February 12, 2021
SCS Project No. 16216088.00

Mr. Eric Clegg
Municipal Solid Waste Permits Section
Waste Permits Division (MC-126)
Texas Commission on Environmental Quality
12100 Park 35 Circle, Bldg. F
Austin, TX 78753

Re: Proposed City of Waco Landfill - McLennan and Limestone Counties, Texas
Municipal Solid Waste - Permit Application No. 2400
New Permit Application – January 21, 2021 Notice of Deficiency Response
Tracking No. 23201563 [25533209/25817489]; RN110471307/CN600131940

Dear Mr. Clegg:

On behalf of the City of Waco, SCS Engineers (SCS) has prepared the following response to the Texas Commission on Environmental Quality's (TCEQ's) January 21, 2021 New Permit Application, Notice-of-Deficiency (NOD) letter/email, related to a permit application for the proposed City of Waco Landfill, TCEQ Permit No. MSW-2400.

For ease of review, we have attached to this response letter your original comment table from your January 21, 2021 NOD letter/email with the response location and response statements provided in separate columns in the table. Additionally, attached to this response letter, we have included one original and two (2) unmarked copies, and one marked copy of all revised pages for use as replacement pages in the permit application. Where possible, we have identified proposed changes from the existing permit application in a redline/strike-out version (i.e., marked version). Additionally, we have included a revision date (February 2021) and revision number (Revision 2 or 3) on pages that have been revised as part of this NOD response. Furthermore, we have attached a signed Part 1 Form, and posted this response on the publically accessible internet website http://www.waco-texas.com/landfill-application-process.asp.

We trust that our responses will assist you in the completion of your technical review. If you have any questions or need additional information, please do not hesitate to contact Ryan Kuntz, P.E. at (817) 358-6117.

Sincerely,

James Lawrence

Jim Lawrence, P.G.
Project Director
SCS Engineers
TBPE Registration No. F-3407

Ryan Kuntz, P.E.
Vice President/Satellite Office Manager
SCS Engineers

Attachments: as described herein

cc: Mr. Charles Dowdell, City of Waco
Mr. Jeffrey Reed, Lloyd Gosselink Rochelle & Townsend, P.C.

NOTICE-OF-DEFICIENCY RESPONSE TABLE

City of Waco Landfill, Permit Application No. MSW-2400
January 21, 2021 Notice-of-Deficiency Response Table

NOD ID	MRI ID	App. Part	Citation	1st NOD Type	NOD Description	Response Location	Response
T1	163	Part II	330.61(m)(2)	Incomplete	Revise to include the final jurisdictional determination and the results on the Section 404 permit application from the USACE and revise the application as necessary. The NOD response indicates that a final response letter or approval from the USACOE has not been received on the jurisdictional determination or the submitted Section 404 permit application (submitted 6/24/2019).	N/A	Consistent with the prior responses requesting this information, at the time of preparing this NOD response, a final response letter or approval from the USACOE has not been received on the jurisdictional determination or the submitted Section 404 permit application (submitted 6/24/2019), respectively.
T8	380	Part III	330.337(b)(2)	Attachment 10	1. Revise Attachment 10, Section 2.5.1, to clarify whether the typical underdrain design contained in Appendix 10D can be used directly to all cells/areas and, as applicable, revise Section 2.5.1 to specify that the underdrain for a specific area will be designed by a Texas licensed P.E. 2. Revise Attachment 10, Section 2.5.1, to refer to Section 11.5 (Ballast Evaluation Report). 3. To accommodate the above discussed revision (use of underdrain), revise Section 11.5 to reflect the main purpose of a BER, i.e., determining if/when the underdrain operation for a specific area is no longer necessary.	Attachment 10, Section 2.5.1 and Section 11.5	These comments have been addressed as requested.
T12	494	Part III	330.63(e)(4)(G)	Attachment 4, Figure 4.13	Revise the existing grade level line to match top of boring B-36.	Attachment 4, Figures 4.9, Figure 4.13, and Table III-4.5	After further review of survey data and project correspondence, boring B-36 had been moved from its original location shown on the previously submitted Figure 4.9 due to lack of accessibility during drilling, as documented in email correspondence to you sent 12/07/2018, and approved by TCEQ on 12/14/2018. As such, Figure 4.9 has been revised to show the installed location and B-36 and cross-section line D-D' has been reoriented to traverse through B-32. As such, Figure 4.13 has also been revised with the B-32 stratigraphy depicted and Attachment 4, Table III-4.5 has been revised with the correct location (northing/easting) of B-36.
T15	689	Part III	330.457(a)(3)	Attachment 9	Revise Attachment 9, Section 2.3.8.1, to clarify whether the newly specified gradient (0.05) is conservative for both sideslopes and topslopes; or, revise to specify proper gradients. Revise Attachment 12, Section 1.4.3.6 to briefly explain why only topslope was evaluated by HELP model; or, revise to include HELP evaluation of sideslope as well.	Attachment 6C, Section 2.3 and Drawing 6C.2; Attachment 8, Appendices 8A and 8B; Attachment 9, Section 2.3.8.1; and Attachment 12, Appendix 12A, Section 1.4.3.6.	Similar to the analysis performed for the topslope condition, a new HELP model analysis was performed for the sideslope condition. However, for the sideslope geocomposite analysis, the average annual drainage collected from the topslope was input into the sideslope model, such that the conveyance of water flow within the geocomposite is associated with the topslope and sideslope flow combined. (i.e., water collected from the topslope flows into the sideslope geocomposite). The result of this HELP model demonstrates that a geocomposite transmissivity of $3.7x10^{-4}$ m^2/s or higher at a gradient of 0.25 will be suitable on the sideslope up to a maximum sideslope drainage length of 375 feet. As such, the final cover design has been revised to include daylighting the sideslope geocomposite at drainage swales (new detail) located a maximum distance of 375 feet from the crest of the sideslope and at each subsequent drainage swale or landfill perimeter toe-of-slope. Additionally, the detail depicting the toe of slope of the landfill has been revised to include rock armoring where the geocomposite daylights at the landfill perimeter.

NOD ID	MRI ID	App. Part	Citation	1st NOD Type	NOD Description	Response Location	Response
							Part III Narrative, Section 3.8.1 and Attachment 6C, Section 2.3 has been revised to include a discussion of daylighting the geocomposite in drainage swales and at the landfill perimeter toe-of-slope. The proposed daylighting of the geocomposite at drainage swales is depicted on newly added Detail E on Drawing 6C.2 (referred to as Sideslope Swale - Geocomposite Termination). The proposed rock armor at the toe-of-slope of the landfill is depicted on revised Details C and D on Drawing 6C.2. Attachment 8, Appendices 8A and 8B were revised to include the additional closure cost associated with daylighting the final cover sideslope geocomposite at drainage swales and landfill toe-of-slope. Attachment 9, Section 2.3.8.1 has been revised to state that transmissivity requirements apply to gradients of 0.05 and 0.25 for topslope and sideslopes, respectively. Additionally, Attachment 9, Section 2.3.8.2 has been revised to include the specifications for the drainage aggregate for daylighting the sideslope geocomposite. Section 1.4.3.6 of Attachment 12, Appendix 12 A has been revised to include a discussion of the HELP model analysis performed for the sideslope geocomposite.

TCEQ PART 1 FORM FOR NEW PERMIT FOR A MSW FACILITY (TCEQ-0650)

Facility Name: City of Waco Landfill
Permittee/Registrant Name: City of Waco
MSW Authorization #:2400
Initial Submittal Date: 8/7/2018
Revision Date: 2/11/2021

Texas Commission on Environmental Quality

Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility

1. Reason for Submittal

☐ Initial Submittal ☒ Notice of Deficiency (NOD) Response

2. Authorization Type

☒ Permit ☐ Registration

3. Application Type

☒ New ☐ Major Amendment

☐ Major Amendment (Limited Scope)

4. Application Fees

☐ Pay by Check ☒ Online Payment

If paid online, e-Pay Confirmation Number: **582EA000311862**

5. Application URL

Is the application submitted for Type I Arid Exempt (AE) and/or Type IV AE facility?

☐ Yes ☒ No

If the answer is "No", provide the URL address of a publicly accessible internet web site where the application and all revisions to that application will be posted.
http://**http://www.waco-texas.com/landfill-application-process.asp**

6. Application Publishing

Party Responsible for Publishing Notice:

☐ Applicant ☐ Agent in Service ☒ Consultant

Contact Name: **Ryan R. Kuntz, P.E.** Title: **Vice President /Project Director**

7. Alternative Language Notice

Is an alternative language notice required for this application? (For determination refer to Alternative Language Checklist on the Public Notice Verification Form TCEQ-20244-Waste)

☐ Yes ☒ No

8. Public Place Location of Application

Name of the Public Place: **Waco-McLennan County Central Library**

Physical Address: **1717 Austin Avenue**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76701**

(Area code) Telephone Number: **254.750.5941**

9. Consolidated Permit Processing

Is this submittal part of a consolidated permit processing request, in accordance with 30 TAC Chapter 33?

☐ Yes ☒ No ☐ Not Applicable

If "Yes", state the other TCEQ program authorizations requested:

10. Confidential Documents

Does the application contain confidential documents?

☐ Yes ☒ No

If "Yes", cross-reference the confidential documents throughout the application and submit as a separate attachment in a binder clearly marked "CONFIDENTIAL."

11. Permits and Construction Approvals

Permit or Approval	Received	Pending	Not Applicable
Hazardous Waste Management Program under the Texas Solid Waste Disposal Act	☐	☐	☒
Underground Injection Control Program under the Texas Injection Well Act	☐	☐	☒
National Pollutant Discharge Elimination System Program under the Clean Water Act and Waste Discharge Program under Texas Water Code, Chapter 26	☐	☒	☐
Prevention of Significant Deterioration Program under the Federal Clean Air Act (FCAA). Nonattainment Program under the FCAA	☐	☐	☒
National Emission Standards for Hazardous Air Pollutants Preconstruction Approval under the FCAA	☐	☐	☒
Ocean Dumping Permits under the Marine Protection Research and Sanctuaries Act	☐	☐	☒

Permit or Approval	Received	Pending	Not Applicable
Dredge or Fill Permits under the CWA	☐	☐	☒
Licenses under the Texas Radiation Control Act	☐	☐	☒
Other (describe)	☐	☐	☐
Other (describe)	☐	☐	☐
Other (describe)	☐	☐	☐
Other (describe)	☐	☐	☐

12. General Facility Information

Facility Name: **City of Waco Landfill**

Contact Name: **Charles Dowdell** Title: **Director of Solid Waste**

MSW Authorization No. (if available): **2400**

Regulated Entity Reference No. (if issued)*: RN**110471307**

Physical or Street Address (if available): **4730 T K Parkway**

City: **Axtell** County: **McLennan & Limestone** State: **TX** Zip Code: **76624**

(Area Code) Telephone Number: **(254) 750-1601**

Latitude (Degrees, Minutes Seconds): **N 31° 42' 05.31"**

Longitude (Degrees, Minutes Seconds): **W 96° 55' 52.07"**

Benchmark Elevation (above mean sea level): ft.

Provide a description of the location of the facility with respect to known or easily identifiable landmarks: **approximately 0.4 mile south of the intersection of TK Parkway and State Highway 31 in McLennan County**

Detail access routes from the nearest United States or state highway to the facility: **approximately 0.4 mile south of the intersection of TK Parkway and State Highway 31 in McLennan County**

*If this number has not been issued for the facility, complete a TCEQ Core Data Form (TCEQ-10400) and submit it with this application. List the Facility as the Regulated Entity.

13. Facility Type(s)

☒ Type I ☐ Type IV ☐ Type V
☐ Type I AE ☐ Type IV AE ☐ Type VI

14. Activities Conducted at the Facility

☐ Storage ☐ Processing ☒ Disposal

15. Facility Waste Management Unit(s)

☒ Landfill Unit(s)	☐ Incinerator(s)
☐ Class 1 Landfill Unit(s)	☐ Autoclave(s)
☐ Process Tank(s)	☐ Refrigeration Unit(s)
☐ Storage Tank(s)	☐ Mobile Processing Unit(s)
☐ Tipping Floor	☐ Type VI Demonstration Unit
☐ Storage Area	☐ Compost Pile(s) and/or Vessel(s)
☐ Container(s)	☐ Other (Specify)
☐ Roll-off Boxes	☐ Other (Specify)
☐ Surface Impoundment	☐ Other (Specify)

16. Description of Proposed Facility or Changes to Existing Facility

Provide a brief description of the proposed activities if application is for a new facility, or the proposed changes to an existing facility or permit conditions if the application is for an amendment.

Proposed Type I Municipal Solid Waste Landfill located on 502.5 acres of land in McLennan and Limestone Counties, designed in accordance with Title 30, Texas Administrative Code, Chapter 330. The primary purpose of this landfill is to serve as a replacement for the current City of Waco landfill (MSW Permit No. 948A). The landfill will provide disposal capacity for residences, businesses, and industries primarily in the communities of McLennan and Limestone Counties and other nearby counties. Includes submittal of Parts III and IV of the permit application, and responses to technical notice of deficiency letters dated 11/19/18, 2/14/19, 8/19/2020, 11/9/2020, and 1/21/2021.

17. Facility Contact Information

Site Operator (Permittee/Registrant) Name: City of Waco

Customer Reference No. (if issued)*: CN**600131940**

Contact Name: **Charles Dowdell** Title: **Director of Solid Waste**

Mailing Address: **501 Schroeder Drive**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76710**

(Area Code) Telephone Number: **(254) 750-1601**

Email Address: **charlesd@wacotx.gov**

TX Secretary of State (SOS) Filing Number:

*If the Site Operator (Permittee/Registrant) does not have this number, complete a TCEQ Core Data Form (TCEQ-10400) and submit it with this application. List the Site Operator (Permittee/Registrant) as the Customer.

Operator Name[1]: same as Permittee

Customer Reference No. (if issued)*:

Contact Name: Title:

Mailing Address:

City: County: State: Zip Code:

(Area Code) Telephone Number:

Email Address:

TX SOS Filing Number:

[1]If the Operator is the same as Site Operator/Permittee type "Same as "Site Operator (Permittee/Registrant)".
*If the Operator does not have this number, complete a TCEQ Core Data Form (TCEQ-10400) and submit it with this application. List the Operator as the customer.

Consultant Name (if applicable): SCS Engineers, TBPE Registration No. F-3407

Texas Board of Professional Engineers Firm Registration Number:

Contact Name: **Ryan R. Kuntz, P.E.** Title: **Vice Pres., Pr. Director**

Mailing Address: **1901 Central Drive, Suite 550**

City: **Bedford** County: **Tarrant** State: **TX** Zip Code: **76021**

(Area Code) Telephone Number: **817.358.6117**

E-Mail Address: **rkuntz@scsengineers.com**

Agent in Service Name (required only for out-of-state):

Mailing Address:

City: County: State: Zip Code:

(Area Code) Telephone Number:

E-Mail Address:

18. Facility Supervisor's License

Select the Type of License that the Solid Waste Facility Supervisor, as defined in 30 TAC Chapter 30, Occupational Licenses and Registrations, will obtain prior to commencing facility operations.

☒ Class A ☐ Class B

19. Ownership Status of the Facility

☐ Corporation	☐ Limited Partnership	☐ Federal Government
☐ Individual	☒ City Government	☐ Other Government
☐ Sole Proprietorship	☐ County Government	☐ Military
☐ General Partnership	☐ State Government	☐ Other (Specify):

Does the Site Operator (Permittee/Registrant) own all the facility units and all the facility property?

☒ Yes ☐ No

If "No", provide the information requested below for any additional ownership.

Owner Name:

Street or P.O. Box:

City: County: State: Zip Code:

(Area Code) Telephone Number:

Email Address (optional):

20. Other Governmental Entities Information

Texas Department of Transportation District: Waco

District Engineer's Name: **Stanley Swiatek, P.E.**

Street Address or P.O. Box: **100 S. Loop Drive**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76704-2858**

(Area Code) Telephone Number: **(254) 867-2700**

E-Mail Address (optional):

The Local Governmental Authority Responsible for Road Maintenance (if applicable): N.A.

