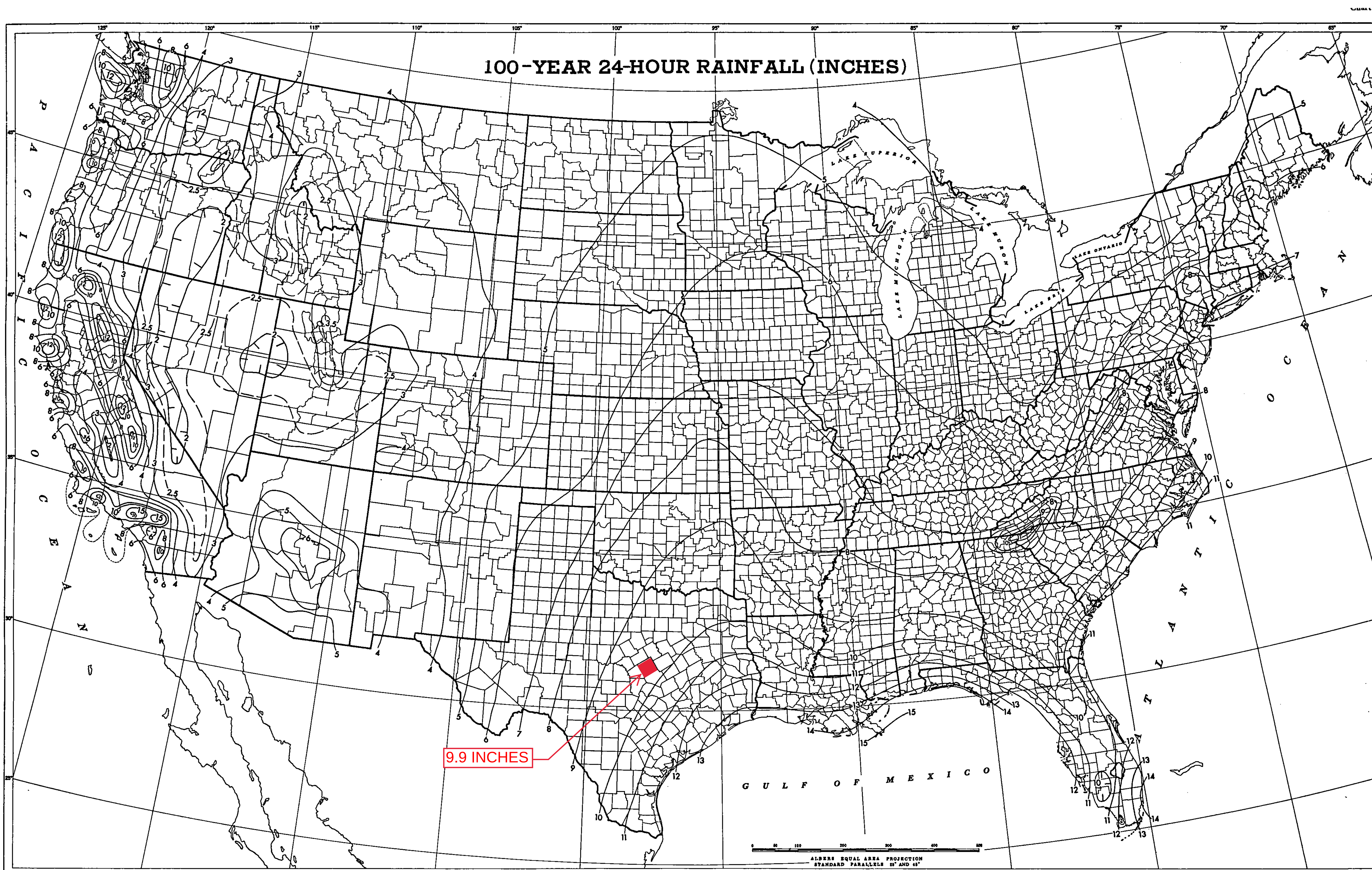

100-YEAR 24-HOUR RAINFALL (INCHES)
9.9 INCHES
G U L F O F M E X I C O
P A C I F I C O C E A N
A T L A N T I C O C E A N
ALBERS EQUAL AREA PROJECTION
STANDARD PARALLELS 29° AND 45°

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APPENDIX 6B-B

HEC-HMS INPUT FILES

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6B-B-1 to 6B-B-55

HEC-HMS INPUT FILE

Pre-Development Conditions

```
Basin: Waco LF-Velocity Method
     Last Modified Date: 29 April 2019
     Last Modified Time: 14:23:32
     Version: 4.0
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: C
     Canvas X: 897.6261127596445
     Canvas Y: -697.3293768545991
     Label X: -1.0
     Label Y: -8.0
     Area: 6.257
     Downstream: Site 19 Reservoir

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.3

     Transform: SCS
     Lag: 155.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: B
     Canvas X: -1344.1558441558445
     Canvas Y: 1142.8571428571427
     Label X: 0.0
     Label Y: -8.0
     Area: 6.033
     Downstream: Site 19 Reservoir

     Canopy: None
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.3

     Transform: SCS
     Lag: 198.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: A-2
     Canvas X: -4021.922428330524
     Canvas Y: 3010.1180438448564
     Label X: 0.0
     Label Y: -9.0
     Area: 0.965
     Downstream: POD-A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79.5

     Transform: SCS
     Lag: 80.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: A-1
     Canvas X: -5564.935064935065
     Canvas Y: 3246.7532467532465
     Label X: -50.0
     Label Y: -5.0
     Area: 0.664
     Downstream: POD-A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None
```

```
     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80.0

     Transform: SCS
     Lag: 44.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: A-4
     Canvas X: -5893.7605396290055
     Canvas Y: 1795.9527824620573
     From Canvas X: -640.8094435075891
     From Canvas Y: -168.63406408094443
     Label X: -48.0
     Label Y: -4.0
     Area: 0.141
     Downstream: POD-A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.2

     Transform: SCS
     Lag: 38.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-A1
     Canvas X: -3939.1691394658747
     Canvas Y: 2047.4777448071218
     Label X: 2.0
     Label Y: -2.0
     Downstream: Horse Creek
End:

Reach: Horse Creek
     Canvas X: -3524.436090225565
     Canvas Y: 601.5037593984962
     From Canvas X: -3939.1691394658747
     From Canvas Y: 2047.4777448071218
```

```
     Label X: -90.0
     Label Y: 3.0
     Downstream: POD-A2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 9549
     Energy Slope: 0.0026
     Width: 79.28
     Side Slope: 0.33
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: A-3
     Canvas X: -2689.7133220910637
     Canvas Y: 1239.460370994941
     Label X: -1.0
     Label Y: -9.0
     Area: 0.457
     Downstream: POD-A2

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.9

     Transform: SCS
     Lag: 59.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-A2
     Canvas X: -3524.436090225565
     Canvas Y: 601.5037593984962
     Downstream: Site 19 Reservoir
End:

Subbasin: D
     Canvas X: -3465.430016863407
     Canvas Y: -1779.089376053963
     Label X: -1.0
     Label Y: -7.0
```

```
     Area: 0.111
     Downstream: Site 19 Reservoir

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 81.5

     Transform: SCS
     Lag: 26.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: RES19
     Canvas X: -5227.941176470587
     Canvas Y: -1323.5294117647054
     Label X: -71.0
     Label Y: -6.0
     Area: 0.106
     Downstream: Site 19 Reservoir

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 99

     Transform: SCS
     Lag: 1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: E
     Canvas X: -5050.590219224284
     Canvas Y: -42.158516020235766
     Label X: -39.0
     Label Y: -6.0
     Area: 0.077
     Downstream: Site 19 Reservoir
```

```
     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.3

     Transform: SCS
     Lag: 64.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: Site 19 Reservoir
     Description: Reservoir 19
     Canvas X: -3396.6942148760336
     Canvas Y: -685.9504132231405
     Label X: 13.0
     Label Y: 13.0

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 520.69
     Elevation-Area Table: Site 19 Reservoir
     Elevation-Outflow Table: Site 19 Reservoir
     Primary Table: Elevation-Outflow
End:

Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
     Maximum View N: 5000.0
     Maximum View S: -5000.0
     Maximum View W: -5000.0
     Maximum View E: 5000.0
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Name
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Fix Element Locations: No
     Fix Hydrologic Order: No
```

```
End:
```

HEC-HMS INPUT FILE

Post-Development Conditions

```
Basin: 100-yr post (post)
     Last Modified Date: 8 April 2020
     Last Modified Time: 19:09:24
     Version: 4.0
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: C
     Canvas X: 126498.69369138428
     Canvas Y: 56328.96222630968
     Area: 6.257
     Downstream: Site-19 Reservoir

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.3

     Transform: SCS
     Lag: 155.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: B
     Canvas X: 96457.23004556191
     Canvas Y: 98053.21728995183
     Label X: 1.0
     Label Y: -2.0
     Area: 5.827
     Downstream: POD-B

     Canopy: None
     Plant Uptake Method: None

     Surface: None
```

```
     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.3

     Transform: SCS
     Lag: 198.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: DA-1B
     Canvas X: -64462.498707523046
     Canvas Y: 81418.72293022805
     Label X: -64.0
     Label Y: -5.0
     Area: 0.0055
     Downstream: DA-1A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 189
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 906
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-1A
     Canvas X: -64812.85504775209
```

```
     Canvas Y: 87725.13705435107
     Label X: -61.0
     Label Y: -2.0
     Area: 0.0355
     Downstream: CHAN-1A3

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 847
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00395
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 536
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-1C
     Canvas X: -131784.3794990044
     Canvas Y: 87602.28483115385
     Label X: -33.0
```

```
     Label Y: -17.0
     Area: 0.0042
     Downstream: CHAN-1A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 11
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: CHAN-1A1
     Canvas X: -99271.61878578762
     Canvas Y: 94018.22714272387
     From Canvas X: -130578.99802267874
     From Canvas Y: 93672.90080101142
     Label X: -43.0
     Label Y: 7.0
     Downstream: CHAN-1A2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 404
     Energy Slope: 0.01
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-1A2
     Canvas X: -64525.10129552474
     Canvas Y: 94790.98895805837
     From Canvas X: -99271.61878578762
     From Canvas Y: 94018.22714272387
     Label X: -48.0
     Label Y: 6.0
     Downstream: CHAN-1A3

     Route: Muskingum Cunge
```

```
     Channel: Trapezoid
     Length: 1274
     Energy Slope: 0.008
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-1A3
     Canvas X: -46618.471754574275
     Canvas Y: 94531.80798768853
     From Canvas X: -64525.10129552474
     From Canvas Y: 94790.98895805837
     Label X: -53.0
     Label Y: 11.0
     Downstream: CHAN-1A4

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 348
     Energy Slope: 0.0025
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-1A4
     Canvas X: -15641.935225423338
     Canvas Y: 96384.24708740615
     From Canvas X: -46618.471754574275
     From Canvas Y: 94531.80798768853
     Label X: -65.0
     Label Y: 11.0
     Downstream: EDA EAST BASIN

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 711
     Energy Slope: 0.022
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:
```

```
Subbasin: EDA EAST
     Canvas X: -40922.55845560902
     Canvas Y: 80803.58880037066
     Label X: -42.0
     Label Y: 16.0
     Area: 0.003
     Downstream: EDA EAST BASIN

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 99

     Transform: SCS
     Lag: 1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: DA-1D
     Canvas X: -17867.228828817577
     Canvas Y: 80807.19186364641
     Label X: -28.0
     Label Y: -17.0
     Area: 0.0023
     Downstream: EDA EAST BASIN

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: EDA EAST BASIN
     Canvas X: -15641.935225423338
```

```
     Canvas Y: 96384.24708740615
     From Canvas X: -43225.466802242976
     From Canvas Y: -15498.126506176006
     Label X: -61.0
     Label Y: 16.0
     Downstream: POD-1

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 534
     Elevation-Area Table: EDA EAST BASIN
     Elevation-Outflow Table: EDA EAST BASIN
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-1R
     Canvas X: 21631.73263143032
     Canvas Y: 101112.99599461893
     Label X: -29.0
     Label Y: 14.0
     Area: 0.0149
     Downstream: POD-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 74.7

     Transform: SCS
     Lag: 11
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: DA-1E
     Canvas X: 14121.366719974729
     Canvas Y: 79972.70676237356
     Area: 0.0019
     Downstream: POD-1

     Canopy: None
     Plant Uptake Method: None

     Surface: None
```

```
     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-1
     Canvas X: 13008.71991827758
     Canvas Y: 96106.08538698187
     Label X: -56.0
     Label Y: -17.0
     Downstream: POD-B
End:

Subbasin: PRE-3R
     Canvas X: -3402.820406754967
     Canvas Y: 58276.09412927965
     Label X: -35.0
     Label Y: -18.0
     Area: 0.0207
     Downstream: POD-3

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 27
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-3
     Canvas X: 16346.660323368968
     Canvas Y: 58832.41753012821
     Label X: -28.0
     Label Y: -17.0
     Downstream: POD-B
End:
```

```
Subbasin: PRE-2R
     Canvas X: -4515.467208452115
     Canvas Y: 71349.69404922085
     Label X: -39.0
     Label Y: -18.0
     Area: 0.0086
     Downstream: POD-2

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 17
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-2
     Canvas X: 14677.690120823274
     Canvas Y: 71349.69404922085
     Label X: -31.0
     Label Y: -18.0
     Downstream: POD-B
End:

Subbasin: PRE-4R
     Canvas X: -4237.305508027843
     Canvas Y: 49653.08141612694
     Label X: -40.0
     Label Y: -20.0
     Area: 0.0056
     Downstream: POD-4

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73
```

```
     Transform: SCS
     Lag: 16
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-4
     Canvas X: 18571.953926763206
     Canvas Y: 50209.4048169755
     Label X: -32.0
     Label Y: -18.0
     Downstream: POD-B
End:

Junction: POD-B
     Canvas X: 98404.36194853188
     Canvas Y: 75522.11955558507
     Downstream: Site-19 Reservoir
End:

Subbasin: A-2
     Canvas X: -151490.0711881423
     Canvas Y: -19425.503567571664
     Area: 0.965
     Downstream: POD-A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79.5

     Transform: SCS
     Lag: 80.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: A-1
     Canvas X: -154282.5768804836
     Canvas Y: 10151.550332780433
     Area: 0.664
     Downstream: POD-A1

     Canopy: None
```

```
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 44.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: A-4
     Canvas X: -130362.20471561825
     Canvas Y: 6812.608712544854
     Area: 0.079
     Downstream: POD-A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.2

     Transform: SCS
     Lag: 37.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-A1
     Canvas X: -129697.66673617053
     Canvas Y: -5202.0848120902665
     Label X: -10.0
     Label Y: -18.0
     Downstream: PRE-8C HC
End:

Reach: PRE-8C HC
     Canvas X: 9392.617812761979
     Canvas Y: -4032.126765759298
     From Canvas X: -129697.66673617053
     From Canvas Y: -5202.0848120902665
```

```
     Label X: -70.0
     Label Y: -21.0
     Downstream: POD-8

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 10612
     Energy Slope: 0.0048
     Width: 28.8
     Side Slope: 0.21
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: PRE-8CR
     Canvas X: 5740.873729981919
     Canvas Y: 3575.4795055499417
     Label X: -1.0
     Label Y: -6.0
     Area: 0.1898
     Downstream: POD-8

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.1

     Transform: SCS
     Lag: 37
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: DA-3B
     Canvas X: -78984.65339242521
     Canvas Y: 25691.23314632714
     Area: 0.0040
     Downstream: DA-3A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None
```

```
    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 179
    Plane 1 Slope: 0.05
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5

    Channel: Main
    Channel Length: 808
    Channel Slope: 0.01
    Channel Mannings N: 0.027
    Shape: Triangle
    Channel Side Slope: 3
    Channel Number of Steps: 5

    Baseflow: None
End:

Subbasin: DA-3A
    Canvas X: -78984.65339242521
    Canvas Y: 20455.0775601547
    Label X: -2.0
    Label Y: -1.0
    Area: 0.0373
    Downstream: CHAN-2A5

    Canopy 1: None
    Plant Uptake Method: None

    Surface 1: None

    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 130
    Plane 1 Slope: 0.25
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5
```

```
     Channel: 2
     Collector Length: 799
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00373
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 634
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-2B
     Canvas X: -83503.45578250417
     Canvas Y: 46772.120947446885
     Label X: -32.0
     Label Y: -19.0
     Area: 0.0030
     Downstream: DA-2A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 117
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 496
```

```
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-2A
     Canvas X: -81602.73118551144
     Canvas Y: 50650.24144041578
     Label X: -33.0
     Label Y: 13.0
     Area: 0.0282
     Downstream: CHAN-2A1

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 757
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00353
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 950
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
```

```
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Reach: CHAN-2A1
     Canvas X: -93794.06375591485
     Canvas Y: 38453.34497887773
     From Canvas X: -93884.94450762353
     From Canvas Y: 50604.63980581959
     Label X: -76.0
     Label Y: -1.0
     Downstream: CHAN-2A2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 223
     Energy Slope: 0.0225
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A2
     Canvas X: -93774.9276375098
     Canvas Y: 28958.301758432593
     From Canvas X: -93794.06375591485
     From Canvas Y: 38453.34497887773
     Label X: -74.0
     Label Y: 2.0
     Downstream: CHAN-2A3

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 818
     Energy Slope: 0.0075
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A3
     Canvas X: -93911.69029629939
     Canvas Y: 15038.91265134334
```

```
     From Canvas X: -93774.9276375098
     From Canvas Y: 28958.301758432593
     Label X: -76.0
     Label Y: -7.0
     Downstream: CHAN-2A4

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 762
     Energy Slope: 0.0225
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A4
     Canvas X: -79087.93352393302
     Canvas Y: 15109.185256967845
     From Canvas X: -93911.69029629939
     From Canvas Y: 15038.91265134334
     Label X: -48.0
     Label Y: -11.0
     Downstream: CHAN-2A5

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1159
     Energy Slope: 0.0025
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-2A5