Contact Person's Name:

Street Address or P.O. Box:

City: County: State: Zip Code:

(Area Code) Telephone Number:

E-Mail Address (optional):

City Mayor Information

City Mayor's Name: **Kyle Deaver**

Office Address: **300 Austin Ave**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76702**

(Area Code) Telephone Number: **(254) 750-5750**

E-Mail Address (optional): **kyle.deaver@wcotx.gov**

City Health Authority: Waco-McLennan County Public Health District

Contact Person's Name: **Dr. Brenda Gray, Director**

Street Address or P.O. Box: **225 W. Waco Drive**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76707**

(Area Code) Telephone Number: **(254) 750-5450**

E-Mail Address (optional):

County Judge Information

County Judge's Name: **Scott M. Felton**

Street Address or P.O. Box: **501 Washington Ave, Room 214**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76701**

(Area Code) Telephone Number: **(254) 757-5049**

E-Mail Address (optional):

County Health Authority: Waco-McLennan County Public Health District

Contact Person's Name: **E. Farley Verner, M.D.**

Street Address or P.O. Box: **7030 New Sanger Road, Suite 202**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76712**

(Area Code) Telephone Number: **(254) 855-9790**

E-Mail Address (optional): **farleyverner@gmail.com**

State Representative Information

District Number: **12**

State Representative's Name: **Kyle Kacal**

District Office Address: **3000 Briarcrest Dr., Ste 203**

City: **Bryan** County: **Brazos** State: **TX** Zip Code: **77802**

(Area Code) Telephone Number: **979-774-7276**

E-Mail Address (optional):

State Senator Information

District Number: **22**

State Senator's Name: **The Honorable Brian Birdwell**

District Office Address: **900 Austin Ave, Suite 500**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76701**

(Area Code) Telephone Number: **(254) 772-6225**

E-Mail Address (optional):

Council of Government (COG) Name: Heart of Texas

COG Representative's Name: **Falen Bohannon**

COG Representative's Title: **Solid Waste Program Manager**

Street Address or P.O. Box: **1514 S. New Road**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76711**

(Area Code) Telephone Number: **(254)292-1800**

E-Mail Address (optional): **Falen.Bohannon@hot.cog.tx.us**

County Judge Information

County Judge's Name: **Limestone County Judge: Honorable Richard Duncan**

Street Address or P.O. Box: **200 W. State ST., Ste 101**

City: **Groesbeck** County: **Limestone** State: **TX** Zip Code: **76642**

(Area Code) Telephone Number: **254-729-3810**

E-Mail Address (optional):

County Health Authority: Limestone Medical Center

Contact Person's Name: **Dr. Jeffrey Rettig**

Street Address or P.O. Box: **204 W. Trinity Street**

City: **Groesbeck** County: **Limestone** State: **TX** Zip Code: **76642**

(Area Code) Telephone Number: **254-729-3740**

E-Mail Address (optional):

State Representative Information

District Number: **12**

State Representative's Name: **Kyle Kacal**

District Office Address: **3000 Briarcrest Dr., Ste 203**

City: **Bryan** County: **Brazos** State: **TX** Zip Code: **77802**

(Area Code) Telephone Number: **979-774-7276**

E-Mail Address (optional):

State Senator Information

District Number: **5**

State Senator's Name: **Charles Schwertner**

District Office Address: **3000 Briarcrest Drive, Suite 202**

City: **Bryan** County: **Brazos** State: **TX** Zip Code: **77802**

(Area Code) Telephone Number: **979-776-0222**

E-Mail Address (optional):

Council of Government (COG) Name: Heart of Texas

COG Representative's Name: **Falen Bohannon**

COG Representative's Title: **Solid Waste Program Manager**

Street Address or P.O. Box: **1514 S. New Road**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76711**

(Area Code) Telephone Number: **(254)292-1800**

E-Mail Address (optional): **Falen.Bohannon@hot.cog.tx.us**

River Basin Authority Name: Brazos River Authority

Contact Person's Name: **Phil Ford**

Watershed Sub-Basin Name:

Street Address or P.O. Box: **4600 Cobbs Drive**

City: **Waco** County: **McLennan** State: **TX** Zip Code: **76710**

(Area Code) Telephone Number: **(888) 922-6272**

E-Mail Address (optional):

Coastal Management Program

Is the facility within the Coastal Management Program boundary?

☐ Yes ☒ No

U.S. Army Corps of Engineers

The facility is located in the following District of the U.S. Army Corps of Engineers:

☐ Albuquerque, NM ☐ Galveston, TX

☒ Ft. Worth, TX ☐ Tulsa, OK

Local Government Jurisdiction

Within City Limits of:

Within Extraterritorial Jurisdiction of:

Is the facility located in an area in which the governing body of the municipality or county has prohibited the storage, processing or disposal of municipal or industrial solid waste?

☐ Yes ☒ No

(If "Yes", provide a copy of the ordinance or order as an attachment):

Signature Page

I, Bradley Ford, City Manager,
(Site Operator (Permittee/Registrant)'s Authorized Signatory) (Title)

certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: _____ Date: 02/12/21

TO BE COMPLETED BY THE OPERATOR IF THE APPLICATION IS SIGNED BY AN AUTHORIZED REPRESENTATIVE FOR THE OPERATOR

I, _____, hereby designate _____
(Print or Type Operator Name) (Print or Type Representative Name)

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

_____
Printed or Typed Name of Operator or Principal Executive Officer

_____
Signature

SUBSCRIBED AND SWORN to before me by the said Bradley Ford
On this 12th day of February 2021
My commission expires on the 31st day of March, 2022

Nita H Mays
Notary Public in and for
McLennan County, Texas
(Note: Application Must Bear Signature & Seal of Notary Public)

NITA H MAYS
Notary Public, State of Texas
Comm. Expires 03-31-2022
Notary ID 1117522-0

Part I Attachments

(See Instructions for P.E. seal requirements.)

Required Attachments	**Attachment No.**
Supplementary Technical Report	**X**
Property Legal Description	**X**
Property Metes and Bounds Description	**X**
Facility Legal Description	**X**
Facility Metes and Bounds Description	**X**
Metes and Bounds Drawings	**X**
On-Site Easements Drawing	**X**
Land Ownership Map	**X**
Land Ownership List	**X**
Electronic List or Mailing Labels	**X**
Texas Department of Transportation (TxDOT) County Map	**X**
General Location Map	**X**
General Topographic Map	**X**
Verification of Legal Status	**X**
Property Owner Affidavit	**X**
Evidence of Competency	**X**
Additional Attachments as Applicable- Select all those apply and add as necessary	
☒ TCEQ Core Data Form(s)	**X**
☒ Signatory Authority Delegation	**X**
☒ Fee Payment Receipt	**X**
☐ Confidential Documents	
☐ Waste Storage, Processing and Disposal Ordinances	
☐ Final Plat Record of Property	
☐ Certificate of Fact (Certificate of Incorporation)	
☐ Assumed Name Certificate	

MARKED VERSION

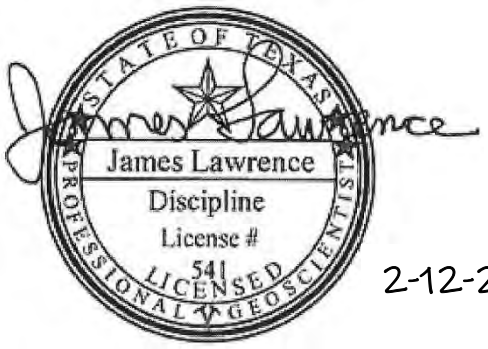
CITY OF WACO LANDFILL
TCEQ PERMIT NO. MSW-2400
McLENNAN AND LIMESTONE COUNTIES, TEXAS

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 4
GEOLOGY AND GROUNDWATER REPORT

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, TX 76710



2-12-2021

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – May 2020
Revision 1 – October 2020
Revision 2 – December 2020
Revision 3 – February 2021
SCS Project No. 16216088.00

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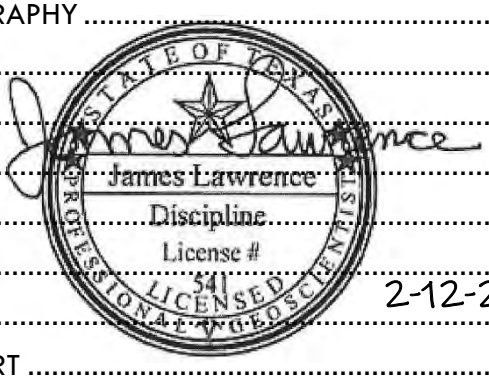
11	SUMMARY	4-11-1
12	REFERENCES	4-12-1



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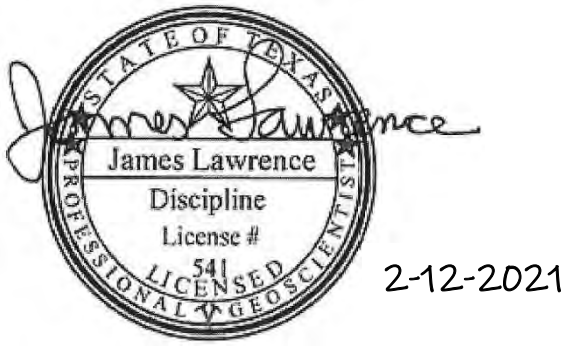

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Appendix III-4.E	State Well Reports
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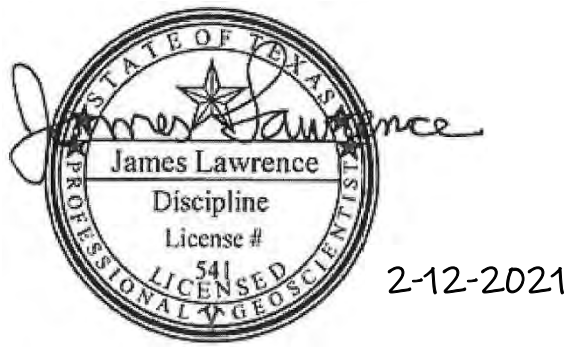

2-12-2021

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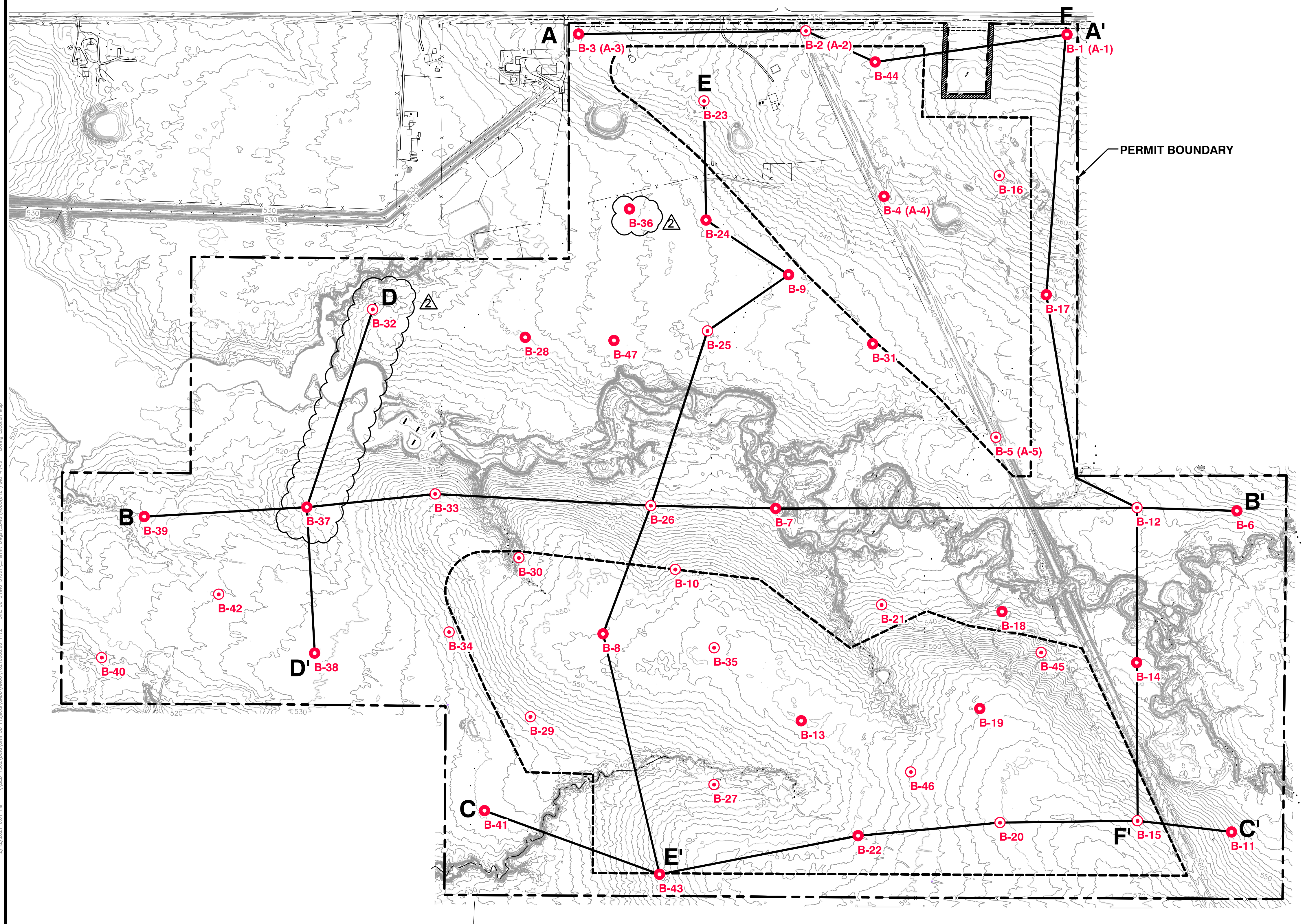


0 300 600

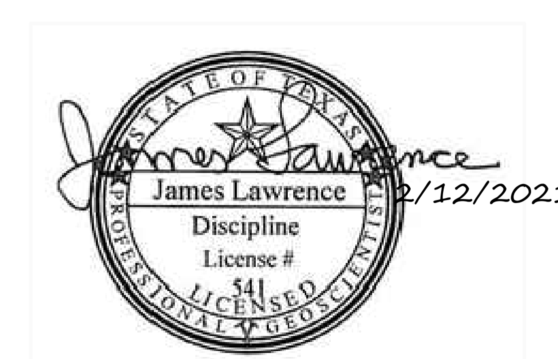
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 535 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- B-9 EXISTING BORING LOCATION – I (SEE NOTE 2)
- B-14 EXISTING BORING LOCATION – II (SEE NOTE 2)
- A—A' CROSS–SECTION LOCATIONS

NOTES:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPATIAL FLOWN ON JULY 03, 2018.
2. EXISTING BORING LOCATIONS – I INDICATE SOIL BORINGS WHICH WERE DRILLED TO A DEPTH OF 5–FEET BELOW EDE (I.E., 500 FT MSL) AND EXISTING BORING LOCATIONS – II INDICATE SOIL BORINGS WHICH WERE DRILLED TO A DEPTH OF 30 FEET BELOW EDE (I.E., 475 FT MSL).



FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	10/2020	UPDATE LIMITS OF WASTE, ADD NOTE 3 AND ADD ADDITIONAL INFORMATION TO CROSS SECTION E–E' AND F–F'	JL
2	1/2021	UPDATE TO B–36 LOCATION AND CROSS SECTION D–D'	JL

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

DRAWING TITLE
BORING LOCATION 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

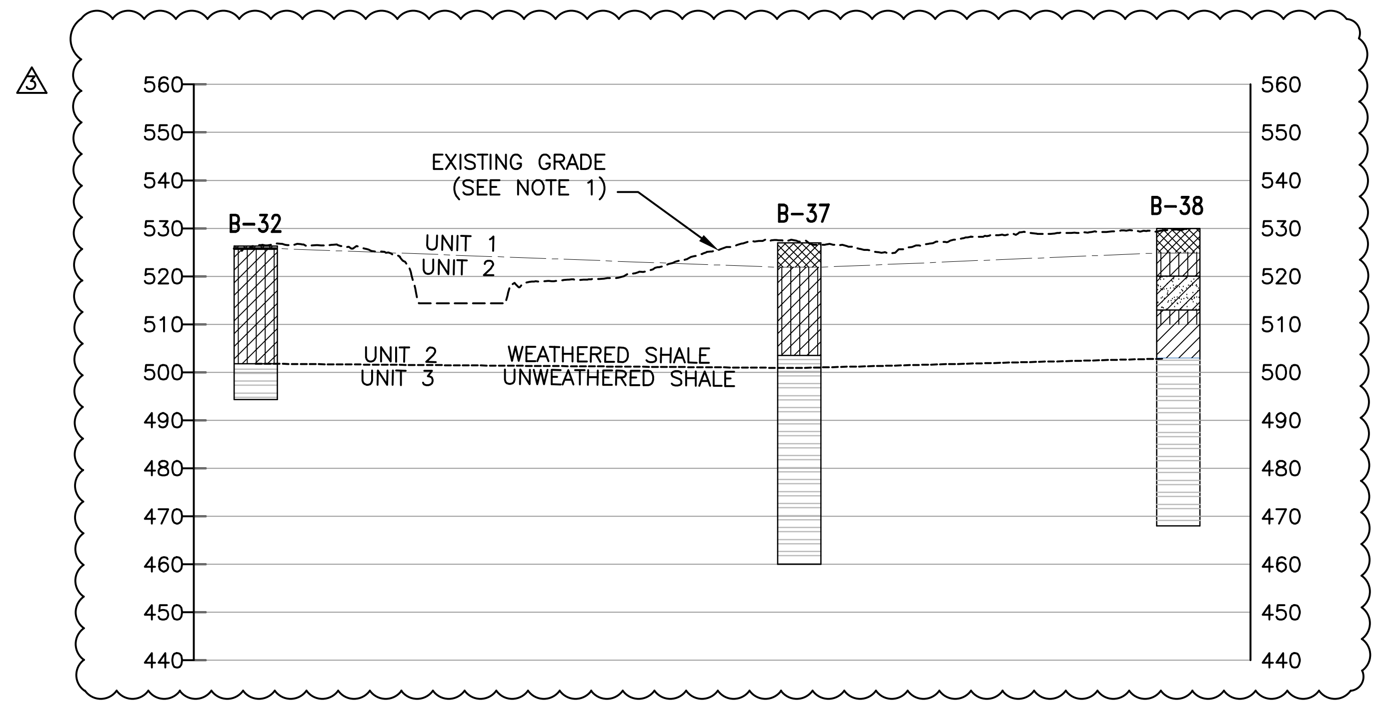
PROJ. NO. 16216088.00	DWN. BY: JLJ/NR	Q/A RVW BY: RRK
DSN. BY: AB/JL	CHK. BY: BJD/AB	APP. BY: JL