     Canvas X: -42998.52918042446
     Canvas Y: 15117.746065427273
     From Canvas X: -79087.93352393302
     From Canvas Y: 15109.185256967845
     Label X: -62.0
     Label Y: -11.0
     Downstream: EDA WEST BASIN

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 852
     Energy Slope: 0.0025
```

```
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: DA-3D
     Canvas X: -53700.4164513312
     Canvas Y: 26506.054202249274
     Label X: -38.0
     Label Y: 11.0
     Area: 0.0040
     Downstream: DA-3C

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 161
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 822
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-3C
     Canvas X: -54025.645098336565
     Canvas Y: 21153.231638311023
     Label X: -38.0
     Label Y: -19.0
     Area: 0.0421
```

```
     Downstream: EDA WEST BASIN

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 903
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00429
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 568
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-3F
     Canvas X: -18441.453268080426
     Canvas Y: 24146.990494238868
     Label X: -56.0
     Label Y: -3.0
     Area: 0.0027
     Downstream: DA-3E
```

```
    Canopy 1: None
    Plant Uptake Method: None

    Surface 1: None

    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 181
    Plane 1 Slope: 0.05
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5

    Channel: Main
    Channel Length: 866
    Channel Slope: 0.01
    Channel Mannings N: 0.027
    Shape: Triangle
    Channel Side Slope: 3
    Channel Number of Steps: 5

    Baseflow: None
End:

Subbasin: DA-3E
    Canvas X: -17974.119327917317
    Canvas Y: 19579.462550758006
    Label X: -59.0
    Label Y: -5.0
    Area: 0.0339
    Downstream: CHAN-3A1

    Canopy 1: None
    Plant Uptake Method: None

    Surface 1: None

    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 130
```

```
    Plane 1 Slope: 0.25
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5

    Channel: 2
    Collector Length: 807
    Collector Slope: 0.01
    Collector Mannings N: 0.027
    Shape: Triangle
    Collector Side Slope: 3
    Collector Area: 0.00376
    Collector Number of Steps: 5

    Channel: Main
    Channel Length: 693
    Channel Slope: 0.25
    Channel Mannings N: 0.033
    Shape: Trapezoid
    Channel Width: 15
    Channel Side Slope: 2
    Channel Number of Steps: 5
    Route Upstream: Yes

    Baseflow: None
End:

Reach: CHAN-3A1
    Canvas X: -42998.52918042446
    Canvas Y: 15117.746065427273
    From Canvas X: -17996.21916407974
    From Canvas Y: 15142.540755769209
    Label X: -36.0
    Label Y: -13.0
    Downstream: EDA WEST BASIN

    Route: Muskingum Cunge
    Channel: Trapezoid
    Length: 2037
    Energy Slope: 0.0025
    Width: 10
    Side Slope: 3
    Mannings n: 0.027
    Use Variable Time Step: No
    Channel Loss: None
End:

Subbasin: EDA WEST
    Canvas X: -43130.79350311213
    Canvas Y: 27144.981808492725
```

```
     Label X: -46.0
     Label Y: 15.0
     Area: 0.011
     Downstream: EDA WEST BASIN

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 99

     Transform: SCS
     Lag: 1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: EDA WEST BASIN
     Canvas X: -42998.52918042446
     Canvas Y: 15117.746065427273
     From Canvas X: -25843.4367849071
     From Canvas Y: 10575.944546616312
     Label X: -78.0
     Label Y: -19.0
     Downstream: POD-8

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 530
     Elevation-Area Table: EDA WEST BASIN
     Elevation-Outflow Table: EDA WEST BASIN
     Primary Table: Elevation-Outflow
End:

Subbasin: DA-5B
     Canvas X: -48966.318849772186
     Canvas Y: -52387.91905003268
     Area: 0.0036
     Downstream: DA-5A

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
```

```
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 176
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 554
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-5A
     Canvas X: -48068.6615501185
     Canvas Y: -57504.18471161605
     Label X: 5.0
     Label Y: 1.0
     Area: 0.0379
     Downstream: CHAN-4B7

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
```

```
    Collector Length: 1038
    Collector Slope: 0.01
    Collector Mannings N: 0.027
    Shape: Triangle
    Collector Side Slope: 3
    Collector Area: 0.00484
    Collector Number of Steps: 5

    Channel: Main
    Channel Length: 844
    Channel Slope: 0.25
    Channel Mannings N: 0.033
    Shape: Trapezoid
    Channel Width: 15
    Channel Side Slope: 2
    Channel Number of Steps: 5
    Route Upstream: Yes

    Baseflow: None
End:

Subbasin: DA-5D
    Canvas X: -83162.79516991359
    Canvas Y: -52037.25937385902
    Label X: -29.0
    Label Y: -19.0
    Area: 0.0048
    Downstream: DA-5C

    Canopy 1: None
    Plant Uptake Method: None

    Surface 1: None

    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 242
    Plane 1 Slope: 0.05
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5

    Channel: Main
    Channel Length: 491
    Channel Slope: 0.01
```

```
    Channel Mannings N: 0.027
    Shape: Triangle
    Channel Side Slope: 3
    Channel Number of Steps: 5

    Baseflow: None
End:

Subbasin: DA-5C
    Canvas X: -93920.29341517741
    Canvas Y: -52037.25937385902
    Label X: -30.0
    Label Y: -19.0
    Area: 0.0099
    Downstream: CHAN-4B3

    Canopy 1: None
    Plant Uptake Method: None

    Surface 1: None

    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 130
    Plane 1 Slope: 0.25
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5

    Channel: 2
    Collector Length: 427
    Collector Slope: 0.01
    Collector Mannings N: 0.027
    Shape: Triangle
    Collector Side Slope: 3
    Collector Area: 0.00199
    Collector Number of Steps: 5

    Channel: Main
    Channel Length: 370
    Channel Slope: 0.25
    Channel Mannings N: 0.033
    Shape: Trapezoid
    Channel Width: 15
    Channel Side Slope: 2
```

```
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-5E
     Canvas X: -95507.46528742944
     Canvas Y: -32814.84447658433
     Label X: -35.0
     Label Y: -20.0
     Area: 0.0033
     Downstream: CHAN-4B1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: CHAN-4B1
     Canvas X: -99918.46890222236
     Canvas Y: -43191.250020324485
     From Canvas X: -100018.86951473463
     From Canvas Y: -32978.82169526743
     Label X: -78.0
     Label Y: -2.0
     Downstream: CHAN-4B2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 448
     Energy Slope: 0.006
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:
```

```
Reach: CHAN-4B2
     Canvas X: -99985.96232959302
     Canvas Y: -52140.32237768591
     From Canvas X: -99918.46890222236
     From Canvas Y: -43191.250020324485
     Label X: -85.0
     Label Y: -6.0
     Downstream: CHAN-4B3

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 104
     Energy Slope: 0.0190
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B3
     Canvas X: -99946.73749156627
     Canvas Y: -61737.672879597725
     From Canvas X: -99985.96232959302
     From Canvas Y: -52140.32237768591
     Label X: -81.0
     Label Y: -7.0
     Downstream: CHAN-4B4

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 714
     Energy Slope: 0.007
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B4
     Canvas X: -90099.30028619742
     Canvas Y: -61766.4197427996
     From Canvas X: -99946.73749156627
     From Canvas Y: -61737.672879597725
     Label X: -48.0
     Label Y: -11.0
     Downstream: CHAN-4B5

     Route: Muskingum Cunge
```

```
     Channel: Trapezoid
     Length: 341
     Energy Slope: 0.01
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B5
     Canvas X: -65530.197431344655
     Canvas Y: -61720.77131889899
     From Canvas X: -90099.30028619742
     From Canvas Y: -61766.4197427996
     Label X: -53.0
     Label Y: -12.0
     Downstream: CHAN-4B6

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 699
     Energy Slope: 0.0065
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B6
     Canvas X: -50312.959806994026
     Canvas Y: -61791.14000809468
     From Canvas X: -65530.197431344655
     From Canvas Y: -61720.77131889899
     Label X: -45.0
     Label Y: -14.0
     Downstream: CHAN-4B7

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 495
     Energy Slope: 0.01
     Width: 10
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:
```

```
Reach: CHAN-4B7
     Canvas X: -32511.75550095027
     Canvas Y: -61742.09825398881
     From Canvas X: -50312.959806994026
     From Canvas Y: -61791.14000809468
     Label X: -45.0
     Label Y: -15.0
     Downstream: CHAN-4B8

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 245
     Energy Slope: 0.01
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4B8
     Canvas X: -33446.05066845761
     Canvas Y: -29597.306973807063
     From Canvas X: -32511.75550095027
     From Canvas Y: -61742.09825398881
     Label X: -10.0
     Label Y: -10.0
     Downstream: WDA BASIN

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1406
     Energy Slope: 0.0025
     Width: 11
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: DA-4B
     Canvas X: -53182.882027375046
     Canvas Y: -31227.672604332285
     Label X: -30.0
     Label Y: -21.0
     Area: 0.005
     Downstream: DA-4A

     Canopy 1: None
     Plant Uptake Method: None
```

```
     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 236
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
     Channel Length: 566
     Channel Slope: 0.01
     Channel Mannings N: 0.027
     Shape: Triangle
     Channel Side Slope: 3
     Channel Number of Steps: 5

     Baseflow: None
End:

Subbasin: DA-4A
     Canvas X: -44541.61294511394
     Canvas Y: -31227.672604332285
     Label X: -27.0
     Label Y: -23.0
     Area: 0.0300
     Downstream: WDA BASIN

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 130
     Plane 1 Slope: 0.25
     Plane 1 Roughness: 0.15
```

```
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: 2
     Collector Length: 804
     Collector Slope: 0.01
     Collector Mannings N: 0.027
     Shape: Triangle
     Collector Side Slope: 3
     Collector Area: 0.00375
     Collector Number of Steps: 5

     Channel: Main
     Channel Length: 438
     Channel Slope: 0.25
     Channel Mannings N: 0.033
     Shape: Trapezoid
     Channel Width: 15
     Channel Side Slope: 2
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-4D
     Canvas X: -84744.4245372149
     Canvas Y: -25448.55307862372
     Area: 0.0027
     Downstream: DA-4C

     Canopy 1: None
     Plant Uptake Method: None

     Surface 1: None

     LossRate 1: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: Kinematic Wave

     Plane: 1
     Plane 1 Length: 218
     Plane 1 Slope: 0.05
     Plane 1 Roughness: 0.15
     Plane 1 Percent of Area: 100
     Plane 1 Number of Steps: 5

     Channel: Main
```

```
    Channel Length: 368
    Channel Slope: 0.01
    Channel Mannings N: 0.027
    Shape: Triangle
    Channel Side Slope: 3
    Channel Number of Steps: 5

    Baseflow: None
End:

Subbasin: DA-4C
    Canvas X: -84744.4245372149
    Canvas Y: -20561.474531529442
    Area: 0.0194
    Downstream: CHAN-4A3