CADD FILE: 4.9 – BORING LOCATION MAP

DATE: 05/2020

SCALE: AS SHOWN

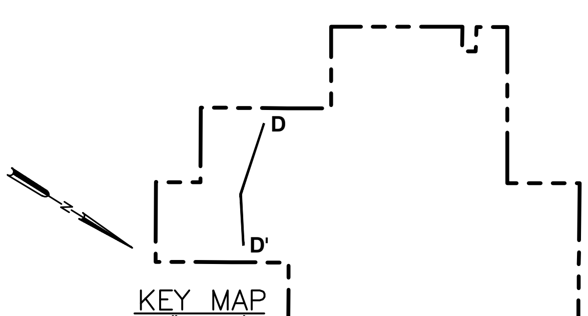
FIGURE: 4.9



CROSS SECTION D-D'

0 20 40
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET



KEY MAP
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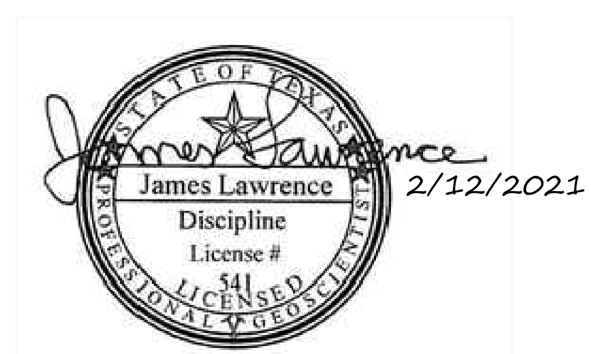

LEGEND:

— — — — — — —	EXISTING GRADE (SEE NOTE 1)
——-——-——	UNIT 1/UNIT 2 CONTACT
-------------	WEATHERED/UNWEATHERED SHALE TRANSITIONAL CONTACT

NOTES:

1. EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPATIAL, FLOWN ON JULY 03, 2018.
2. SEE APPENDIX III–4.D FOR SUBSURFACE MATERIAL LEGEND.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	10/2020	REVISIONS INCLUDE: FIX GRADE LEVEL AT B–36; ADD UNIT1/UNIT 2 CONTACT	JL
2	12/2020	REVISIONS INCLUDE: CORRECT DEPTH AT B–36	JL
3	1/2021	REVISIONS INCLUDE: REMOVED B–36 AND ADD B–32	JL

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

DRAWING TITLE
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 | DWN. BY: JLJ/NR | Q/A RVW BY: RRK
DSN. BY: AB/JL | CHK. BY: BJD/AB | APP. BY: JL

CADD FILE: 4.10–4.15 – GEOLOGIC CROSS SECTIONS

DATE: 05/2020

SCALE: AS SHOWN

FIGURE: **4.13**

2/12/2021 6:03 PM \\BED-FS02\Data\Civil 3D Projects\CADD\WACO\16216088.00 T172 – SITE 50 SITING STUDY_Permit Dwgs_DWG\NOD3(0121)\Att 4\4.10–4.15 – Geologic Cross Sections

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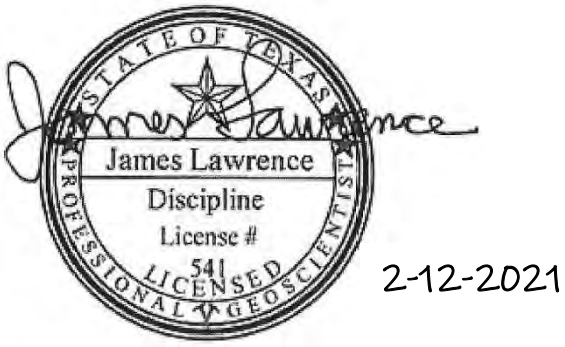
Table III-4.5 Coordinates and Elevations of Borings Advanced at the Site by SCS Engineers

Boring Number	Easting	Northing	Hollow Stem Auger Type	Ground Elevation (ft-msl)	Depth Drilled (ft-bgs)	Elevation of Bottom (ft-msl)
B-1	3353867.3	10599904.81	7 ¼	551.67	82.0	469.7
B-1 (PZ-1)	3353867.3	10599904.81	7 ¼	551.74	39.5	512.24
B-2	3354595.81	10598697.6	7 ¼	549.78	55.0	494.78
B-3	3355259.69	10597665.32	7 ¼	541.1	72.0	469.1
B-3 (PZ-3)	3355259.69	10597665.32	7 ¼	541.20	45.0	496.2
B-4	3355130.33	10599528	7 ¼	550.04	101.0	449.04
B-5	3355913.87	10600728.3	7 ¼	541.38	47.0	494.38
B-6	3355562.96	10602041.9	7 ¼	545.55	70.7	474.85
B-7	3356670.83	10599929.6	8 ¼	530.50	55.5	475
B-8 (PZ-8)	3357935.82	10599489.18	8 ¼	550.34	75.0	475.34
B-9 (PZ-9)	3355762.31	10599314.37	8 ¼	535.30	40.0	495.30
B-9 cont.	3355762.31	10599314.37	8 ¼	535.30	135.0	400.30
B-10	3356199.16	10602404.1	8 ¼	545.40	53.0	492.4
B-11	3357048	10602933.5	7 ¼	553.50	78.5	475
B-12	3355833.07	10601575	8 ¼	542.85	48.0	494.85
B-13	3357768.09	10600645.6	8 ¼	555.15	80.0	475.15
B-14	3356543.77	10602016.3	8 ¼	539.20	65.5	473.7
B-15	3357265.27	10602471.1	7 ¼	563.35	70.0	493.35
B-16	3354706.01	10599996.8	8 ¼	560.25	61.0	499.25
B-17	3355568.96	10600519.6	7 ¼	546.75	71.0	475.75
B-18 (PZ-18)	3356694.76	10601254.04	8 ¼	534.84	56.0	478.84
B-19	3357202	10601429	7 ¼	562.05	87.0	475.05
B-20 (PZ-20)	3357666.42	10601846.53	7 ¼	564.68	73.0	491.68
B-21	3357008	10600682	8 ¼	538.75	45.0	493.75
B-22	3358132.03	10601234	8 ¼	555.00	80.0	475
B-23	3355207.68	10598431	8 ¼	540.08	45.7	494.38
B-24	3355746.69	10598780.1	7 ¼	533.63	59.2	474.43
B-25	3356251.06	10599102.9	7 ¼	533.25	33.0	500.25
B-26	3356929.04	10599457.3	8 ¼	530.45	36.0	494.5
B-27	3358308.89	10600427.7	8 ¼	546.65	53.0	493.65
B-28	3356800.71	10598286.7	8 ¼	529.6	55.0	474.6
B-29	3358523.03	10599393	8 ¼	540.25	45.0	495.25
B-30	3357828.13	10598886.4	8 ¼	543.05	48.0	495.05
B-31	3355837.8	10599897	8 ¼	537.55	63.0	474.55
B-32	3357077.27	10597864.5	8 ¼	526.3	32.0	494.3
B-33 (PZ-33)	3357774.62	10598320.64	8 ¼	539.20	55.0	484.2
B-34	3358367.31	10598778.6	8 ¼	535.65	41.0	494.65
B-35	3357682.18	10600037.4	8 ¼	553.3	59.0	494.3
B-36	3355915.263~~35~~ ~~7239.12~~	10598397.80~~10~~ ~~596730.2~~	8 ¼	532.5	58.0	474.5
B-37	3358201.19	10597770.6	8 ¼	526.9	52.0	474.9
B-38	3358847.64	10598223.2	8 ¼	529.85	55.0	474.85
B-39	3358709.87	10597052.3	8 ¼	522.95	48.0	475
B-40	3359476.22	10597259.9	8 ¼	522.80	28.0	494.8
B-41 (PZ-41)	3359083.91	10599450.64	8 ¼	534.62	60.0	474.62
B-42	3358523.73	10597484.3	8 ¼	527.00	32.0	495.0
B-43 (PZ-43)	3358875.54	10600433.69	8 ¼	548.86	75.0	473.86

Boring Number	Easting	Northing	Hollow Stem Auger Type	Ground Elevation (ft-msl)	Depth Drilled (ft-bgs)	Elevation of Bottom (ft-msl)
B-43 cont.	3358875.54	10600433.69	8 ¼	548.86	150	398.86
B-44	3354540.62	10599103.1	7 ¼	551.20	76.0	475.20
B-45	3356769.83	10601549.1	8 ¼	545.50	51.0	494.5
B-46	3357689.45	10601293.2	8 ¼	559.25	65.4	493.85
B-47 (PZ-47)	3356561.53	10598701.96	8 ¼	532.48	57.4	475.08

msl = mean sea level
b.g.s indicates depth is measured from below ground surface



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

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – April 2020
Revision 1 – October 2020
Revision 2 – February 2021
SCS Project No. 16216088.00

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2.2 LEACHATE COLLECTION SYSTEM....6C-2-1
2.3 FINAL COVER SYSTEM....6C-2-2

Drawings

6C.1 Bottom Liner Details
6C.2 Final Cover Details

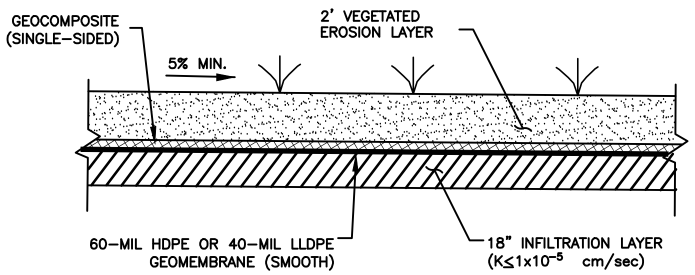
SCS Engineers
TBPE Reg. # F-3407

- 6-inch-thick daily cover or 12-inch-thick intermediate cover.

Note, the sideslope geocomposite should be day-lighted a maximum distance of 375 feet from the crest of the sideslope and at each subsequent downslope drainage swale or at the landfill perimeter toe of slope, as shown on details provided on Drawing 6C.2. In cases where a drainage length of 375 feet occurs between drainage swales, the geocomposite should be day-lighted at the drainage swale immediately upslope of this location. Additionally, where the geocomposite is day-lighted, the final cover, including landfill toe of slope, will be protected with rock armor to prevent erosion resulting from stormwater seepage from the geocomposite drainage layer. 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.

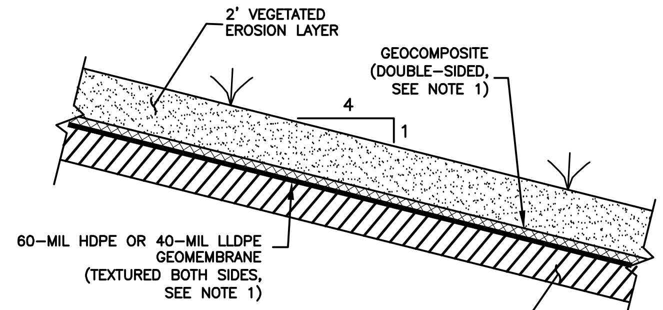
DRAWINGS

- Drawing 6C.1 Bottom Liner Details
- Drawing 6C.2 Final Cover Details



FINAL COVER – TOPSLOPE (A / 6C.2)

NTS

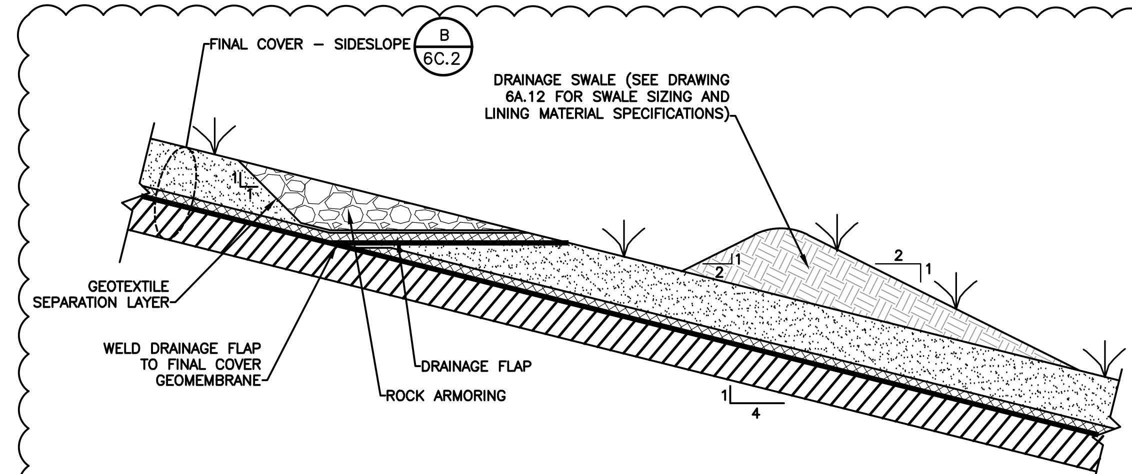


FINAL COVER – SIDESLOPE (B / 6C.2)

NTS

NOTE:

1. TEXTURED GEOMEMBRANE AND DOUBLE–SIDED GEOCOMPOSITE WILL EXTEND A MINIMUM OF 5 FEET ONTO THE LANDFILL TOPSLOPE.

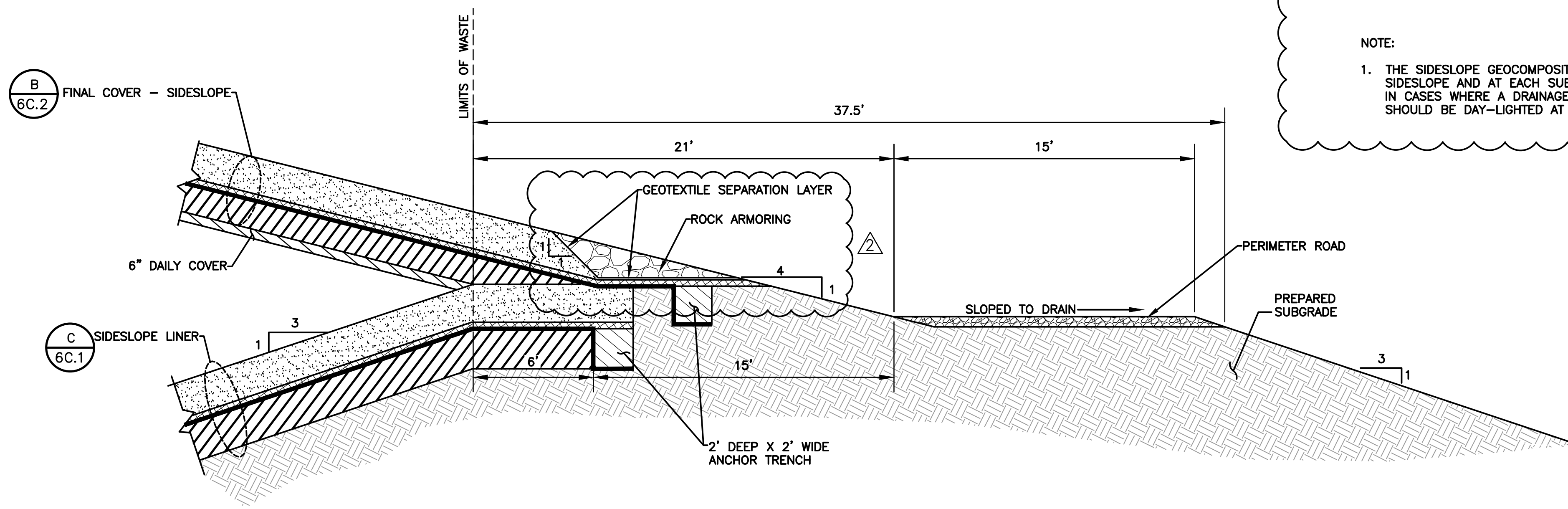


SIDESLOPE SWALE – GEOCOMPOSITE TERMINATION (E / 6C.2)

NTS

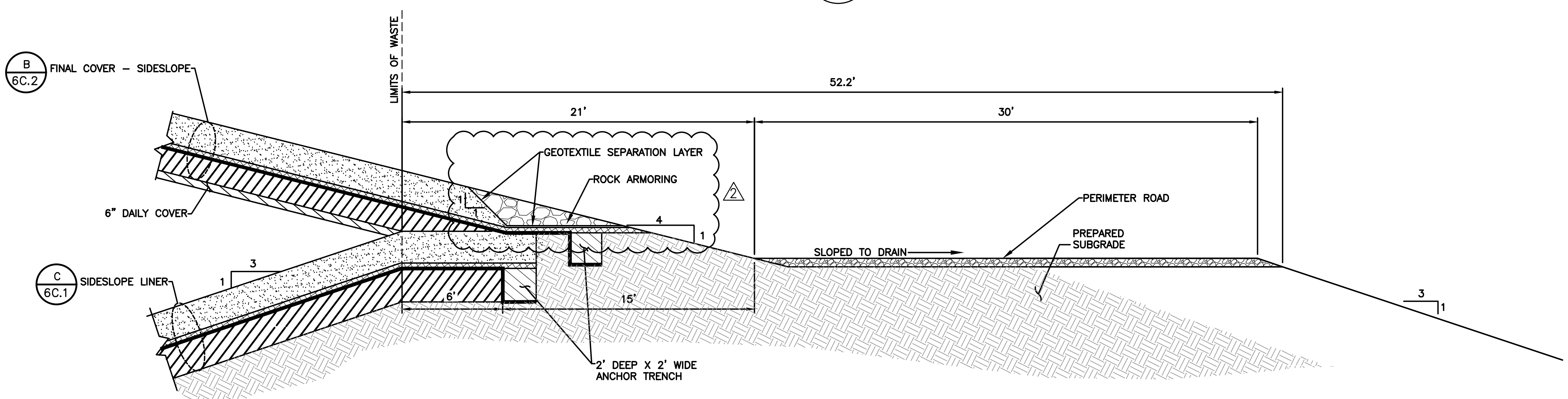
NOTE:

1. THE SIDESLOPE GEOCOMPOSITE SHOULD BE DAY–LIGHTED A MAXIMUM DISTANCE OF 375 FEET FROM THE CREST OF THE SIDESLOPE AND AT EACH SUBSEQUENT DOWNSLOPE DRAINAGE SWALE OR AT THE LANDFILL PERIMETER TOE OF SLOPE. IN CASES WHERE A DRAINAGE LENGTH OF 375 FEET OCCCURS BETWEEN DRAINAGE SWALES, THE GEOCOMPOSITE SHOULD BE DAY–LIGHTED AT THE DRAINAGE SWALE IMMEDIATELY UPSLOPE OF THIS LOCATION.



LANDFILL PERIMETER BERM (C / 6C.2)

NTS



LANDFILL PERIMETER BERM (EDA – NORTH) (D / 6C.2)

NTS

STATE OF TEXAS
RYAN R. KUNTZ
104689
LICENSED
PROFESSIONAL ENGINEER
2/12/2021

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	10/2020	ADDED GEOCOMPOSITE ON TOPSLOPE OF FINAL COVER. REVISED NOTE 1 TO CHANGE GEOCOMPOSITE EXTENSION LENGTH TO 5 FEET. ON TOP SLOPE.	
2	02/2021	ADDED NEW DETAIL TO DEPICT GEOCOMPOSITE DAYLIGHTING AT SWALE. ADDED ROCK AT TOE OF SLOPE TERMINATION.	

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
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: SDS | 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

2/12/2021 5:15 PM G:\WACO\16216088.00 T172 – SITE 50 SITING STUDY_Permit Dwgs_DWG\WOD\(0121)\Att 6\6C2 – Final Cover Detail–1

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

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 8
CLOSURE AND POST-CLOSURE COST ESTIMATES

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, Texas 76710

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – April 2020
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Revision 2 – December 2020
Revision 3 – February 2021
SCS Project No. 16216088.00

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8A Closure Cost Estimate Form for Municipal Solid Waste Type I Landfills
8B Closure Cost Estimate Calculations
8C Post-Closure Care Cost Estimate Form for Municipal Solid Waste Type I Landfills
8D Post-Closure Care Cost Estimate Calculations

SCS Engineers
TBPE Reg. # F-3407

APPENDIX 8A

CLOSURE COST ESTIMATE FORM
FOR MUNICIPAL SOLID WASTE TYPE I LANDFILLS

SCS Engineers
TBPE Reg. # F-3407
Inclusive of pages 8A-1 to 8A-15

Texas Commission on Environmental Quality

Closure Cost Estimate Form for Municipal Solid Waste Type I Landfills

This form is for use by applicants or site operators to provide cost estimates for closure of MSW Type I landfills to meet the requirements in 30 Texas Administrative Code (TAC) Chapter 330, Section 330.63(j) and 30 TAC Chapter 330 Subchapter L. The costs to be provided herein are cost estimates for hiring a third party to close the largest waste fill area that could potentially be open in the year to follow and those areas that have not received final cover. If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

Facility Name: City of Waco Landfill

MSW Permit No.: 2400

Site Operator/Permittee Name and Mailing Address: City of Waco

Total Closure Cost Estimate (2020 Dollar Amount): $2,454,380

I. Professional Engineer's Statement, Seal, and Signature

I am a licensed professional engineer in the State of Texas. To the best of my knowledge, this Closure Cost Estimate has been completed in substantial conformance with the facility Closure Plan and, in my professional opinion, is in compliance with Title 30 of the Texas Administrative Code, Chapter 330.

Name: Ryan Kuntz, P.E. Title: Vice President

Date:

Company Name: SCS Engineers Firm Registration Number: F-3407

Professional Engineer's Seal

Professional Engineer's Signature

D. Closure Cost Estimates Worksheet

If any item listed in this worksheet is not applicable to the subject facility, enter "NA" (Not Applicable) in the affected field.

Table 1. Closure Cost Estimates Worksheet.

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
1. Engineering Costs						
1.1	Topographic Survey	Acres	21.3	$70.00	$1,491	(4)
1.2	Boundary Survey	Acres	502.5	$15.00	$7,538	(4)
1.3	Site Evaluation	Acres	502.5	$25.00	$12,563	(4)
1.4	Development of Plans	Lump Sum	1	$35,000	$35,000	(4)
1.5	Contract Administration (bidding and award)	Lump Sum	1	$2,830	$2,830	(4)
1.6	Closure Inspection and Testing	Acres	21.3	$5,000	$106,500	(4)
1.7	TPDES and other Permits	Lump Sum	1	$5,000	$5,000	(4)
1.8	Additional Engineering Cost Items (describe in attachments)	NA	NA	NA	NA	NA
1.9 Engineering Costs Subtotal						
1.9.1	Engineering Costs Subtotal	NA	NA	NA	$170,922	NA
2. Construction Costs						
2.1 Mobilization						
2.1.1	Mobilization of Personnel and Equipment	Lump Sum	1	$93,716	$93,716	(4)
2.2 Final Cover System						
2.2.1 Side Slope Cover						
2.2.1a	Infiltration Layer – Compacted Clay	CY	41,233	$2.50	$103,083	(4)
2.2.1b	Infiltration Layer – Geosynthetic Clay Liner	SF	NA	NA	NA	NA
2.2.1c	Flexible Membrane Cover – HDPE	SF	742,200	$0.55	$408,210	(4)
2.2.1d	Flexible Membrane Cover – LLDPE	SF	NA	NA	NA	NA

Closure Cost Estimate for MSW Type I Landfill

Facility Name: __City of Waco Landfill____ Revision No.: ___2_____

Permit No: ___2400_____ Date: __February 2021

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.2.1e	Drainage Layer – Aggregate (Geocomposite Termination)	LF	4,695	$32.60	$153,057	(4)
2.2.1f	Drainage Layer – Drainage Geocomposite Material	SF	742,200	$0.60	$445,320	(4)
2.2.1g	Erosion Layer	CY	54,978	$2.75	$151,190	(4)
2.2.1h	Vegetation	Acres	17.04	$1,000	$17,040	(4)
2.2.2 Top Slope Cover						
2.2.2a	Infiltration Layer – Compacted Clay	CY	10,311	$2.50	$25,778	(4)
2.2.2b	Infiltration Layer – Geosynthetic Clay Liner	SF	NA	NA	NA	NA
2.2.2c	Flexible Membrane Cover – HDPE	SF	185,600	$0.50	$92,800	(4)
2.2.2d	Flexible Membrane Cover – LLDPE	SF	NA	NA	NA	NA
2.2.2e	Drainage Layer – Aggregate	CY	NA	NA	NA	NA
2.2.2f	Drainage Layer – Drainage Geocomposite Material	SF	185,600	$0.55	$102,080	(4)
2.2.2g	Erosion Layer	CY	13,748	$2.75	$37,807	(4)
2.2.2h	Vegetation	Acres	4.26	$1,000	$4,260	(4)
2.2.3 Cells for Class 1 Nonhazardous Industrial Waste						
2.2.3a	Dike Construction	NA	NA	NA	NA	NA
2.3 Site Grading						
2.3.1	Site Grading	Acres	21.3	$500	$10,650	(4)
2.4 Site Fencing and Security						
2.4.1	Site Fencing and Security	Lump Sum	1	$10,000	$10,000	(4)
2.5 Landfill Gas Monitoring and Control System						
2.5.1	Gas Control Wells	NA	NA	NA	NA	NA
2.5.2	Gas Header Piping	NA	NA	NA	NA	NA
2.5.3	Gas Lateral Piping	NA	NA	NA	NA	NA
2.5.4	Flare Station	Lump Sum			NA	NA

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.5.5	Condensate Sumps	NA	NA	NA	NA	NA
2.5.6	Completion of LFG Monitoring System	NA	NA	NA	NA	NA
2.6 Groundwater Monitoring System						
2.6.1	Groundwater Monitoring Well Installation	Each	NA	NA	NA	NA
2.6.2	Piezometer and Monitor Well Plugging and Abandonment	Each	NA	NA	NA	NA
2.7 Leachate Management						
2.7.1	Completion of Leachate Management System	NA	NA	NA	NA	NA
2.8 Stormwater Management						
2.8.1	Stormwater Drainage Management System	Lump Sum	1	$313,050	$313,050	(3)
2.9 Other Cost Items						
2.9.1	Additional Construction Cost Items (describe in attachments)	NA	NA	NA	NA	NA
2.10 Construction Costs Subtotal						
2.10.1	Construction Costs Subtotal	NA	NA	NA	$1,968,041	NA
3. Storage and Processing Unit Closure Costs						
3.1	Waste Disposal	☐ Tons ☒ Cubic Yards	180	$1.67	$301	(4)
3.2	Material Removal and Disinfection	Lump Sum	1	$3,900	$3,900	(4)
3.3	Demolition and Disposal	Each	8	$50	$400	(4)
3.4	Additional Storage and Processing Unit Closure Cost Items (describe in attachments)	NA	NA	NA	NA	NA
3.5 Storage and Processing Unit Closure Costs Subtotal						
3.5.1	Storage and Processing Unit Closure Costs Subtotal	NA	NA	NA	$4,601	NA

Closure Cost Estimate for MSW Type I Landfill

Facility Name: __City of Waco Landfill____ Revision No.: ___2_____

Permit No: ___2400_____ Date: __February 2021

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
4. Sum of Engineering, Construction, and Storage and Processing Unit Closure Costs						
4.1	Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals	NA	NA	NA	$2,143,564	NA
5. Contingency						
5.1	Contingency (10% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	$214,356	NA
6. Contract Performance Bond						
6.1	Contract Performance Bond (2% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	$42,871	NA
7. Third Party Administration and Project Management Costs						
7.1	Third Party Administration and Project Management Costs (2.5% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	$53,589	NA
8. Total Closure Costs						
8.1	Total Closure Costs (sum of amounts in Sections 4, 5, 6, and 7)	NA	NA	NA	$2,454,380	NA

[1] For items marked "specify," the responsible professional engineer will enter appropriate unit of measurement

[2] Sources of Unit Costs for Cost Estimates table may include:
(1) Published Cost Estimator Manuals (e.g., RS Means);
(2) Third Party Quotes (e.g., Environmental Field Services Contractors);
(3) Verifiable Data based on Actual Operations; or
(4) Other sources of cost acceptable to the executive director of the TCEQ.

APPENDIX 8B

CLOSURE COST ESTIMATE CALCULATIONS

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 8B-1 to 8B-4

2.2.1c Flexible Membrane Cover - HDPE

				742,200	sf		
			$	0.55	/ sf =	$	408,210

2.2.1e Drainage Layer - Aggregate (Geocomposite Termination)

		2,825	ft at landfill toe-of-slope				
		1,870	ft for swale				
		4,695	ft total length				
		11	sf cross-sectional area of aggregate				
		1,913	cy of aggregate				
Aggregate @	$ 60.00	/ cy =	$	114,800	=	$	24.50 / lf
13	lf geotextile	@	$	0.30	/ sf =	$	3.90 / lf
10	lf membrane drainage flap	@	$	0.50	/ sf =	$	5.00 / lf
10	lf geocomposite runout	@	$	0.55	/ sf =	$	5.50 / lf
	Swale Geosynthetic Unit Rate:			1,870	lf @	$	14.40 / lf
	Toe-of-Slope Geotextile Unit Rate:			2,825	lf @	$	3.90 / lf
	Geosyntehtic Unit Rate (Weighted Average):					$	8.10 / lf
Geocomposite Termination:	4,695	lf @	$	32.60	/ lf =	$	153,057

2.2.1f Drainage Layer - Drainage Geocomposite Material (double-sided 200 mil)

				742,200	sf		
			$	0.60	/ sf =	$	445,320

2.2.1g Erosion Layer

		2.0	ft thick				
		742,200	sf				
		54,978	cy for erosion layer				
		Soil available on-site for installation					
			$	2.75	/ cy =	$	151,190

2.2.1h Vegetation

	17.04	ac @	$	1,000	/ ac =	$	17,040

2.2.2 Top Slope Cover

2.2.2a Infiltration Layer - Compacted Clay

		1.5	ft thick				
		185,600	sf				
		10,311	cy for infiltration layer				
		Soil available on-site for installation					
			$	2.50	/ cy =	$	25,778

2.2.2c Flexible Membrane Cover - HDPE

				185,600	sf		
			$	0.50	/ sf =	$	92,800

2.2.2f Drainage Layer - Drainage Geocomposite Material (single-sided 200 mil)

				185,600	sf		
			$	0.55	/ sf =	$	102,080

2.2.2g Erosion Layer

		2.0	ft thick				
		185,600	sf				
		13,748	cy for erosion layer				
		Soil available on-site for installation					
			$	2.75	/ cy =	$	37,807

2.2.2h Vegetation

	4.26	ac @	$	1,000	/ ac =	$	4,260

2.3 Site Grading

	21.3	ac @	$	500	/ ac =	$	10,650

2.4 Site Fencing and Security

If the site were closed prior to entire permitted footprint being filled, site fencing and security for the entire landfill would already be in place. Nevertheless, to ensure adequacy of the fencing for access control, an allowance was included in this estimate.

				Allowance =	$	10,000

2.5 Landfill Gas Monitoring and Control System **(See Note 3)**

0.0	ac @	$	-	/ ac =	$	-

2.6 Groundwater Monitoring System **(See Note 4)**

2.6.1 Groundwater Monitoring Well Installation

0.0	per well @	$	-	/ well =	$	-

2.6.2 Piezometer and Monitor Well Plugging and Abandonment

0.0	per well @	$	-	/ well =	$	-

2.7 Leachate Management

The forced closure scenario assumes that the LCS has been installed. No expenses are projected for this item.

2.8 Stormwater Management

Downchutes	800	lf @	$	200.00	/ lf =	$ 160,000
Drainage Swales	5,250	lf @	$	15.00	/ lf =	$ 78,750
Drainage Pond Excavation	19,800	cy @	$	3.50	/ cy =	$ 69,300
Drainage Pond Outlet Structure					Lump Sum =	$ 5,000
					Stormwater Management Subtotal =	$ 313,050
					Construction Costs Subtotal =	**$ 1,968,041**

3.0 Storage and Processing Unit Closure Costs (Citizen's Collection Station)

3.1 Waste Disposal

6.0	roll-off containers (MSW)					
30	cy per container					
180	cy of MSW					
		$	1.67	/ cy =	$	301

3.2 Material Removal and Disinfection **(See Note 5)**

Material						
Tires	1.0	Tire trailer @	$	2,500	/ trailer =	$ 2,500
Metals	3.0	Containers @	$	50	/ container =	$ 150
Cardboard/Plastics/others	2.0	Containers @	$	50	/ container =	$ 100
White Goods	1.0	Containers @	$	50	/ container =	$ 50
Disinfection (MSW Containers)	6.0	Containers @	$	100	/ container =	$ 600
Disinfection (Facility)					Lump Sum =	$ 500
					Subtotal =	$ 3,900

3.3 Demolition and Disposal **(See Note 6)**

8.0	Containers @	$	50	/ container =	$	400
					Storage and Processing Unit Closure Costs Subtotal =	**$ 4,601**

Note 1: As discussed in Section 2 of Attachment 9, this assumes approximately 21.3 acres of waste-in-place in Sector 1.
Note 2: Aerial coverage of topographic survey only required for filled, excavated, and stockpiled areas.
Note 3: Based on landfill gas emissions from landfills of similar size and characteristics, it is assumed that the estimated emissions from the landfill at this stage of development will be below regulatory thresholds that would warrant installation of a LFG control system.
Note 4: Under a forced closure scenario, it is assumed the compliance boundary will not change, and the existing groundwater monitoring system will be sufficient at closure. This also assumes that no piezometers or monitoring wells will be required to be abandoned.
Note 5: Offsite disposal costs of all materials (tires, metals, containers, white goods, etc.) are included, with exception to MSW (see Item 3.1), as well as transporation costs for offsite removal/disposal of the containers, as applicable. Both the contents and containers for metals and white goods will be disposed at a metal salvage yard, concurrently. Disinfection of the MSW containers will occur after disposal at the landfill working face (Item 3.1).
Note 6: This includes disposal of roll-off containers at a metal salvage yard, after disinfection of MSW containers and disposal of cardboard, plastic, and other recycable materials (Item 3.2). It is also assumed there will be no demolition required on-site.