    Canopy 1: None
    Plant Uptake Method: None

    Surface 1: None

    LossRate 1: SCS
    Percent Impervious Area: 0.0
    Curve Number: 85

    Transform: Kinematic Wave

    Plane: 1
    Plane 1 Length: 130
    Plane 1 Slope: 0.25
    Plane 1 Roughness: 0.15
    Plane 1 Percent of Area: 100
    Plane 1 Number of Steps: 5

    Channel: 2
    Collector Length: 694
    Collector Slope: 0.01
    Collector Mannings N: 0.027
    Shape: Triangle
    Collector Side Slope: 3
    Collector Area: 0.00324
    Collector Number of Steps: 5

    Channel: Main
    Channel Length: 387
    Channel Slope: 0.25
    Channel Mannings N: 0.033
    Shape: Trapezoid
    Channel Width: 15
    Channel Side Slope: 2
```

```
     Channel Number of Steps: 5
     Route Upstream: Yes

     Baseflow: None
End:

Subbasin: DA-4E
     Canvas X: -94802.05556642853
     Canvas Y: -27700.623999327756
     Label X: -33.0
     Label Y: 11.0
     Area: 0.0047
     Downstream: CHAN-4A1

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 85

     Transform: SCS
     Lag: 7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: CHAN-4A1
     Canvas X: -99612.41688037939
     Canvas Y: -16947.720817565078
     From Canvas X: -99594.44755383424
     From Canvas Y: -27707.389718607825
     Label X: -73.0
     Label Y: -5.0
     Downstream: CHAN-4A2

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 434
     Energy Slope: 0.0025
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:
```

```
Reach: CHAN-4A2
     Canvas X: -84758.90482867799
     Canvas Y: -17039.526632119327
     From Canvas X: -99612.41688037939
     From Canvas Y: -16947.720817565078
     Label X: -47.0
     Label Y: 3.0
     Downstream: CHAN-4A3

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 416
     Energy Slope: 0.030
     Width: 5
     Side Slope: 3
     Mannings n: 0.027
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4A3
     Canvas X: -58838.42769660833
     Canvas Y: -17017.39364914017
     From Canvas X: -84758.90482867799
     From Canvas Y: -17039.526632119327
     Label X: -47.0
     Label Y: 8.0
     Downstream: CHAN-4A4

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 338
     Energy Slope: 0.015
     Width: 10
     Side Slope: 3
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Reach: CHAN-4A4
     Canvas X: -32438.239348354735
     Canvas Y: -17017.393649140184
     From Canvas X: -58838.42769660833
     From Canvas Y: -17017.39364914017
     Label X: -37.0
     Label Y: 8.0
     Downstream: CHAN-4A5

     Route: Muskingum Cunge
```

```
    Channel: Trapezoid
    Length: 1636
    Energy Slope: 0.006
    Width: 10
    Side Slope: 3
    Mannings n: 0.027
    Use Variable Time Step: No
    Channel Loss: None
End:

Reach: CHAN-4A5
    Canvas X: -33446.05066845761
    Canvas Y: -29597.306973807063
    From Canvas X: -32438.239348354735
    From Canvas Y: -17017.393649140184
    Label X: -78.0
    Label Y: 7.0
    Downstream: WDA BASIN

    Route: Muskingum Cunge
    Channel: Trapezoid
    Length: 240
    Energy Slope: 0.0025
    Width: 10
    Side Slope: 3
    Mannings n: 0.027
    Use Variable Time Step: No
    Channel Loss: None
End:

Subbasin: WDA
    Canvas X: -40411.640574288234
    Canvas Y: -39237.09612221115
    Label X: -27.0
    Label Y: -21.0
    Area: 0.010
    Downstream: WDA BASIN

    Canopy: None
    Plant Uptake Method: None

    Surface: None

    LossRate: SCS
    Percent Impervious Area: 0.0
    Curve Number: 99

    Transform: SCS
    Lag: 1
    Unitgraph Type: STANDARD
```

```
     Baseflow: None
End:

Reservoir: WDA BASIN
     Canvas X: -33446.05066845761
     Canvas Y: -29597.306973807063
     Label X: -4.0
     Label Y: -11.0
     Downstream: POD-8

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 531
     Elevation-Area Table: WDA BASIN
     Elevation-Outflow Table: WDA BASIN
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-8DR
     Canvas X: -21587.64157199234
     Canvas Y: -109138.88239504454
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
     Label X: -34.0
     Label Y: -19.0
     Area: 0.0312
     Downstream: Junction-2

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.7

     Transform: SCS
     Lag: 35
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-2
     Canvas X: -20004.997414405923
     Canvas Y: -97269.05121314635
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
```

```
     Label X: -48.0
     Label Y: 16.0
     Downstream: Junction-3
End:

Subbasin: OS-3
     Canvas X: 6899.953264563344
     Canvas Y: -108347.56031625131
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
     Label X: -29.0
     Label Y: -16.0
     Area: 0.02334
     Downstream: Junction-3

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80

     Transform: SCS
     Lag: 29
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction-3
     Canvas X: 10266.326655575278
     Canvas Y: -73600.98908444638
     From Canvas X: -2451.2800345420183
     From Canvas Y: -51837.25099194079
     Label X: 2.0
     Label Y: -1.0
     Downstream: OS-3 REACH
End:

Reach: OS-3 REACH
     Canvas X: 9392.617812761979
     Canvas Y: -4032.126765759298
     From Canvas X: 10266.326655575278
     From Canvas Y: -73600.98908444638
     Label X: -91.0
     Label Y: -18.0
     Downstream: POD-8
```

```
     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 2039
     Energy Slope: 0.0030
     Width: 5
     Side Slope: 10
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: POD-8
     Canvas X: 9392.617812761979
     Canvas Y: -4032.126765759298
     Label X: -1.0
     Label Y: -5.0
     Downstream: POD-A2
End:

Subbasin: PRE-7R
     Canvas X: 213.28169876069296
     Canvas Y: 17664.485867334617
     Label X: -34.0
     Label Y: -20.0
     Area: 0.0223
     Downstream: POD-7

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 30
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-7
     Canvas X: 16902.98372421757
     Canvas Y: 19055.294369456024
     Label X: -31.0
     Label Y: -20.0
     Downstream: POD-A2
End:
```

```
Subbasin: PRE-9R
     Canvas X: 40399.69397230647
     Canvas Y: -25972.16863724096
     Label X: -31.0
     Label Y: -21.0
     Area: 0.0029
     Downstream: POD-9

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 33
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-9
     Canvas X: 42025.86935885207
     Canvas Y: -22302.583533191544
     Label X: -2.0
     Label Y: -5.0
     Downstream: POD-A2
End:

Junction: POD-A2
     Canvas X: 47500.770770888485
     Canvas Y: -2641.3182636378915
     Label X: -34.0
     Label Y: 18.0
     Downstream: Site-19 Reservoir
End:

Subbasin: D
     Canvas X: 131783.76599944563
     Canvas Y: -7091.905470426398
     Area: 0.111
     Downstream: Site-19 Reservoir

     Canopy: None
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 81.5

     Transform: SCS
     Lag: 26.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: RES19
     Canvas X: 146248.1744215082
     Canvas Y: 2643.7540444234473
     Area: 0.106
     Downstream: Site-19 Reservoir

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 99

     Transform: SCS
     Lag: 1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: PRE-5R
     Canvas X: -4237.305508027843
     Canvas Y: 39639.26020085282
     Label X: -35.0
     Label Y: -16.0
     Area: 0.0352
     Downstream: POD-5

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
```

```
     Curve Number: 73

     Transform: SCS
     Lag: 29
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-5
     Canvas X: 19684.600728460355
     Canvas Y: 40751.90700254994
     Label X: -30.0
     Label Y: -18.0
     Downstream: Site-19 Reservoir
End:

Subbasin: E
     Canvas X: 99238.84704980475
     Canvas Y: -22112.637293337568
     Area: 0.023
     Downstream: Site-19 Reservoir

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 78.3

     Transform: SCS
     Lag: 26.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: PRE-6R
     Canvas X: -621.203402512183
     Canvas Y: 27956.468783033022
     Label X: -36.0
     Label Y: -18.0
     Area: 0.0043
     Downstream: POD-6

     Canopy: None
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73

     Transform: SCS
     Lag: 26
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-6
     Canvas X: 17528.847550172184
     Canvas Y: 30976.510101925218
     Label X: -30.0
     Label Y: -16.0
     Downstream: Site-19 Reservoir
End:

Reservoir: Site-19 Reservoir
     Canvas X: 99238.84704980475
     Canvas Y: 14604.707162667532
     Label X: 1.0
     Label Y: 5.0

     Route: Modified Puls
     Routing Curve: Elevation-Area-Outflow
     Initial Elevation: 520.69
     Elevation-Area Table: Site 19 Reservoir
     Elevation-Outflow Table: Site 19 Reservoir
     Primary Table: Elevation-Outflow
End:

Subbasin: PRE-10B
     Canvas X: -67598.29641900968
     Canvas Y: -84892.19575697934
     From Canvas X: -90031.3351708689
     From Canvas Y: -99990.4409789023
     Label X: 0.0
     Label Y: -2.0
     Area: 0.0029
     Downstream: POD-10

     Canopy: None
     Plant Uptake Method: None

     Surface: None
```

```
    LossRate: SCS
    Percent Impervious Area: 0.0
    Curve Number: 80

    Transform: SCS
    Lag: 33
    Unitgraph Type: STANDARD

    Baseflow: None
End:

Subbasin: PRE-10A
    Canvas X: -87440.86694689252
    Canvas Y: -81930.61806625058
    From Canvas X: -90031.3351708689
    From Canvas Y: -99990.4409789023
    Area: 0.0016
    Downstream: PRE-10 TK Parkway

    Canopy: None
    Plant Uptake Method: None

    Surface: None

    LossRate: SCS
    Percent Impervious Area: 0.0
    Curve Number: 80

    Transform: SCS
    Lag: 25
    Unitgraph Type: STANDARD

    Baseflow: None
End:

Reach: PRE-10 TK Parkway
    Canvas X: -64340.56095920803
    Canvas Y: -102957.81967042494
    From Canvas X: -93233.43594239092
    From Canvas Y: -103953.33380756754
    Label X: -66.0
    Label Y: -19.0
    Downstream: POD-10

    Route: Muskingum Cunge
    Channel: Trapezoid
    Length: 1215.664
    Energy Slope: 0.008
    Width: 17.8
    Side Slope: 0.12
```

```
     Mannings n: 0.033
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: POD-10
     Canvas X: -64340.56095920803
     Canvas Y: -102957.81967042494
     From Canvas X: -90031.3351708689
     From Canvas Y: -99990.4409789023
End:

Subbasin: PRE-11
     Canvas X: -126412.92443014431
     Canvas Y: -90671.2068608241
     From Canvas X: -90031.3351708689
     From Canvas Y: -99990.4409789023
     Area: 0.010
     Downstream: POD-11

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 80.0

     Transform: SCS
     Lag: 19
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: POD-11
     Canvas X: -125197.11832232957
     Canvas Y: -98269.99503466622
     From Canvas X: -98234.55254098363
     From Canvas Y: -98416.36375248755
     Label X: -72.0
     Label Y: -3.0
End:

Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
```

```
    Maximum View N: 53477.804796960794
    Maximum View S: -61263.896628055125
    Maximum View W: -117782.14367979346
    Maximum View E: 17236.009823300818
    Extent Method: Elements
    Buffer: 0
    Draw Icons: Yes
    Draw Icon Labels: Name
    Draw Map Objects: No
    Draw Gridlines: No
    Draw Flow Direction: No
    Fix Element Locations: No
    Fix Hydrologic Order: No
End:
```

APPENDIX 6B-C

HEC-HMS OUTPUT FILES

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6B-C-1 to 6B-C-20

HEC-HMS OUTPUT FILE

Pre-Development Conditions

Project: City of Waco Landfill Simulation Run: 100 yr, 24 hr pre-develop 6B

Start of Run: 02Oct2018, 00:00 Basin Model: 100-yr pre
End of Run: 03Oct2018, 00:05 Meteorologic Model: 100-year, 24-hour
Compute Time: 08Apr2020, 12:35:34 Control Specifications: 24-hour

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
C	6.257	5221.6	02Oct2018, 14:45	2290.6
B	6.033	4233.4	02Oct2018, 15:35	2154.2
A-2	0.965	1290.6	02Oct2018, 13:25	371.0
A-1	0.664	1301.1	02Oct2018, 12:50	260.2
A-4	0.141	291.4	02Oct2018, 12:40	53.6
POD-A1	1.770	2579.1	02Oct2018, 12:55	684.9
Horse Creek	1.770	2552.5	02Oct2018, 13:15	680.1
A-3	0.457	679.7	02Oct2018, 13:05	159.4
POD-A2	2.227	3224.2	02Oct2018, 13:10	839.5
D	0.111	291.9	02Oct2018, 12:30	44.8
RES19	0.106	577.6	02Oct2018, 12:05	55.3
E	0.077	117.4	02Oct2018, 13:10	29.1
Site 19 Reservoir	14.811	518.8	03Oct2018, 00:05	161.0

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Subbasin:	A-1

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	1301.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:50
Precipitation Volume:	350.6 (AC-FT)	Direct Runoff Volume:	260.2 (AC-FT)
Loss Volume:	87.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	263.0 (AC-FT)	Discharge Volume:	260.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Subbasin:	A-2

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	1290.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:25
Precipitation Volume:	509.5 (AC-FT)	Direct Runoff Volume:	371.0 (AC-FT)
Loss Volume:	130.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	378.9 (AC-FT)	Discharge Volume:	371.0 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Subbasin:	A-3

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	679.7 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:05
Precipitation Volume:	241.3 (AC-FT)	Direct Runoff Volume:	159.4 (AC-FT)
Loss Volume:	79.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	161.9 (AC-FT)	Discharge Volume:	159.4 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Subbasin:	A-4

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	291.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:40
Precipitation Volume:	74.4 (AC-FT)	Direct Runoff Volume:	53.6 (AC-FT)
Loss Volume:	20.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	54.1 (AC-FT)	Discharge Volume:	53.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B

Subbasin: B

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	4233.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 15:35
Precipitation Volume:	3185.4 (AC-FT)	Direct Runoff Volume:	2154.2 (AC-FT)
Loss Volume:	866.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2319.3 (AC-FT)	Discharge Volume:	2154.2 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B

Subbasin: C

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	5221.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 14:45
Precipitation Volume:	3303.7 (AC-FT)	Direct Runoff Volume:	2290.6 (AC-FT)
Loss Volume:	898.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2405.4 (AC-FT)	Discharge Volume:	2290.6 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Subbasin:	D

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	291.9 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:30
Precipitation Volume:	58.6 (AC-FT)	Direct Runoff Volume:	44.8 (AC-FT)
Loss Volume:	13.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	45.1 (AC-FT)	Discharge Volume:	44.8 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Subbasin:	E

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	117.4 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Precipitation Volume:	40.7 (AC-FT)	Direct Runoff Volume:	29.1 (AC-FT)
Loss Volume:	11.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	29.6 (AC-FT)	Discharge Volume:	29.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B

Reach: Horse Creek

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	2579.1 (CFS)	Date/Time of Peak Inflow	02Oct2018, 12:55
Peak Discharge:	2552.5 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:15
Inflow Volume:	684.9 (AC-FT)	Discharge Volume:	680.1 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Junction:	POD-A1

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	2579.1 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:55
Volume:	684.9 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B

Junction: POD-A2

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	3224.2 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 13:10
Volume:	839.5 (AC-FT)		

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B
		Subbasin:	RES19

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge:	577.6 (CFS)	Date/Time of Peak Discharge:	02Oct2018, 12:05
Precipitation Volume:	56.0 (AC-FT)	Direct Runoff Volume:	55.3 (AC-FT)
Loss Volume:	0.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	55.3 (AC-FT)	Discharge Volume:	55.3 (AC-FT)

Project:	City of Waco Landfill	Simulation Run:	100 yr, 24 hr pre-develop 6B

Reservoir: Site 19 Reservoir

Start of Run:	02Oct2018, 00:00	Basin Model:	100-yr pre
End of Run:	03Oct2018, 00:05	Meteorologic Model:	100-year, 24-hour
Compute Time:	08Apr2020, 12:35:34	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Inflow:	10595.2 (CFS)	Date/Time of Peak Inflow:	02Oct2018, 14:45
Peak Discharge:	518.8 (CFS)	Date/Time of Peak Discharge:	03Oct2018, 00:05
Inflow Volume:	5413.5 (AC-FT)	Peak Storage:	5252.5 (AC-FT)
Discharge Volume:	161.0 (AC-FT)	Peak Elevation:	533.4 (FT)

HEC-HMS OUTPUT FILE

Post-Development Conditions

Project: City of Waco Landfill Simulation Run: 100 yr, 24 hr (post)

Start of Run: 02Oct2018, 00:00 Basin Model: 100-yr post (post)
End of Run: 03Oct2018, 00:05 Meteorologic Model: 100-year, 24-hour
Compute Time: 08Apr2020, 14:12:07 Control Specifications: 24-hour

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
C	6.257	5221.6	02Oct2018, 14:45	2290.6
B	5.827	4088.8	02Oct2018, 15:35	2080.7
DA-1B	0.0055	28.0	02Oct2018, 12:05	2.4
DA-1A	0.0410	211.2	02Oct2018, 12:05	17.6
DA-1C	0.0042	15.8	02Oct2018, 12:10	1.8
CHAN-1A1	0.0042	15.8	02Oct2018, 12:15	1.8
CHAN-1A2	0.0042	15.6	02Oct2018, 12:20	1.8
CHAN-1A3	0.0452	212.2	02Oct2018, 12:05	19.4
CHAN-1A4	0.0452	204.6	02Oct2018, 12:05	19.4
EDA EAST	0.003	16.3	02Oct2018, 12:05	1.6
DA-1D	0.0023	9.4	02Oct2018, 12:10	1.0
EDA EAST BASIN	0.0505	150.0	02Oct2018, 12:15	20.7
PRE-1R	0.0149	49.0	02Oct2018, 12:15	5.3
DA-1E	0.0019	8.2	02Oct2018, 12:05	0.8
POD-1	0.0673	204.5	02Oct2018, 12:15	26.8
PRE-3R	0.0207	47.1	02Oct2018, 12:30	7.2
POD-3	0.0207	47.1	02Oct2018, 12:30	7.2
PRE-2R	0.0086	23.9	02Oct2018, 12:20	3.0
POD-2	0.0086	23.9	02Oct2018, 12:20	3.0
PRE-4R	0.0056	15.9	02Oct2018, 12:20	1.9
POD-4	0.0056	15.9	02Oct2018, 12:20	1.9
POD-B	5.9292	4112.9	02Oct2018, 15:35	2119.6
A-2	0.965	1290.6	02Oct2018, 13:25	371.0
A-1	0.664	1301.1	02Oct2018, 12:50	260.2
A-4	0.079	165.7	02Oct2018, 12:40	30.1
POD-A1	1.708	2467.0	02Oct2018, 13:00	661.3
PRE-8C HC	1.708	2455.5	02Oct2018, 13:10	658.1
PRE-8CR	0.1898	368.3	02Oct2018, 12:40	65.6
DA-3B	0.0040	20.4	02Oct2018, 12:05	1.7
DA-3A	0.0413	212.9	02Oct2018, 12:05	17.7