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

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 9
FINAL CLOSURE AND POST-CLOSURE PLAN

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, TX 76710

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – April 2020
Revision 1 – October 2020
Revision 2 – December 2020
Revision 3 – February 2021
SCS Project No. 16216088.00

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9A Closure Plan Form
9B Post-Closure Care Plan Form

Figures

9.1 Final Closure Schedule

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The GP or his/her qualified representative will observe all destructive and non-destructive testing of repairs and will record the number of each repair, type, date and test outcome. Repairs that pass the non-destructive tests will be taken as an indication of an adequate repair. Repairs more than 150 ft long will also be required to have a destructive test performed. Repairs that fail the initial retest will be redone and retested until a passing test results. All work and testing of repairs will be fully documented in a repair log.

2.3.8 Geocomposite and Erosion Layer Testing

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development and stress imparted to the geomembrane. If possible, cover should be placed during the coolest weather available. Small wrinkles should be isolated and covered as quickly as possible to prevent their growth. In no case will the geomembrane be allowed to fold over on itself.

2.3.8.1 Geocomposite

A single-sided and double-sided geocomposite will be installed over the geomembrane on the landfill topslope and sideslopes, respectively. The geocomposite will conform to the material and performance properties specified by the GP, consistent with project construction plans and technical specifications. The geocomposite transmissivity shall meet or exceed a transmissivity of 3.7x10-4 m^2/sec at a gradients of 0.05 and 0.25, for topslope and sideslopes, respectively (see Attachment 12, Appendix 12A – Leachate Generation Model Narrative) and the non-woven geotextile heat-bonded to the geonet shall comply with the minimum material properties presented in the calculations provided in Attachment 12, Appendix 12B. The drainage geocomposite manufacturer (or supplier), will conduct quality control testing at the minimum frequencies and test methods presented in Table 9-2-5 and certify that all materials delivered comply with project specifications. The material certifications shall be reviewed by the GP and approved for the project prior to acceptance of any of the material.

Table 9-2-5. Manufacturer's Testing Schedule for Geocomposite

PRODUCT	TEST	METHOD	MINIMUM FREQUENCY
Resin	Density	ASTM D1505 or D792	1 per batch and every resin lot
	Melt Flow Index	ASTM D1238	
Geonet	Density	ASTM D1505 or D792	1 per 100,000 ft^2 and every resin lot
	Mass/Area	ASTM D1603	
	Thickness	ASTM D5199	
Geotextile	Mass/Area	ASTM D5261	1 per 100,000 ft^2 and every resin lot
	Grab Tensile Strength	ASTM D4632	
	Trapezoidal Tear Strength	ASTM D4533	
	Apparent Opening Size	ASTM D4751	
	Permittivity	ASTM D4491	
Geocomposite	Transmissivity	ASTM D4716	One test per product type

Additionally, conformance testing will be performed for transmissivity (ASTM D4716) and ply adhesion (D413) by an independent third-party laboratory chosen by the GP. Conformance testing for these parameters will be performed at least once per product type and project.

2.3.8.2 Erosion Layer

The erosion layer will consist of a 24-inch-thick soil layer, with the top 6 inches capable of sustaining vegetation in accordance with §330.457(a)(3). The required thickness of the layer will be verified by settlement plates or survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface area. A minimum of two verification points is required. The selected grid will be the same for both beginning and finished elevations of the erosion layer, so that minimum thickness can be calculated and verified. All elevation calculations necessary for thickness determination will be included as part of the supporting documentation in the FCSER.

Drainage aggregate where sideslope geocomposite daylights (see Attachment 6C, Drawing 6C.2) at drainage swales or landfill toe-of-slope will consist of durable particles of crushed stone, natural gravel, or lightweight aggregate free of silt, clay, or other unsuitable materials. The aggregate shall have a loss of mass due to calcium carbonate of less than 15 percent (in accordance with J&L Test Designation S-105-89 or ASTM D3042 modified to use a solution of hydrochloric acid having a pH of 5). The drainage aggregate will meet the following gradation:

Sieve Size Square Opening	Percent Passing
2 inches	100
½ inch	0 – 5

The drainage aggregate shall be tested for gradation and calcium carbonate, in accordance with ASTM C136 and J&L Test Designation S-105-89 or ASTM D3042 modified, respectively, at the supply source at a minimum of 1 test per source/3,000 cubic yards, whichever is greater. The physical characteristics of the aggregate shall be evaluated through visual inspection and laboratory classification testing before construction and visual inspection during construction. The drainage aggregate may be tested during construction at the discretion of the CQA Monitor. The test results for the drainage aggregate will be included in the FCSER.

The erosion layer and geocomposite termination drainage aggregate does not require compaction control; however, it should be stable for construction and disposal traffic. The erosion layer will be deployed in "fingers" along the geomembrane or geocomposite to control the amount of slack and minimize wrinkles and/or folds. Soil cover will generally be placed in an up-slope direction on sideslopes so that stress imparted to the geocomposite and geomembrane is minimized. Care will be exercised in placement of the erosion layer and drainage aggregate so as not to shift, wrinkle or damage any underlying geosynthetic layers, and the placement methods will be documented.

2.4 FINAL COVER SYSTEM EVALUATION REPORT

Upon completion of each area of final cover construction and evaluation, the GP will prepare and submit in triplicate the FCSER, prepared in accordance with this plan, to the TCEQ for review and approval. This report will be submitted along with a construction documentation report.

Each FCSER will include a discussion of the construction of the final cover elements, a cover placement map which shows the covered area being submitted for approval and areas covered by all previous FCSER submittals with the dates of acceptance by the TCEQ. The map should depict the site grid system, graphic scale, and north arrow. The FCSER will be signed and/or sealed by the GP performing the evaluation and a representative of the site operator.

The construction documentation will contain a narrative describing the work performed and the testing procedures performed prior to and during construction, record drawings, and results of field and laboratory testing. The FCSER will include the following:

- All field and laboratory test documentation for infiltration layer soils, including test and sample locations plotted on plan view drawings representing each 6 inch lift;
- Geomembrane manufacturer's certifications, documentation of all manufacturer's and independent testing, geomembrane seaming and repair logs, seam testing results, and a site map showing locations of panels, repairs, and tests;
- Geocomposite manufacturer's certification and testing documentation; and
- Survey documentation for the thickness of the infiltration layer and erosion layer.

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

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 10
SOILS AND LINER QUALITY CONTROL PLAN

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, TX 76710

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
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817/571-2288

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10D Typical Underdrain Design

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When the base of the cell excavation extends below the SHWT, the stability of the liner system against hydrostatic uplift is considered for two cases: (1) short-term, i.e., during construction and filling operations; and (2) long-term, i.e., after filling and into post-closure. Short-term stability against uplift of the liner system will be required by installation of an active underdrain system when excavation is below the SHWT. Underdrain systems constructed beneath the landfill cells prevent development of excessive hydrostatic uplift pressures until an adequate thickness of soils and waste ballast is achieved. Long-term stability against uplift of the liner systems is provided by the weight of the clay liner, liner protective cover, soil ballast, waste materials, and final cover system components, or collectively, ballast. Once an adequate thickness of ballast is provided, underdrain systems, if employed to provide short-term stability, are decommissioned upon approval from the TCEQ. The assumptions and calculations for the ballast evaluation and underdrain design are described in Section 11.5 (see also Appendix 10C) and Appendix 10D, respectively.

2.5.1 Control of Seepage During Construction (Short-Term Groundwater Control)

The base of the proposed excavation will be located in the Taylor Group (Wolfe City Formation), shale-marl, portions of which may be below the seasonal high groundwater table. Hydraulic conductivity test results for the geologic stratum at the Site are summarized in Attachment 5 – Geotechnical/Stability Analysis and the laboratory results of the hydraulic conductivity results are provided in Attachment 4 – Geology and Groundwater Report, Appendix III-4.F.

If groundwater seepage is observed in measureable quantities that could be detrimental to the overlying liner or softening of the subgrade, the GP will provide a summary of his observations of the seepage, the methods and procedures used to control the seepage and stabilize the foundation soils, and verification that the seepage has been controlled prior to liner placement. If groundwater seepage is observed from an area during construction that will be detrimental to the overlying liner or if excavation is below the SHWT, an underdrain system to control groundwater will be employed for that cell area, and the design of the underdrain system will be ~~confirmed~~ designed by a Professional Engineer licensed in the State of Texas using the calculation methodology presented in Appendix 10D. Any underdrain system installed within a respective cell will be documented in the SLER and GLER for the respective constructed cell. ~~This~~ The underdrain design presented in Appendix 10D is based on the assumed SHWT map described in Section 2.5.2 and presented in Appendix 10B. This design represents the worst case scenario of groundwater seepage and can be used directly for design of an underdrain system for all future disposal cells/areas of the landfill.

As discussed in Section 2.5, when installed, an underdrain system may be decommissioned upon approval of TCEQ once an adequate thickness of ballast is achieved for long-term stability against hydrostatic uplift. A Ballast Evaluation Report (BER) will be prepared and submitted to TCEQ, as discussed in Section 11.5, when ballast or dewatering (i.e., for cells/areas with an installed underdrain system) is no longer necessary in accordance with §330.337(j).

2.5.2 Seasonal High Groundwater Table

A SHWT map has been developed based on standard standpipe piezometers and vibrating wire piezometers (VWPs) installed at the site during the subsurface and groundwater investigation (see Attachment 4, Section 6). Based on the observations presented in Attachment 4, the shallow occurrences of groundwater do not appear to be uniform across the site and may occur in isolated pockets; there exists a continuously saturated groundwater zone that occurs at deeper elevations below the base of the proposed excavation grades; and the shallow and deep occurrences of groundwater do not appear to be hydraulically connected. However, as a conservative approach to sizing underdrain components for short-term groundwater control and evaluating long-term groundwater control (waste or soil ballast), if needed, the SHWT map was developed with a culmination of high water level readings from both the shallow standpipe piezometers/VWPs and deep VWPs installed at the site during the groundwater investigation. This SHWT map, provided in Appendix 10B, depicts the measurement points, including the seasonal high groundwater table (SHWT) levels, and future excavation grades. As shown on the map, portions of the excavation grades extend below this assumed SHWT.

As noted in this SLQCP, the SHWT map will be reviewed and updated, if necessary, prior to the design of each cell based on the most recent data available at the time of design. If the groundwater elevations at monitoring points has increased since the last cell construction, the SHWT map will be revised upward to reflect those increases. An updated SHWT map will be presented in the SLER and GLER. In addition, observations of the subgrade soil characteristics and indications of groundwater seepage (if any) and potential impacts to the dewatering and ballast calculations will also be documented in the SLER and GLER.

- All test documentation for leachate collection and protective cover layers (GLER);
- For geomembrane, include manufacturer's certifications, documentation of all manufacturer's and independent testing, seam tests (non-destructive and destructive seam testing), and seaming and repair records (GLER);
- Manufacturer's certification and testing documentation for all geosynthetics (SLER/GLER); and
- Survey documentation of the thickness of the soil liner (SLER), a geomembrane drawing showing locations of panels, repairs, and destructive tests (GLER), leachate collection (GLER), and protective cover layers (GLER).

11.4 INTERIM STATUS REPORT

For any liner that will remain uncovered with waste for a period exceeding 6 months, Interim Status Reports will be prepared and submitted to the TCEQ, in accordance with 30 TAC §330.341(d). Any damaged areas will be repaired promptly. A new report shall be submitted on the new construction for all liners that need repair due to damage.

11.5 BALLAST EVALUATION REPORT (BER)

If ballast or an underdrain system are required during cell construction, the Owner/Operator will submit a Ballast Evaluation Report (BER) following confirmation that an adequate thickness of ballast has been placed or dewatering through the use of an underdrain is no longer necessary. An underdrain system may be decommissioned upon approval of TCEQ once an adequate thickness of ballast is achieved for long-term stability against hydrostatic uplift, as described in Section 2.5. If a BER~~ballasting~~ is required, ~~a BER~~it will be prepared and submitted to the TCEQ, in accordance with the requirements set forth in 30 TAC §330.337(j).

The BER will incorporate the following components:

- Summary of soil stratigraphy and soil properties exposed on the bottom and sideslopes of the constructed cell.
- Adjusted seasonal high water table based on groundwater monitoring well data and other site observations.
- Calculation of ballast required, and type of ballast to be used (soil and/or waste), as described in Section 11.5.1.
- Discussion of whether an underdrain system or other dewatering system will be installed, as described in Section 2.5. In the event a dewatering system is required, the design of the dewatering system will be submitted with the SLER, GLER and BER and maintained in the Site Operating Record.

- Method of controlling uplift forces during construction (low-permeability foundation soil, dewatering, or combination).

- Monitoring of dewatering system, if required, to demonstrate that hydrostatic forces did not develop during liner construction.

- Subgrade and top-of-liner elevations, as reported in the respective SLER and confirmation of liner weight.

- Certification that ballast met the criteria established in Section 11.5.1 and in the liner quality control plan.

- The BER will be signed and sealed by an independent licensed professional engineer performing the evaluation and will include the signature of the facility operator or their authorized representative.

A BER should be submitted to the TCEQ after sufficient ballast is in place to demonstrate adequate uplift resistance against the long-term seasonal high groundwater table for a given waste phase. If the TCEQ provides no response within 14 days of the date of receipt of the BER, the Owner may discontinue the operation of the underdrain system, in the event a dewatering system is installed.

11.5.1 Ballast Calculations (Long-Term Groundwater Controls)

Calculations will be prepared that demonstrate that the weight of the liner system, including ballast, is sufficient to offset any unbalanced upward or inward hydrostatic forces on the liner by a factor of 1.2 (for soil ballast) or 1.5 (for waste ballast). Sample ballasting calculations are provided in Appendix 10C. The unit weight values used in the sample calculations are assumptions only. Field-verified values will be incorporated into the BER.

11.5.2 Soil as Ballast

If soil is to be used as ballast, it will be placed after liner system construction. Soil ballast may include the protective cover, leachate collection system, additional soil over the liner or waste, and intermediate and final cover soils. For soil ballast placed during cell construction, the SLER should include a statement that the soil ballast, or a component of the ballast (i.e. protective cover or additional soil over protective cover) will be documented in the GLER, which will include the following field confirmations and calculations:

- Determine the density of the soil used as ballast. An estimate of soil density will be developed using geotechnical properties developed during soil construction.

- Initial and final survey of the area to receive soil as ballast, which should be accomplished at the same frequency required in this SLQCP for the liner. The top of clay survey or geomembrane survey may be used as the initial survey for soil ballast.

- Calculate the thickness of soil utilized as ballast (from survey), to determine the resulting confining pressure from the soil ballast. The calculated confining pressure for soil ballast will be reduced by a factor-of-safety of 1.2 in accordance with 30 TAC §330.337(b)(1).

11.5.3 Waste as Ballast – 40,000 Pound or Greater Compactor

If waste is a component used for ballast, the approval of the GLER must first be received from TCEQ prior to ballasting. The BER must include (in addition to the items described in Section 11.4) the following documentation and calculations:

- Certification from the landfill operator that the wheeled compactor used to compact the waste weighs no less than 40,000 pounds, and that the compactor was utilized during the entire period of placing the waste ballast.

- Certification from the landfill operator that the type of waste placed in the lower 5 feet was free of brush and large bulky items, which would damage the underlying system or which cannot be compacted to the required density.

- Initial and final survey of the area to receive waste as ballast to determine the thickness of waste. The survey of the top of protective cover can be used as the initial survey.

- Calculation of the confining pressure of the waste by assuming a density of 1,200 pounds per cubic yard in accordance with 30 TAC §330.337(h)(2). The confining pressure for the waste ballast will be reduced by a factor-of-safety of 1.5.