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
DA-2B	0.0030	15.5	02Oct2018, 12:05	1.3
DA-2A	0.0312	161.1	02Oct2018, 12:05	13.4
CHAN-2A1	0.0312	160.1	02Oct2018, 12:05	13.4
CHAN-2A2	0.0312	153.3	02Oct2018, 12:05	13.4
CHAN-2A3	0.0312	144.6	02Oct2018, 12:05	13.4
CHAN-2A4	0.0312	137.3	02Oct2018, 12:10	13.4
CHAN-2A5	0.0725	297.3	02Oct2018, 12:10	31.1
DA-3D	0.0040	20.5	02Oct2018, 12:05	1.7
DA-3C	0.0461	237.9	02Oct2018, 12:05	19.8
DA-3F	0.0027	13.7	02Oct2018, 12:05	1.2
DA-3E	0.0366	188.7	02Oct2018, 12:05	15.7
CHAN-3A1	0.0366	168.9	02Oct2018, 12:10	15.6
EDA WEST	0.011	59.9	02Oct2018, 12:05	5.7
EDA WEST BASIN	0.1662	89.2	02Oct2018, 13:05	41.5
DA-5B	0.0036	18.5	02Oct2018, 12:05	1.5
DA-5A	0.0415	213.9	02Oct2018, 12:05	17.8
DA-5D	0.0048	24.4	02Oct2018, 12:05	2.1
DA-5C	0.0147	75.2	02Oct2018, 12:05	6.3
DA-5E	0.0033	14.1	02Oct2018, 12:10	1.4
CHAN-4B1	0.0033	13.8	02Oct2018, 12:10	1.4
CHAN-4B2	0.0033	13.7	02Oct2018, 12:10	1.4
CHAN-4B3	0.0180	83.1	02Oct2018, 12:05	7.7
CHAN-4B4	0.0180	80.2	02Oct2018, 12:05	7.7
CHAN-4B5	0.0180	76.6	02Oct2018, 12:10	7.7
CHAN-4B6	0.0180	75.6	02Oct2018, 12:10	7.7
CHAN-4B7	0.0595	275.9	02Oct2018, 12:05	25.5
CHAN-4B8	0.0595	245.3	02Oct2018, 12:10	25.4
DA-4B	0.005	25.4	02Oct2018, 12:05	2.1
DA-4A	0.0350	180.1	02Oct2018, 12:05	15.0
DA-4D	0.0027	13.8	02Oct2018, 12:05	1.2
DA-4C	0.0221	114.0	02Oct2018, 12:05	9.5
DA-4E	0.0047	20.1	02Oct2018, 12:10	2.0
CHAN-4A1	0.0047	19.5	02Oct2018, 12:10	2.0
CHAN-4A2	0.0047	18.9	02Oct2018, 12:10	2.0
CHAN-4A3	0.0268	127.6	02Oct2018, 12:05	11.5

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CHAN-4A4	0.0268	121.2	02Oct2018, 12:10	11.5
CHAN-4A5	0.0268	119.1	02Oct2018, 12:10	11.5
WDA	0.010	54.5	02Oct2018, 12:05	5.2
WDA BASIN	0.1313	34.7	02Oct2018, 14:45	27.9
PRE-8DR	0.0312	63.1	02Oct2018, 12:40	10.9
Junction-2	0.0312	63.1	02Oct2018, 12:40	10.9
OS-3	0.02334	57.4	02Oct2018, 12:30	9.2
Junction-3	0.05454	119.5	02Oct2018, 12:35	20.1
OS-3 REACH	0.05454	117.9	02Oct2018, 12:45	20.0
POD-8	2.24984	2913.3	02Oct2018, 13:05	813.1
PRE-7R	0.0223	48.2	02Oct2018, 12:35	7.7
POD-7	0.0223	48.2	02Oct2018, 12:35	7.7
PRE-9R	0.0029	6.0	02Oct2018, 12:35	1.0
POD-9	0.0029	6.0	02Oct2018, 12:35	1.0
POD-A2	2.27504	2943.1	02Oct2018, 13:05	821.9
D	0.111	291.9	02Oct2018, 12:30	44.8
RES19	0.106	577.6	02Oct2018, 12:05	55.3
PRE-5R	0.0352	77.1	02Oct2018, 12:35	12.2
POD-5	0.0352	77.1	02Oct2018, 12:35	12.2
E	0.023	57.4	02Oct2018, 12:30	8.8
PRE-6R	0.0043	10.0	02Oct2018, 12:30	1.5
POD-6	0.0043	10.0	02Oct2018, 12:30	1.5
Site-19 Reservoir	14.74074	462.4	03Oct2018, 00:05	146.2
PRE-10B	0.0029	6.7	02Oct2018, 12:35	1.1
PRE-10A	0.0016	4.2	02Oct2018, 12:30	0.6
PRE-10 TK Parkway	0.0016	4.2	02Oct2018, 12:35	0.6
POD-10	0.0045	10.9	02Oct2018, 12:35	1.8
PRE-11	0.010	29.7	02Oct2018, 12:20	3.9
POD-11	0.010	29.7	02Oct2018, 12:20	3.9

APPENDIX 6B-D

HEC-RAS OUTPUT SUMMARY

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 6B-D-1 to 6B-D-2

HEC-RAS Plan: Plan 12 Profile: PF 1

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
PW	PW	5	PF 1	4233.40	529.73	539.39		539.42	0.000485	1.38	3075.08	602.63	0.11
PW	PW	4	PF 1	4233.40	521.78	533.59		533.99	0.009570	5.04	839.99	218.74	0.45
PW	PW	3	PF 1	4233.40	516.19	533.47		533.47	0.000036	0.56	8349.62	1250.45	0.03
PW	PW	2	PF 1	4233.40	512.61	533.41		533.41	0.000007	0.28	17451.59	2543.61	0.02
PW	PW	1	PF 1	4233.40	513.30	533.40	514.71	533.40	0.000002	0.12	35190.66	4783.34	0.01
HC	1	9	PF 1	1301.10	537.87	541.87		542.33	0.034192	5.42	240.03	146.30	0.75
HC	1	7	PF 1	2579.10	529.03	540.00		540.04	0.000764	1.77	1641.33	566.67	0.14
HC	1	6	PF 1	2579.10	527.15	538.43	532.21	538.94	0.002868	5.72	451.14	752.84	0.30
HC	1	5.1		Culvert									
HC	1	5	PF 1	2579.10	527.00	536.60	532.05	537.30	0.004894	6.71	384.38	458.69	0.38
HC	1	4.1	PF 1	2579.10	522.71	535.53		535.62	0.001679	2.56	1314.16	463.61	0.20
HC	1	4	PF 1	2579.10	521.25	533.78		533.86	0.003362	2.29	1126.09	438.45	0.25
HC	1	3	PF 1	2579.10	515.64	533.44		533.45	0.000044	0.51	5128.03	879.54	0.03
HC	1	2	PF 1	2579.10	514.46	533.41		533.41	0.000010	0.22	11848.91	2167.17	0.02
HC	1	1	PF 1	3224.20	514.41	533.40	517.21	533.40	0.000002	0.15	24772.75	2879.28	0.01
HC	2	8.2	PF 1	1290.60	539.09	545.35		545.39	0.001732	1.46	885.30	417.08	0.18
HC	2	8.1	PF 1	1290.60	532.04	537.46	537.46	538.19	0.063870	6.84	188.81	131.54	1.00

CITY OF WACO LANDFILL
TCEQ PERMIT NO. MSW-2400
MCLENNAN AND LIMESTONE COUNTIES, TEXAS

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 6C
GROUNDWATER PROTECTION PLAN

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, Texas 76710

STATE OF TEXAS
RYAN R. KUNTZ
104689
LICENSED
PROFESSIONAL ENGINEER
5/13/2020

Prepared by:

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Texas Board of Professional Engineers, Reg. No. F-3407
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1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – April 2020
SCS Project No. 16216088.00

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Drawings

STATE OF TEXAS
RYAN R. KUNTZ
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LICENSED
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5/13/2020

SCS Engineers
TBPE Reg. # F-3407

1 INTRODUCTION

Attachment 6C presents the landfill components designed for protection of groundwater. Specifically, Attachment 6C presents the liner, leachate collection, and final cover systems proposed for the City of Waco Landfill (landfill). The liner system and final cover system details are presented on Drawings 6C.1 and 6C.2; and the leachate collection system details are presented on Drawing 12.4. The liner system, leachate collection system, and final cover system have been designed consistent with 30 TAC §330.331, §330.333, and §330.457, respectively, as described in the following sections of this attachment.