11.5.4 Waste as Ballast – Less Than 40,000 Pound Compactor

If a less than 40,000 pound compactor is used, calculations to determine the in-place density of waste will be performed. These calculations will include the following:

- Initial survey of the area to receive waste as ballast. The survey of the top of the protective cover may be used for this initial survey.

- Weight of waste placed, based on actual measurements of truck weights at the scalehouse.

- Survey of the top of waste to document that the thickness calculated in the GLER has been placed.

- Calculate the volume of waste used as ballast from the survey. The actual density of the placed waste will be calculated by dividing the previously recorded weight by the volume of waste determined by the survey. The calculated density will be used in the ballast calculations. In the event the calculated density is greater than 1,200 pounds per cubic yard, a density of 1,200 pounds per cubic yard will be used for the ballast calculations. As previously stated, the confining pressure for the waste ballast will be reduced by a factor of safety of 1.5 in accordance with 30 TAC §330.337(h)(2).

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

PART III
SITE DEVELOPMENT PLAN -ATTACHMENT 12
LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN

Prepared for:

CITY OF WACO

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APPENDIX 12A

LEACHATE GENERATION MODEL (HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP) OUTPUT FILES)

- Leachate Generation Model Narrative
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- HELP Output Files (Without Leachate Recirculation)
- HELP Output Files (With Leachate Recirculation)

LEACHATE GENERATION MODEL NARRATIVE

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

PART III
SITE DEVELOPMENT PLAN
ATTACHMENT 12, APPENDIX A
LEACHATE GENERATION MODEL NARRATIVE

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conditions, the hydraulic conductivity was assumed to be 1.0 x 10^{-3} cm/s (i.e., HELP default) for the top 100 ft of waste. For the remaining lower thickness of waste, where the waste has been compacted and in-place for longer periods, 5.0 x 10^{-4} cm/s was used as hydraulic conductivity

Lower hydraulic conductivity of landfilled MSW is attributed to increased overburden stress and increased finer particles resulting from degradation. Reddy et. al. (2011) reported two orders of magnitude reduction in hydraulic conductivity of synthetic MSW with degradation. In another study, hydraulic conductivities of 1 x 10^{-4} cm/s to 1 x 10^{-7} cm/s are reported for MSW for uncompacted MSW and MSW at 90 feet depth, respectively (Reddy et. al., 2009).

1.4.3.5 Daily and Intermediate Cover

The daily cover for active condition consists of a 6-inch-thick layer of soil and the intermediate cover for the interim condition has an additional 6-inch layer of soil for a total thickness of 12 inches. The daily and intermediate cover were assumed to be clayey soil, with a hydraulic conductivity of 1.7 x 10^{-5} cm/s. Default soil characteristics were used for the daily and intermediate cover soils (HELP default texture 15).

1.4.3.6 Final Cover

Final cover on the landfill topslope and sideslopes from top to bottom will consist of a 24-inch thick erosion layer, a geocomposite drainage layer, a 40-mil geomembrane, and an 18-inch thick infiltration layer (compacted clay). The geocomposite will be installed to drain infiltrating water from the final cover. ~~However, only~~Both ~~the~~ topslope and sideslope cover systems ~~was~~ were evaluated in the HELP modeling. The minimum manufactured thickness of the geocomposite will be 200-mil (approximately 0.20 inches). To evaluate the hydraulic performance of the geocomposite layer, the hydraulic conductivity value used in the HELP model was adjusted until the maximum depth of stormwater percolating through the erosion layer to the geocomposite (for peak daily flow) was less than or approximately equal to the thickness of the geocomposite (i.e., less than 0.20 inches). In this manner water flow above the geomembrane was confined in the geocomposite layer only. Based on this evaluation the minimum allowable transmissivity was calculated based on the hydraulic conductivity to be 3.7x10^{-4} m^2/sec (i.e., T_{min} = k x t x 2.54 cm/in x 0.0001 m^2/cm^2, where T_{min} = Transmissivity [minimum, m^2/sec], k = hydraulic conductivity [cm/sec], and t = Geocomposite Thickness [inches]) at ~~a~~ gradients of 0.05 and 0.25 for topslope and sideslopes, respectively. For the sideslope geocomposite analysis, the average annual drainage collected from the topslope over the modeling period was input into the sideslope model, as subsurface inflow into the geocomposite drainage layer. This approach models the conveyance of water flow within the geocomposite associated with the topslope and sideslope flow combined (i.e., water collected from the topslope flows into the sideslope geocomposite). The result of the sideslope cover system analysis demonstrates that the maximum depth of stormwater within the geocomposite is limited to the thickness of the geocomposite (i.e., 0.20 inches) for a maximum drainage length of 375 feet. As a result, the final cover design includes daylighting the geocomposite at drainage swales and the landfill perimeter top of slope located no greater than 375 feet apart, as shown in Attachment 6C, Drawing 6C.2.

For the purposes of this model, it has been assumed that the erosion layer will consist of a clayey soil with a hydraulic conductivity of 1.7 x 10^{-5} cm/s, consistent with soil modeled from daily and

intermediate cover described in Section 1.4.3.5. The geomembrane was modeled for good installation quality, 4 defect per acre, and a pinhole density of 1 hole/acre (Berger and Schroeder, 2013). The infiltration layer will consist of compacted soil with a hydraulic conductivity of 1.0 x 10^{-5} cm/s or less. Default soil characteristics from the HELP model were selected to represent the layers within the final cover system.

1.5 LEACHATE RECIRCULATION

As previously mentioned, the active and interim conditions, described in Section 1.4.1 of this appendix, were also modeled for leachate recirculation. For both scenarios, the weather data described in Section 1.4.2 was used in the model. These conditions are considered representative of the worst case below-grade and above-grade conditions for which leachate generation and resulting leachate head would be affected by leachate recirculation.

A synthetic storm duration of 10 years was modeled for the active condition. A synthetic storm duration of 50 years was modeled for the interim conditions, which is greater than the estimated site life of the landfill (note, see Part III narrative, Section 2.2 for estimated site life of the landfill). Since the maximum time leachate recirculation can take place is less than 50 years, and in accordance with standard engineering practice, this duration is appropriate for analysis of the impacts on the leachate collection system associated with leachate recirculation. Furthermore, this duration conservatively approximates the longest time period for which the below-grade and above-grade waste disposal will likely occur for a given sector of the landfill.

Incorporating the above assumptions, for both the active and interim conditions, the percentage of leachate recirculated was increased within the HELP model until the calculated leachate head on the liner was less than or equal to the compressed thickness of the geocomposite. The model results for leachate recirculation are summarized in the HELP Model Summary Sheet (with leachate recirculation) provided in this appendix.

The allowable leachate recirculation volume is provided in the table below. Based on the results of the leachate recirculation demonstration, the allowable leachate recirculation volume for below-grade and above-grade waste disposal is represented by the active, 10-foot waste condition and interim, 170-foot waste condition, respectively. As shown, during periods of leachate recirculation, leachate head on the liner is maintained within the compressed thickness of the geocomposite. However, it should be noted that in all cases, actual leachate recirculation will also be controlled by the ability of the landfill operator to meet the 30-centimeter maximum leachate head over the bottom liner criteria, as verified by monitoring of the leachate levels at the sumps, as described in Attachment 12, Section 3.5.

ALLOWABLE LEACHATE RECIRCULATION

Fill Condition	Average Annual Recirculation (cf/yr/ac) [1]	Peak Leachate Head (in)	Allowable Recirculation (gallons/yr/ac)[2]
Below-Grade	80,200	0.22	599,900
Above-Grade	26,690	0.19	199,640

[1] Referenced from the HELP Model Output (with leachate recirculation) provided in this appendix.
[2] The allowable recirculation values pertain to areas draining to a common sump.

1.6 HELP MODEL RESULTS

The HELP model results are presented in the attached HELP Model Summary Sheets for both "without leachate recirculation" and "with leachate recirculation." Additionally, the HELP model output files are also provided in this appendix. As presented in the HELP model output, the depth of leachate over the bottom liner is predicted to be confined to the geocomposite lateral drainage layer, which is well below the 30 centimeter regulatory requirement, whether during periods of with or without leachate recirculation.

1.7 REFERENCES

Berger, K. and Schroeder, P.R. "The Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for HELP-D Version 3.95 D", Version 3.95 D, Institute of Soil Science, University of Hamburg, Germany, 2013.

Reddy, K., Hettiarachchi, H., Gangathulasi, J., and Bogner, J.E. "Geotechnical Properties of Fresh Municipal Solid Waste at Orchard Hills Landfill, USA", Waste Management, 29, pp. 952-959, 2009.

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HELP OUTPUT FILES
(WITHOUT LEACHATE RECIRCULATION)

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 12A-19 to 12A-58(11)

UNMARKED VERSION

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

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 4
GEOLOGY AND GROUNDWATER REPORT

Prepared for:

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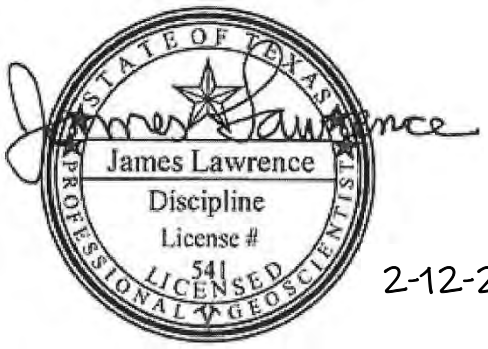

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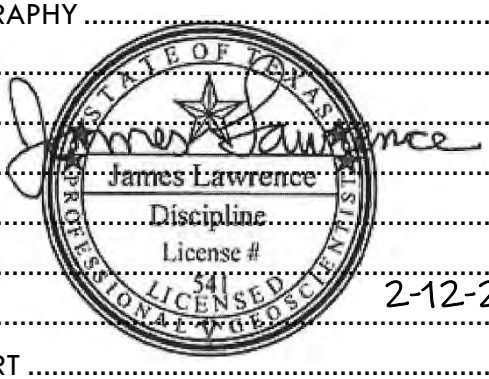

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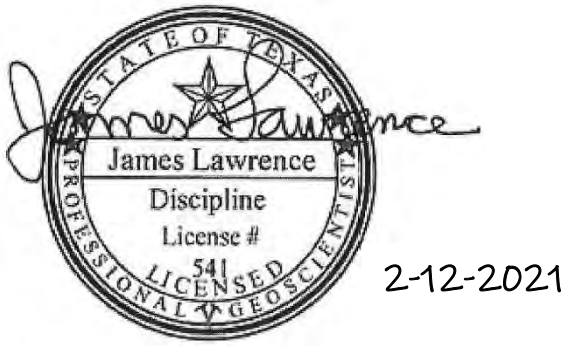

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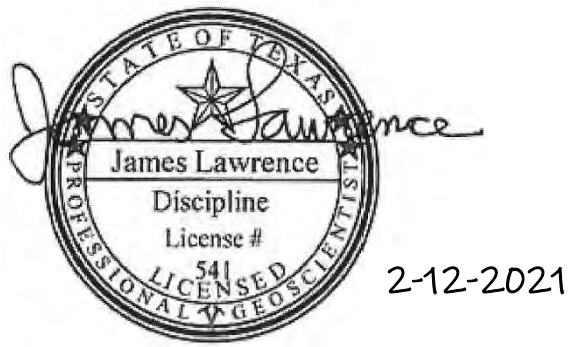

2-12-2021

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- Figure - 4.5 Structural Cross Sections of Regional Geology and the Trinity Aquifer
- Figure - 4.6 Seismic Impact Zone Map
- Figure - 4.7 Tectonic Map of Texas
- Figure - 4.8 Trinity Aquifer
- Figure - 4.9 Boring Location Map
- Figure - 4.10 Geologic Cross Section A-A'
- Figure - 4.11 Geologic Cross Section B-B'
- Figure - 4.12 Geologic Cross Section C-C'
- Figure - 4.13 Geologic Cross Section D-D'
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- Figure - 4.15 Geologic Cross Section F-F'
- Figure - 4.16 Piezometer Location Map
- Figure - 4.17 VWP Location Map
- Figure - 4.18 July 2020 Piezometer/Shallow VWP Potentiometric Map
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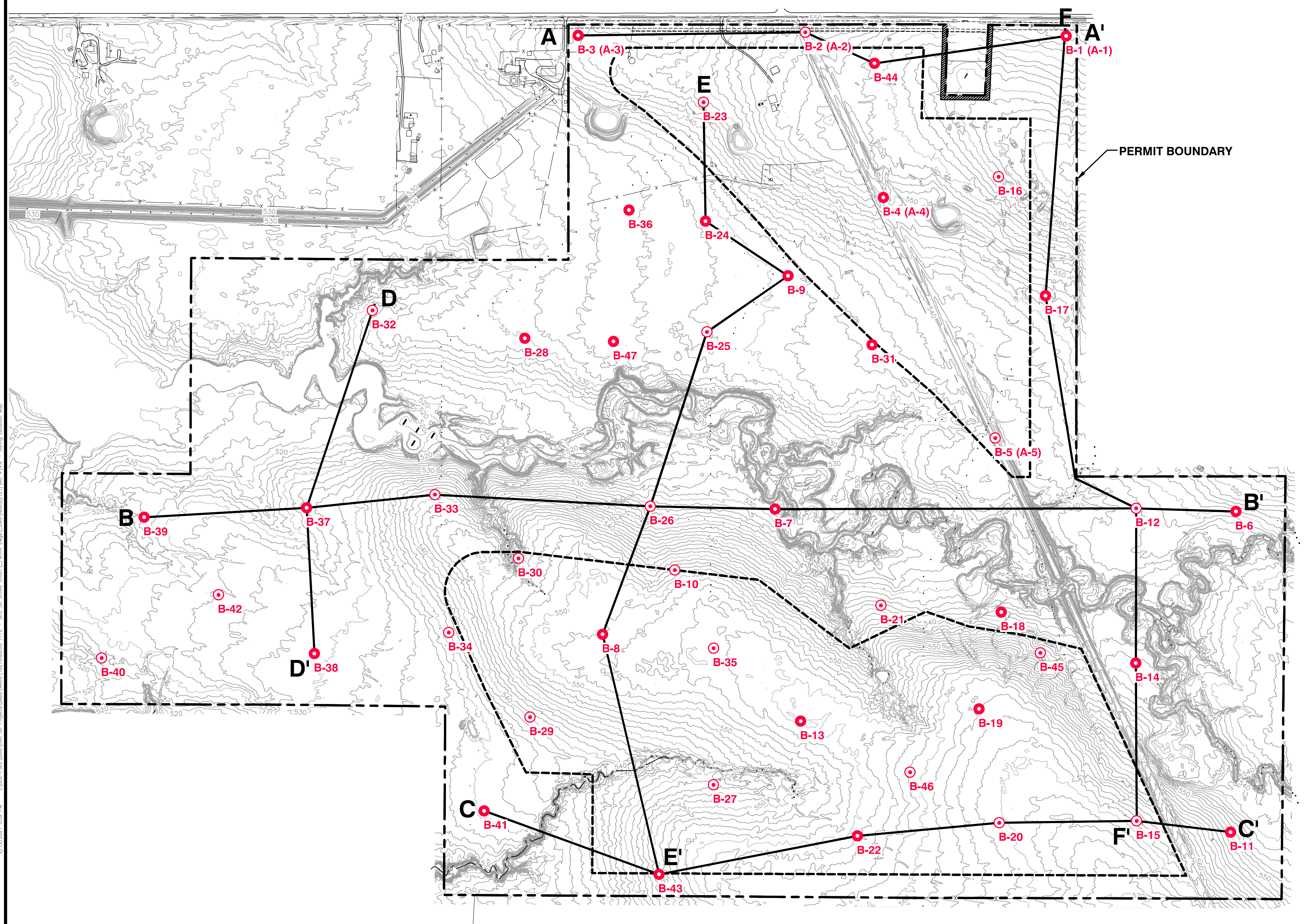
- Figure - 4.19 July 2020 Deep VWP Potentiometric Map
- Figure – 4.19A December 2020 Deep VWP Potentiometric Map
- Figure - 4.20 Proposed GWM System Map
- Figure - 4.21 Typical Monitoring Well Detail



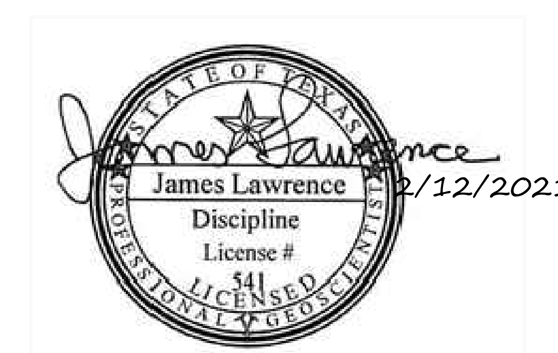
0 300 600
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 535 EXISTING TOPOGRAPHIC CONTOURS (SEE NOTE 1)
- B-9 EXISTING BORING LOCATION – I (SEE NOTE 2)
- B-14 EXISTING BORING LOCATION – II (SEE NOTE 2)
- A — A' CROSS–SECTION LOCATIONS

NOTES:

1. THE EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPATIAL FLOWN ON JULY 03, 2018.
2. EXISTING BORING LOCATIONS – I INDICATE SOIL BORINGS WHICH WERE DRILLED TO A DEPTH OF 5–FEET BELOW EDE (I.E., 500 FT MSL) AND EXISTING BORING LOCATIONS – II INDICATE SOIL BORINGS WHICH WERE DRILLED TO A DEPTH OF 30 FEET BELOW EDE (I.E., 475 FT MSL).



FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	10/2020	UPDATE LIMITS OF WASTE, ADD NOTE 3 AND ADD ADDITIONAL INFORMATION TO CROSS SECTION E-E' AND F-F'	JL
2	1/2021	UPDATE TO B-38 LOCATION AND CROSS SECTION D-D'	JL

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

DRAWING TITLE: BORING LOCATION 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

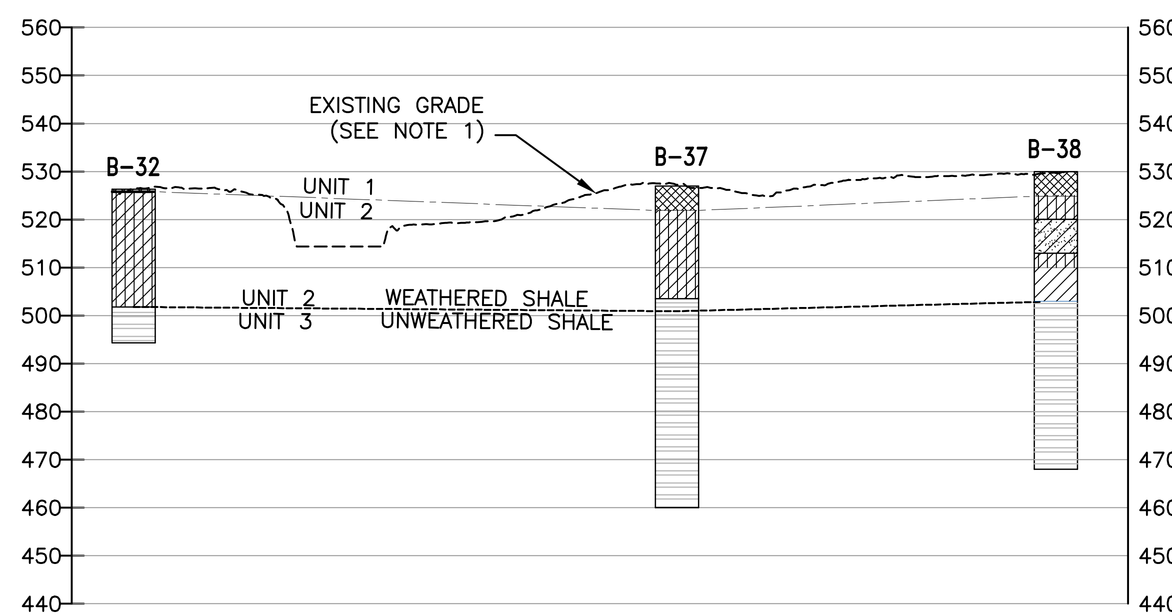
PROJ. NO. 16216088.00 | DWN. BY: JLJ/NR | Q/A RVW BY: RRK
DSN. BY: AB/JL | CHK. BY: BJD/AB | APP. BY: JL

CADD FILE: 4.9 – BORING LOCATION MAP

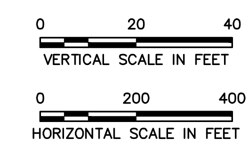
DATE: 05/2020

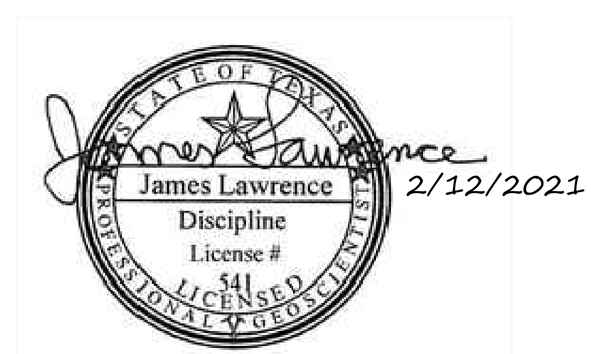
SCALE: AS SHOWN

FIGURE: 4.9



CROSS SECTION D-D'



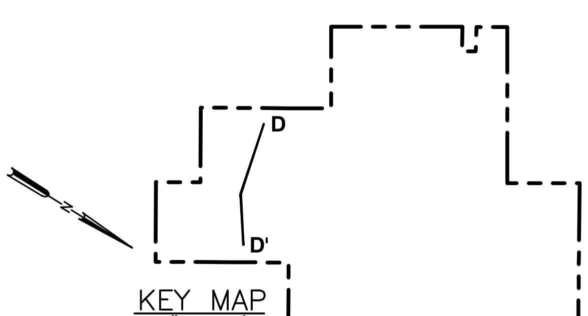


LEGEND:

- - - - - - -	EXISTING GRADE (SEE NOTE 1)
—·—·—	UNIT 1/UNIT 2 CONTACT
- - - - - - - - -	WEATHERED/UNWEATHERED SHALE TRANSITIONAL CONTACT

NOTES:

1. EXISTING TOPOGRAPHY SHOWN ON THIS PLAN WAS DEVELOPED BY DAS GEOSPATIAL, FLOWN ON JULY 03, 2018.
2. SEE APPENDIX III-4.D FOR SUBSURFACE MATERIAL LEGEND.



KEY MAP
1"=4,000'

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	10/2020	REVISIONS INCLUDE: FIX GRADE LEVEL AT B-38; ADD UNIT1/UNIT 2 CONTACT	JL
2	12/2020	REVISIONS INCLUDE: CORRECT DEPTH AT B-38	JL
3	1/2021	REVISIONS INCLUDE: REMOVED B-36 AND ADD B-32	JL

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

DRAWING TITLE
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: AB/JL | DWN. BY: JLJ/NR | CHK. BY: BJD/AB | Q/A RVW BY: RRK | APP. BY: JL

CADD FILE: 4.10-4.15 - GEOLOGIC CROSS SECTIONS

DATE: 05/2020

SCALE: AS SHOWN

FIGURE: 4.13

TABLES

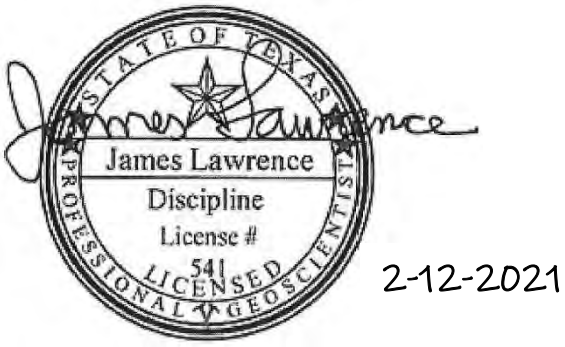
- Table III-4.1 Regional Physiography
- Table III-4.2 Waco Average Monthly Rainfall
- Table III-4.3 Geologic Units and their Water-Bearing Properties
- Table III-4.4 Recorded Wells within 1 Mile
- Table III-4.5 Coordinates and Elevations of Borings
- Table III-4.6 Properties of Unit I
- Table III-4.7 Properties of Unit II
- Table III-4.8 Properties of Unit III
- Table III-4.9 Existing Piezometer Completion Data
- Table III-4.10 Summary Initial and Static Water Level Data
- Table III-4.11 Vibrating Wire Piezometer Completion Data
- Table III-4.12 Vibrating Wire Piezometer Inferred Groundwater Elevation Data
- Table III-4.13 Summary of Aquifer (Slug) Tests Performed by SCS Engineers
- Table III-4.14 Summary of Horizontal Flow Rate Calculation Data
- Table III-4.15 Proposed Monitoring Well Information

Table III-4.5 Coordinates and Elevations of Borings Advanced at the Site by SCS Engineers

Boring Number	Easting	Northing	Hollow Stem Auger Type	Ground Elevation (ft-msl)	Depth Drilled (ft-bgs)	Elevation of Bottom (ft-msl)
B-1	3353867.3	10599904.81	7 ¼	551.67	82.0	469.7
B-1 (PZ-1)	3353867.3	10599904.81	7 ¼	551.74	39.5	512.24
B-2	3354595.81	10598697.6	7 ¼	549.78	55.0	494.78
B-3	3355259.69	10597665.32	7 ¼	541.1	72.0	469.1
B-3 (PZ-3)	3355259.69	10597665.32	7 ¼	541.20	45.0	496.2
B-4	3355130.33	10599528	7 ¼	550.04	101.0	449.04
B-5	3355913.87	10600728.3	7 ¼	541.38	47.0	494.38
B-6	3355562.96	10602041.9	7 ¼	545.55	70.7	474.85
B-7	3356670.83	10599929.6	8 ¼	530.50	55.5	475
B-8 (PZ-8)	3357935.82	10599489.18	8 ¼	550.34	75.0	475.34
B-9 (PZ-9)	3355762.31	10599314.37	8 ¼	535.30	40.0	495.30
B-9 cont.	3355762.31	10599314.37	8 ¼	535.30	135.0	400.30
B-10	3356199.16	10602404.1	8 ¼	545.40	53.0	492.4
B-11	3357048	10602933.5	7 ¼	553.50	78.5	475
B-12	3355833.07	10601575	8 ¼	542.85	48.0	494.85
B-13	3357768.09	10600645.6	8 ¼	555.15	80.0	475.15
B-14	3356543.77	10602016.3	8 ¼	539.20	65.5	473.7
B-15	3357265.27	10602471.1	7 ¼	563.35	70.0	493.35
B-16	3354706.01	10599996.8	8 ¼	560.25	61.0	499.25
B-17	3355568.96	10600519.6	7 ¼	546.75	71.0	475.75
B-18 (PZ-18)	3356694.76	10601254.04	8 ¼	534.84	56.0	478.84
B-19	3357202	10601429	7 ¼	562.05	87.0	475.05
B-20 (PZ-20)	3357666.42	10601846.53	7 ¼	564.68	73.0	491.68
B-21	3357008	10600682	8 ¼	538.75	45.0	493.75
B-22	3358132.03	10601234	8 ¼	555.00	80.0	475
B-23	3355207.68	10598431	8 ¼	540.08	45.7	494.38
B-24	3355746.69	10598780.1	7 ¼	533.63	59.2	474.43
B-25	3356251.06	10599102.9	7 ¼	533.25	33.0	500.25
B-26	3356929.04	10599457.3	8 ¼	530.45	36.0	494.5
B-27	3358308.89	10600427.7	8 ¼	546.65	53.0	493.65
B-28	3356800.71	10598286.7	8 ¼	529.6	55.0	474.6
B-29	3358523.03	10599393	8 ¼	540.25	45.0	495.25
B-30	3357828.13	10598886.4	8 ¼	543.05	48.0	495.05
B-31	3355837.8	10599897	8 ¼	537.55	63.0	474.55
B-32	3357077.27	10597864.5	8 ¼	526.3	32.0	494.3
B-33 (PZ-33)	3357774.62	10598320.64	8 ¼	539.20	55.0	484.2
B-34	3358367.31	10598778.6	8 ¼	535.65	41.0	494.65
B-35	3357682.18	10600037.4	8 ¼	553.3	59.0	494.3
B-36	3355915.26	10598397.80	8 ¼	532.5	58.0	474.5
B-37	3358201.19	10597770.6	8 ¼	526.9	52.0	474.9
B-38	3358847.64	10598223.2	8 ¼	529.85	55.0	474.85
B-39	3358709.87	10597052.3	8 ¼	522.95	48.0	475
B-40	3359476.22	10597259.9	8 ¼	522.80	28.0	494.8
B-41 (PZ-41)	3359083.91	10599450.64	8 ¼	534.62	60.0	474.62
B-42	3358523.73	10597484.3	8 ¼	527.00	32.0	495.0
B-43 (PZ-43)	3358875.54	10600433.69	8 ¼	548.86	75.0	473.86

Boring Number	Easting	Northing	Hollow Stem Auger Type	Ground Elevation (ft-msl)	Depth Drilled (ft-bgs)	Elevation of Bottom (ft-msl)
B-43 cont.	3358875.54	10600433.69	8 ¼	548.86	150	398.86
B-44	3354540.62	10599103.1	7 ¼	551.20	76.0	475.20
B-45	3356769.83	10601549.1	8 ¼	545.50	51.0	494.5
B-46	3357689.45	10601293.2	8 ¼	559.25	65.4	493.85
B-47 (PZ-47)	3356561.53	10598701.96	8 ¼	532.48	57.4	475.08

msl = mean sea level
b.g.s indicates depth is measured from below ground surface



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

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – April 2020
Revision 1 – October 2020
Revision 2 – February 2021
SCS Project No. 16216088.00

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2 GROUNDWATER PROTECTION DESIGN.....6C-2-1

2.1 LINER SYSTEM.....6C-2-1
2.2 LEACHATE COLLECTION SYSTEM.....6C-2-1
2.3 FINAL COVER SYSTEM.....6C-2-2

Drawings

6C.1 Bottom Liner Details
6C.2 Final Cover Details

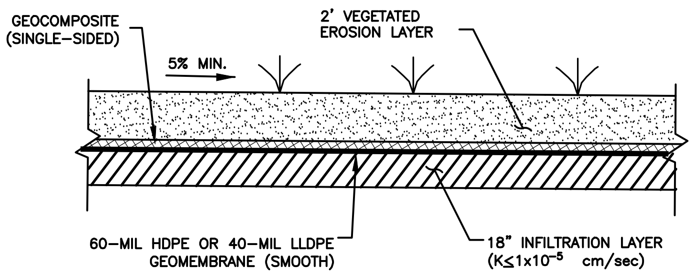
SCS Engineers
TBPE Reg. # F-3407

- 6-inch-thick daily cover or 12-inch-thick intermediate cover.

Note, the sideslope geocomposite should be day-lighted a maximum distance of 375 feet from the crest of the sideslope and at each subsequent downslope drainage swale or at the landfill perimeter toe of slope, as shown on details provided on Drawing 6C.2. In cases where a drainage length of 375 feet occurs between drainage swales, the geocomposite should be day-lighted at the drainage swale immediately upslope of this location. Additionally, where the geocomposite is day-lighted, the final cover, including landfill toe of slope, will be protected with rock armor to prevent erosion resulting from stormwater seepage from the geocomposite drainage layer. 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.