2 GROUNDWATER PROTECTION DESIGN

2.1 LINER SYSTEM

As shown on Drawing 6C.1, a composite liner system, as defined in §330.331(b), is proposed for the landfill. Beginning from the waste and working down, the bottom liner will be comprised of the following components:

- 24-inch-thick soil protective cover;
- Single-sided geocomposite (non-woven geotextile on the top side only of geonet);
- 60-mil high-density polyethylene (HDPE) geomembrane (smooth);
- 2-foot-thick compacted clay liner ($k \leq 1x10^{-7}$ cm/sec); and
- Prepared subgrade (excavation grade).

The sideslope liner system will be comprised of the following components (from waste and working down):

- 24-inch thick soil protective cover;
- Double-sided geocomposite (non-woven geotextile on both sides of geonet);
- 60-mil textured HDPE geomembrane (textured on both sides);
- 2-foot-thick compacted clay liner ($k \leq 1x10^{-7}$ cm/sec); and
- Prepared subgrade (excavation grade).

The transition between textured geomembrane on the sideslopes and smooth geomembrane on the floor of a cell will occur on the floor. This transition will occur a minimum 5 feet from the toe of the sideslope. The quality assurance and quality control requirements for construction of the liner system is specified in Attachment 10 – Soil and Liner Quality Control Plan (SLQCP).

2.2 LEACHATE COLLECTION SYSTEM

The leachate collection system (LCS) has been designed in accordance with 30 TAC §330.333. Consistent with §330.331(a)(2), the LCS has been designed to maintain less than 30 centimeters of leachate head over the bottom liner, as confirmed with the Hydrologic Evaluation of Landfill Performance (HELP) model. A demonstration for leachate generation, including maximum head on the liner, is provided in Attachment 12 – Leachate and Contaminated Water Management

Plan, Appendix 12A. This section provides a summary of the LCS and associated components. Additional description is provided in Attachment 12. Drawings that depict the layout of the leachate collection system components, as well as selected details of the leachate collection system are also provided in Attachment 12.

The primary collection component of the LCS is the leachate drainage layer, which consists of a geonet-geotextile composite (referred to as geocomposite) placed directly over the geomembrane component of the liner system. The geocomposite will serve to collect and convey leachate to the LCS pipes and sumps. The geocomposite will consist of an HDPE geonet with a non-woven geotextile heat bonded to one or both sides of the geonet. The geocomposite will maintain less than 30 centimeters leachate head above the bottom liner system. Calculations demonstrating the required material properties for the geocomposite are presented in the Attachment 12, Appendix 12B.

A 2-foot thick protective soil cover will be placed over the geocomposite prior to waste placement. Chimney drains, comprised of aggregate wrapped in a non-woven geotextile, will be constructed over the leachate collection piping for both leachate drainage and pipe stability. The bottom liner system of each sector will slope to drain at a minimum 2 percent grade toward a perforated leachate collection pipe located in the center of each sector. The leachate collection piping will be sloped at a minimum 1 percent to drain leachate into leachate collection sumps located at the perimeter of the landfill. Additional discussion and calculations regarding pipe stability to prevent collapse, spacing and size for anticipated leachate flows, and perforations to prevent clogging are presented in Attachment 15, Appendix 12B.

Leachate collected in the sumps will be removed via submersible pumps lowered into the sumps through a riser extending up the sector sideslope. Additional description of the sumps, including sump sizing calculations, is also presented in Attachment 12, Appendix 12B.

2.3 FINAL COVER SYSTEM

As shown on Drawing 6C.2, the final cover system will be a soil-geomembrane composite meeting the requirements of §330.457(a). Beginning from the surface and working down, the final cover system will be comprised of the following components:

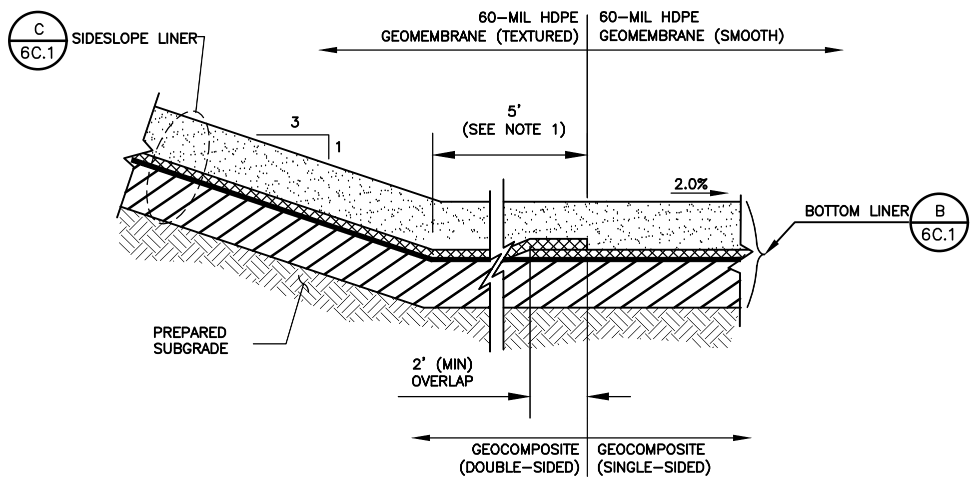
- Vegetation (native and/or introduced grasses);
- 24-inch-thick vegetative erosion layer, with the upper 6 inches capable of sustaining vegetation;
- Double-sided geocomposite (sideslopes only);
- 60-mil HDPE geomembrane, or 40-mil linear low density polyethylene (LLDPE) geomembrane (smooth on the topslope and textured [both sides] on the sideslopes);
- 18-inch-thick clayey soil infiltration layer ($k \leq 1x10^{-5}$ cm/sec); and

- 6-inch-thick daily cover or 12-inch-thick intermediate cover.

Procedures for installation of the final cover system and closure of the landfill are described in Attachment 9 – Final Closure and Post-Closure Care Plan.

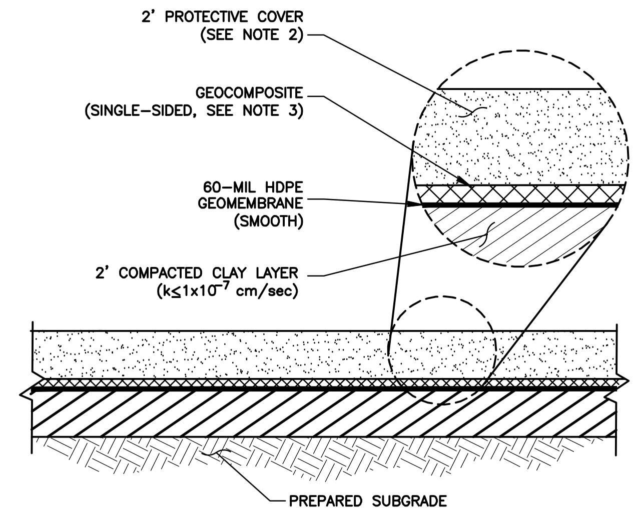
DRAWINGS

- Drawing 6C.1 Bottom Liner Details
- Drawing 6C.2 Final Cover Details



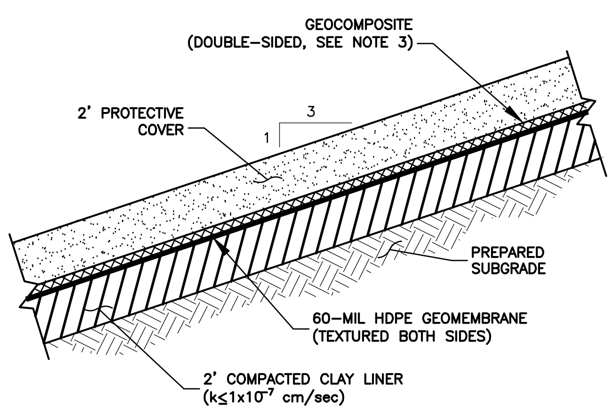
SIDESLOPE/BOTTOM LINER TRANSITION (A / 6C.1)

NTS



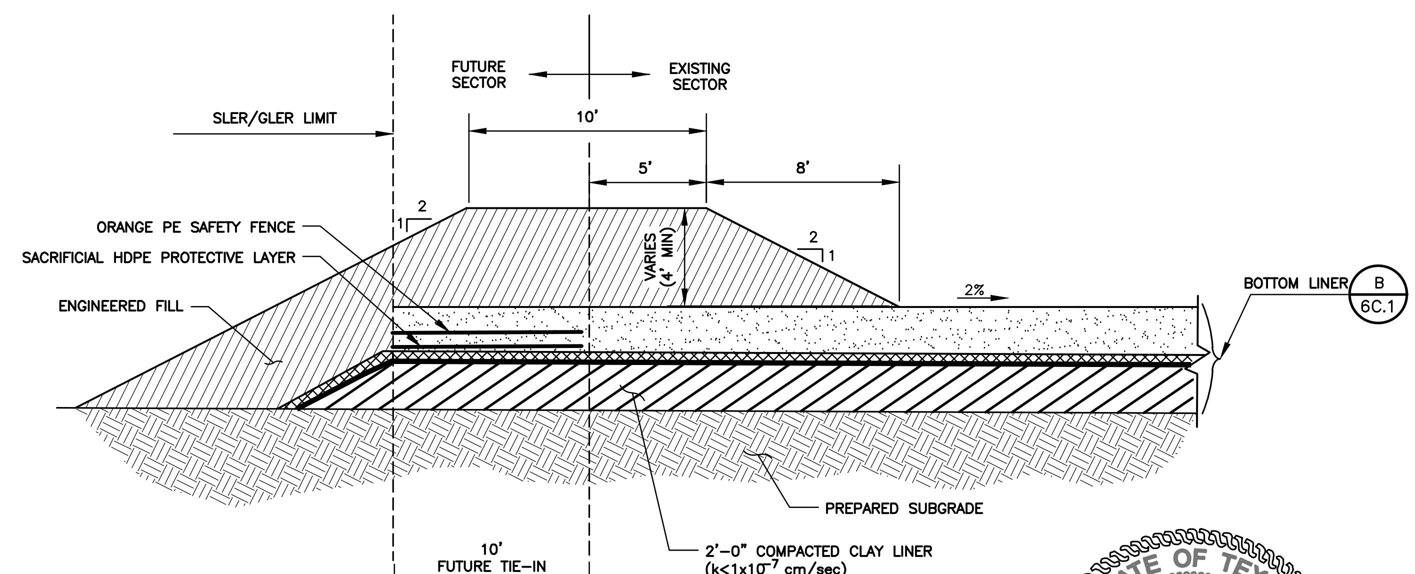
BOTTOM LINER (B / 6C.1)

NTS



SIDESLOPE LINER (C / 6C.1)

NTS



LINER TERMINATION (D / 6C.1)

NTS

NOTES:

1. TEXTURED HDPE TO EXTEND A MINIMUM OF 5' ONTO CELL FLOOR IN ALL AREAS.
2. PROTECTIVE COVER WILL BE PLACED USING LOW PRESSURE GROUND EQUIPMENT AS DESCRIBED IN ATTACHMENT 10-SLQCP, SECTION 7.
3. SEE ATTACHMENT 12-LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN FOR LEACHATE COLLECTION SYSTEM MATERIAL DESCRIPTION.

STATE OF TEXAS
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5/13/2020

FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: BOTTOM LINER DETAILS

PROJECT TITLE: CITY OF WACO LANDFILL TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DWN. BY: NR | Q/A RVW BY: RRK
DSN. BY: BG/RRK | CHK. BY: BJD | APP. BY: RRK

CADD FILE: 6C1 - BOTTOM LINER DETAIL

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6C.1

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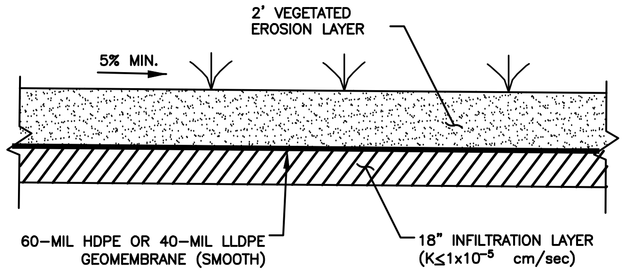
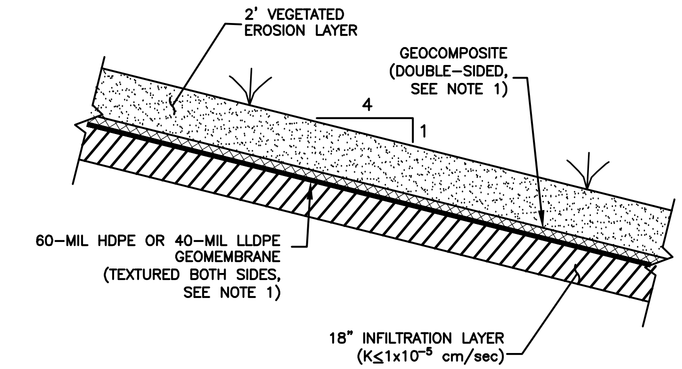


FINAL COVER – TOPSLOPE (A / 6C.2)

NTS

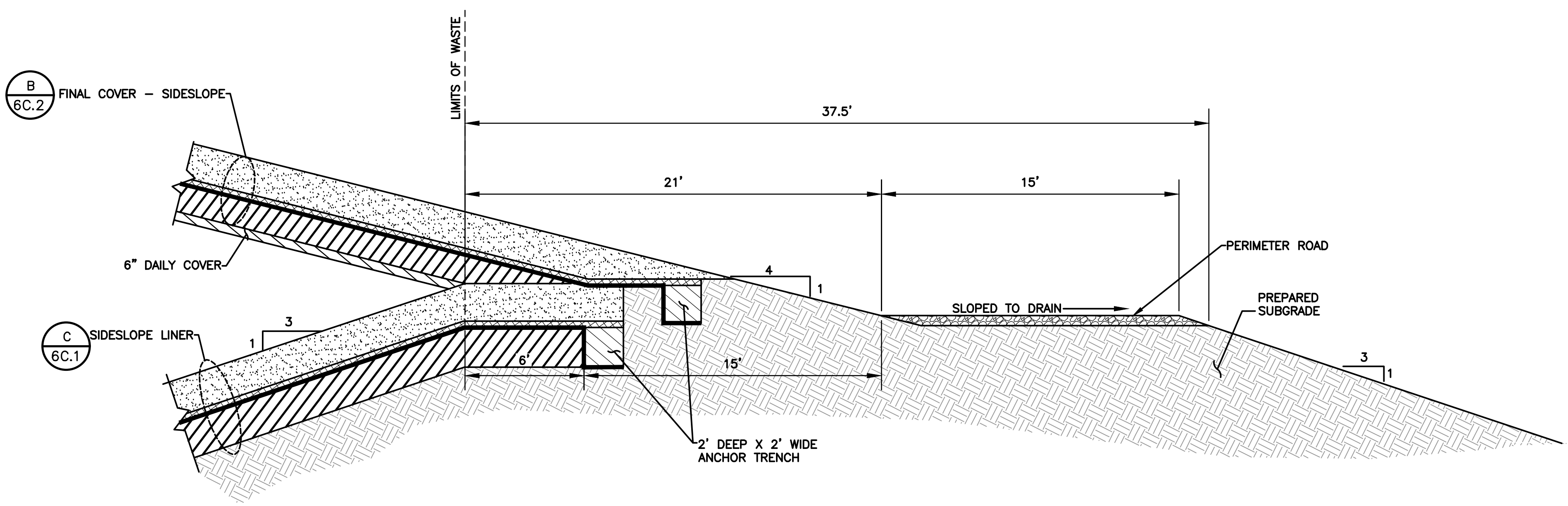


FINAL COVER – SIDESLOPE (B / 6C.2)

NTS

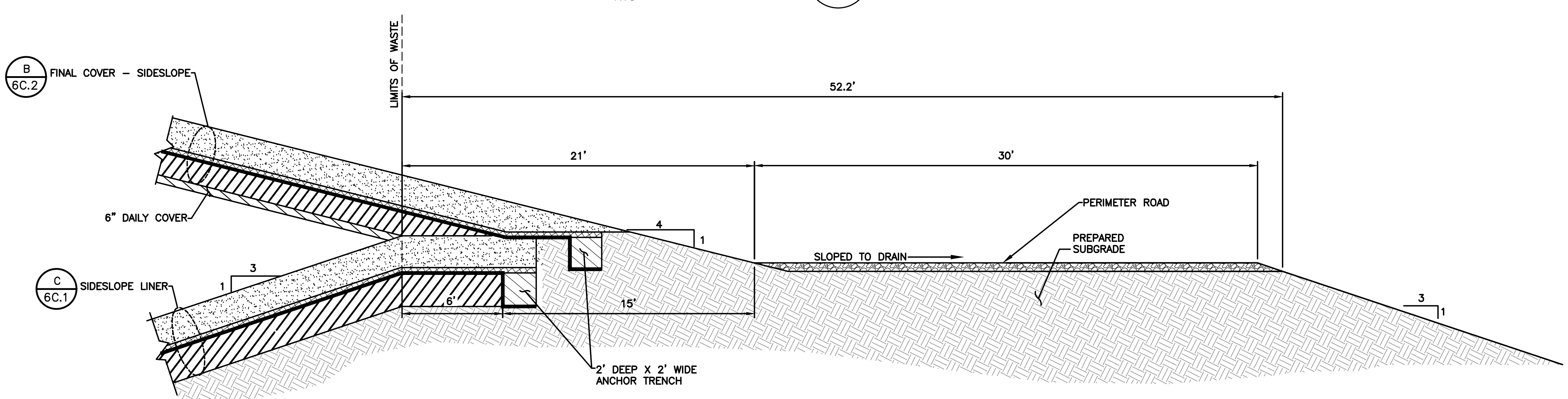
NOTE:

1. TEXTURED GEOMEMBRANE AND DOUBLE-SIDED GEOCOMPOSITE WILL EXTEND A MINIMUM OF 14 FEET ONTO THE LANDFILL TOPSLOPE.



LANDFILL PERIMETER BERM (C / 6C.2)

NTS



LANDFILL PERIMETER BERM (EDA – NORTH) (D / 6C.2)

NTS

STATE OF TEXAS
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5/13/2020

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: FINAL COVER DETAILS

PROJECT TITLE: CITY OF WACO LANDFILL
TYPE I MSW - PERMIT APPLICATION

CLIENT: CITY OF WACO
SOLID WASTE SERVICES

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
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PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16216088.00 | DSN. BY: BG/RRK | DWN. BY: NR | CHK. BY: BJD | Q/A RVW BY: RRK | APP. BY: RRK

CADD FILE: 6C2 - FINAL COVER DETAIL-1

DATE: 04/2020

SCALE: AS SHOWN

DRAWING NO. 6C.2

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