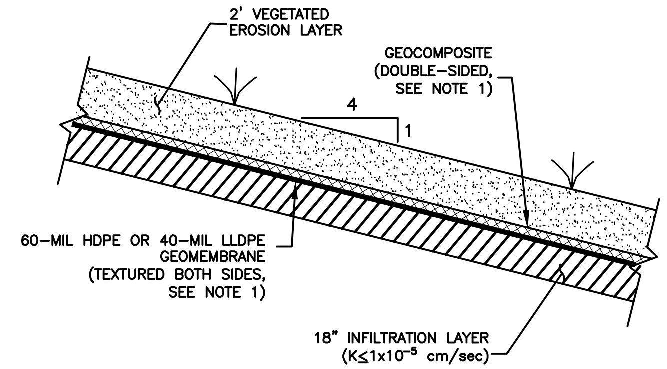
DRAWINGS

- Drawing 6C.1 Bottom Liner Details
- Drawing 6C.2 Final Cover Details



FINAL COVER – TOPSLOPE (A / 6C.2)

NTS

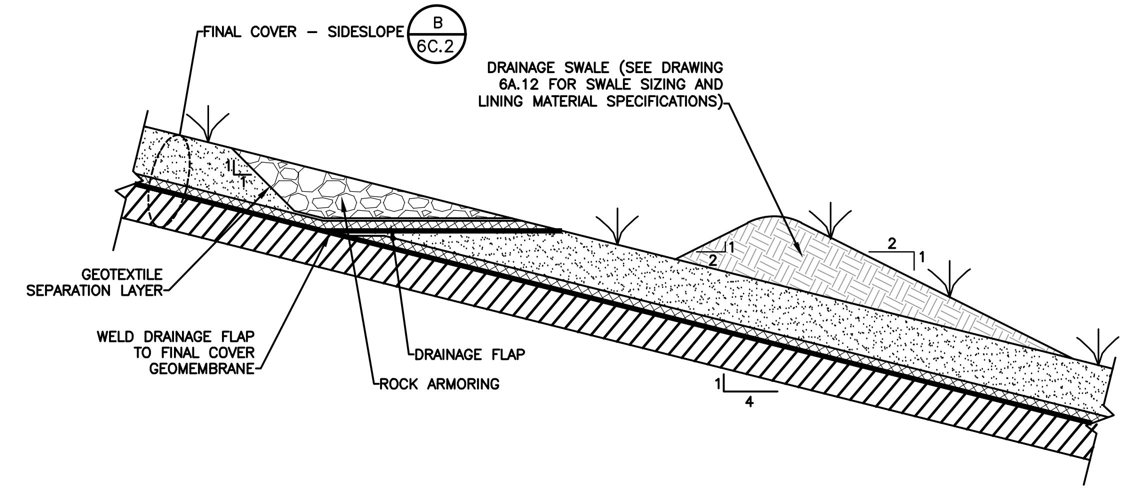


FINAL COVER – SIDESLOPE (B / 6C.2)

NTS

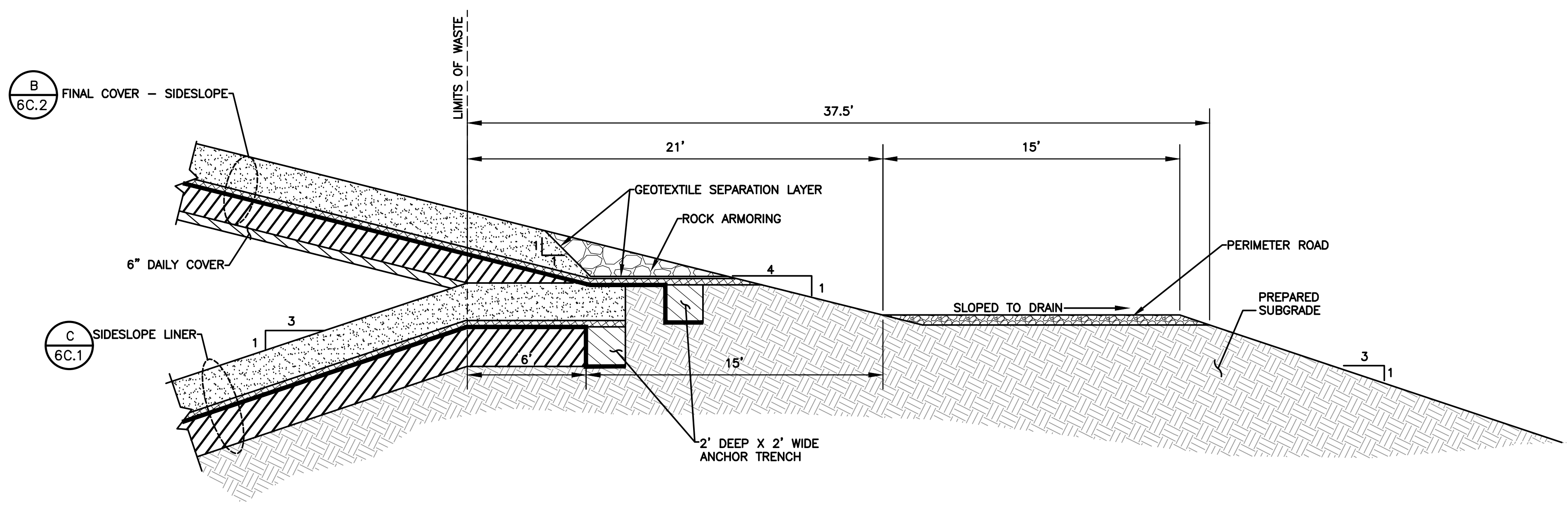
NOTE:

1. TEXTURED GEOMEMBRANE AND DOUBLE-SIDED GEOCOMPOSITE WILL EXTEND A MINIMUM OF 5 FEET ONTO THE LANDFILL TOPSLOPE.



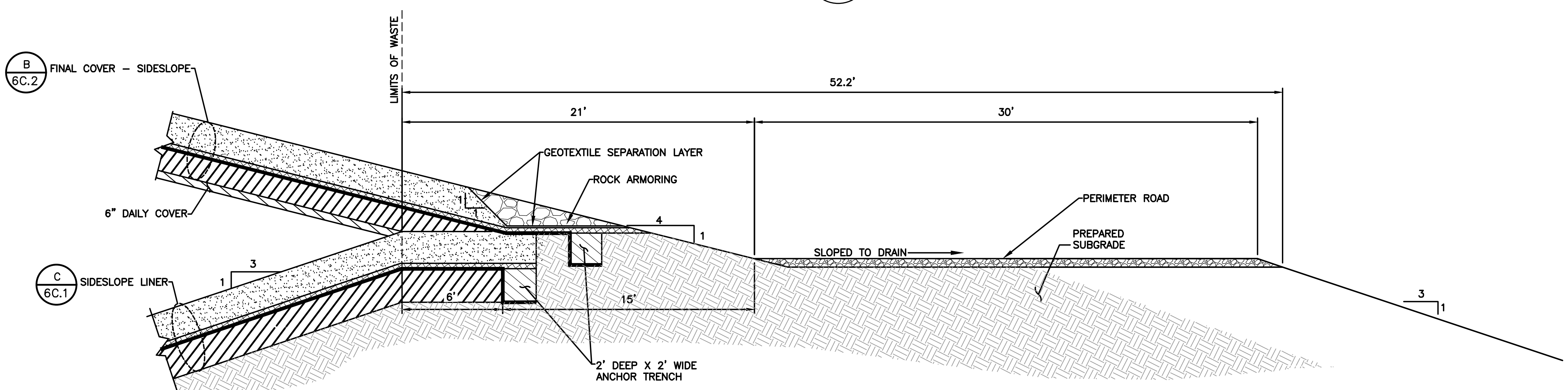
SIDESLOPE SWALE – GEOCOMPOSITE TERMINATION (E / 6C.2)

NTS



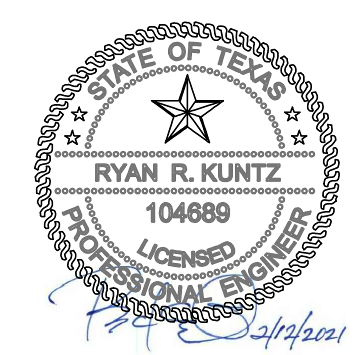
LANDFILL PERIMETER BERM (C / 6C.2)

NTS



LANDFILL PERIMETER BERM (EDA – NORTH) (D / 6C.2)

NTS



FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	10/2020	ADDED GEOCOMPOSITE ON TOPSLOPE OF FINAL COVER. REVISED NOTE 1 TO CHANGE GEOCOMPOSITE EXTENSION LENGTH TO 5 FEET. ON TOP SLOPE.	
2	02/2021	ADDED NEW DETAIL TO DEPICT GEOCOMPOSITE DAYLIGHTING AT SWALE. ADDED ROCK AT TOE OF SLOPE TERMINATION.	

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
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: SDS | 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

2/12/2021 5:14 PM

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

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 8
CLOSURE AND POST-CLOSURE COST ESTIMATES

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, Texas 76710

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – April 2020
Revision 1 – October 2020
Revision 2 – December 2020
Revision 3 – February 2021
SCS Project No. 16216088.00

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3 POST-CLOSURE CARE COST ESTIMATE 8-3-1

4 COST ESTIMATE ADJUSTMENTS 8-4-1

Appendices

8A Closure Cost Estimate Form for Municipal Solid Waste Type I Landfills
8B Closure Cost Estimate Calculations
8C Post-Closure Care Cost Estimate Form for Municipal Solid Waste Type I Landfills
8D Post-Closure Care Cost Estimate Calculations

SCS Engineers
TBPE Reg. # F-3407

APPENDIX 8A

CLOSURE COST ESTIMATE FORM
FOR MUNICIPAL SOLID WASTE TYPE I LANDFILLS

SCS Engineers
TBPE Reg. # F-3407
Inclusive of pages 8A-1 to 8A-15

Texas Commission on Environmental Quality

Closure Cost Estimate Form for Municipal Solid Waste Type I Landfills

This form is for use by applicants or site operators to provide cost estimates for closure of MSW Type I landfills to meet the requirements in 30 Texas Administrative Code (TAC) Chapter 330, Section 330.63(j) and 30 TAC Chapter 330 Subchapter L. The costs to be provided herein are cost estimates for hiring a third party to close the largest waste fill area that could potentially be open in the year to follow and those areas that have not received final cover. If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

Facility Name: City of Waco Landfill

MSW Permit No.: 2400

Site Operator/Permittee Name and Mailing Address: City of Waco

Total Closure Cost Estimate (2020 Dollar Amount): $2,454,380

I. Professional Engineer's Statement, Seal, and Signature

I am a licensed professional engineer in the State of Texas. To the best of my knowledge, this Closure Cost Estimate has been completed in substantial conformance with the facility Closure Plan and, in my professional opinion, is in compliance with Title 30 of the Texas Administrative Code, Chapter 330.

Name: Ryan Kuntz, P.E. Title: Vice President

Date:

Company Name: SCS Engineers Firm Registration Number: F-3407

Professional Engineer's Seal

Professional Engineer's Signature

D. Closure Cost Estimates Worksheet

If any item listed in this worksheet is not applicable to the subject facility, enter "NA" (Not Applicable) in the affected field.

Table 1. Closure Cost Estimates Worksheet.

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
1. Engineering Costs						
1.1	Topographic Survey	Acres	21.3	$70.00	$1,491	(4)
1.2	Boundary Survey	Acres	502.5	$15.00	$7,538	(4)
1.3	Site Evaluation	Acres	502.5	$25.00	$12,563	(4)
1.4	Development of Plans	Lump Sum	1	$35,000	$35,000	(4)
1.5	Contract Administration (bidding and award)	Lump Sum	1	$2,830	$2,830	(4)
1.6	Closure Inspection and Testing	Acres	21.3	$5,000	$106,500	(4)
1.7	TPDES and other Permits	Lump Sum	1	$5,000	$5,000	(4)
1.8	Additional Engineering Cost Items (describe in attachments)	NA	NA	NA	NA	NA
1.9 Engineering Costs Subtotal						
1.9.1	Engineering Costs Subtotal	NA	NA	NA	$170,922	NA
2. Construction Costs						
2.1 Mobilization						
2.1.1	Mobilization of Personnel and Equipment	Lump Sum	1	$93,716	$93,716	(4)
2.2 Final Cover System						
2.2.1 Side Slope Cover						
2.2.1a	Infiltration Layer – Compacted Clay	CY	41,233	$2.50	$103,083	(4)
2.2.1b	Infiltration Layer – Geosynthetic Clay Liner	SF	NA	NA	NA	NA
2.2.1c	Flexible Membrane Cover – HDPE	SF	742,200	$0.55	$408,210	(4)
2.2.1d	Flexible Membrane Cover – LLDPE	SF	NA	NA	NA	NA

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.2.1e	Drainage Layer – Aggregate (Geocomposite Termination)	LF	4,695	$32.60	$153,057	(4)
2.2.1f	Drainage Layer – Drainage Geocomposite Material	SF	742,200	$0.60	$445,320	(4)
2.2.1g	Erosion Layer	CY	54,978	$2.75	$151,190	(4)
2.2.1h	Vegetation	Acres	17.04	$1,000	$17,040	(4)
2.2.2 Top Slope Cover						
2.2.2a	Infiltration Layer – Compacted Clay	CY	10,311	$2.50	$25,778	(4)
2.2.2b	Infiltration Layer – Geosynthetic Clay Liner	SF	NA	NA	NA	NA
2.2.2c	Flexible Membrane Cover – HDPE	SF	185,600	$0.50	$92,800	(4)
2.2.2d	Flexible Membrane Cover – LLDPE	SF	NA	NA	NA	NA
2.2.2e	Drainage Layer – Aggregate	CY	NA	NA	NA	NA
2.2.2f	Drainage Layer – Drainage Geocomposite Material	SF	185,600	$0.55	$102,080	(4)
2.2.2g	Erosion Layer	CY	13,748	$2.75	$37,807	(4)
2.2.2h	Vegetation	Acres	4.26	$1,000	$4,260	(4)
2.2.3 Cells for Class 1 Nonhazardous Industrial Waste						
2.2.3a	Dike Construction	NA	NA	NA	NA	NA
2.3 Site Grading						
2.3.1	Site Grading	Acres	21.3	$500	$10,650	(4)
2.4 Site Fencing and Security						
2.4.1	Site Fencing and Security	Lump Sum	1	$10,000	$10,000	(4)
2.5 Landfill Gas Monitoring and Control System						
2.5.1	Gas Control Wells	NA	NA	NA	NA	NA
2.5.2	Gas Header Piping	NA	NA	NA	NA	NA
2.5.3	Gas Lateral Piping	NA	NA	NA	NA	NA
2.5.4	Flare Station	Lump Sum			NA	NA

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.5.5	Condensate Sumps	NA	NA	NA	NA	NA
2.5.6	Completion of LFG Monitoring System	NA	NA	NA	NA	NA
2.6 Groundwater Monitoring System						
2.6.1	Groundwater Monitoring Well Installation	Each	NA	NA	NA	NA
2.6.2	Piezometer and Monitor Well Plugging and Abandonment	Each	NA	NA	NA	NA
2.7 Leachate Management						
2.7.1	Completion of Leachate Management System	NA	NA	NA	NA	NA
2.8 Stormwater Management						
2.8.1	Stormwater Drainage Management System	Lump Sum	1	$313,050	$313,050	(3)
2.9 Other Cost Items						
2.9.1	Additional Construction Cost Items (describe in attachments)	NA	NA	NA	NA	NA
2.10 Construction Costs Subtotal						
2.10.1	Construction Costs Subtotal	NA	NA	NA	$1,968,041	NA
3. Storage and Processing Unit Closure Costs						
3.1	Waste Disposal	☐ Tons ☒ Cubic Yards	180	$1.67	$301	(4)
3.2	Material Removal and Disinfection	Lump Sum	1	$3,900	$3,900	(4)
3.3	Demolition and Disposal	Each	8	$50	$400	(4)
3.4	Additional Storage and Processing Unit Closure Cost Items (describe in attachments)	NA	NA	NA	NA	NA
3.5 Storage and Processing Unit Closure Costs Subtotal						
3.5.1	Storage and Processing Unit Closure Costs Subtotal	NA	NA	NA	$4,601	NA

Closure Cost Estimate for MSW Type I Landfill

Facility Name: __City of Waco Landfill____ Revision No.: ___2_____

Permit No: ___2400_____ Date: __February 2021

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
4. Sum of Engineering, Construction, and Storage and Processing Unit Closure Costs						
4.1	Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals	NA	NA	NA	$2,143,564	NA
5. Contingency						
5.1	Contingency (10% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	$214,356	NA
6. Contract Performance Bond						
6.1	Contract Performance Bond (2% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	$42,871	NA
7. Third Party Administration and Project Management Costs						
7.1	Third Party Administration and Project Management Costs (2.5% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	$53,589	NA
8. Total Closure Costs						
8.1	Total Closure Costs (sum of amounts in Sections 4, 5, 6, and 7)	NA	NA	NA	$2,454,380	NA

[1] For items marked "specify," the responsible professional engineer will enter appropriate unit of measurement

[2] Sources of Unit Costs for Cost Estimates table may include:

(1) Published Cost Estimator Manuals (e.g., RS Means);

(2) Third Party Quotes (e.g., Environmental Field Services Contractors);

(3) Verifiable Data based on Actual Operations; or

(4) Other sources of cost acceptable to the executive director of the TCEQ.

APPENDIX 8B

CLOSURE COST ESTIMATE CALCULATIONS

SCS Engineers
TBPE Reg. # F-3407
Inclusive of pages 8B-1 to 8B-4

2.2.1c Flexible Membrane Cover - HDPE

				742,200	sf			
			$	0.55	/ sf =	$	408,210	

2.2.1e Drainage Layer - Aggregate (Geocomposite Termination)

	2,825	ft at landfill toe-of-slope						
	1,870	ft for swale						
	4,695	ft total length						
	11	sf cross-sectional area of aggregate						
	1,913	cy of aggregate						
Aggregate @	$ 60.00	/ cy =	$	114,800	=	$	24.50	/ lf
13	lf geotextile	@	$	0.30	/ sf =	$	3.90	/ lf
10	lf membrane drainage flap	@	$	0.50	/ sf =	$	5.00	/ lf
10	lf geocomposite runout	@	$	0.55	/ sf =	$	5.50	/ lf
	Swale Geosynthetic Unit Rate:			1,870	lf @	$	14.40	/ lf
	Toe-of-Slope Geotextile Unit Rate:			2,825	lf @	$	3.90	/ lf
	Geosyntehtic Unit Rate (Weighted Average):					$	8.10	/ lf
Geocomposite Termination:	4,695	lf @	$	32.60	/ lf =	$	153,057	

2.2.1f Drainage Layer - Drainage Geocomposite Material (double-sided 200 mil)

				742,200	sf			
			$	0.60	/ sf =	$	445,320	

2.2.1g Erosion Layer

	2.0	ft thick						
	742,200	sf						
	54,978	cy for erosion layer						
	Soil available on-site for installation							
			$	2.75	/ cy =	$	151,190	

2.2.1h Vegetation

	17.04	ac @	$	1,000	/ ac =	$	17,040	

2.2.2 Top Slope Cover

2.2.2a Infiltration Layer - Compacted Clay

	1.5	ft thick						
	185,600	sf						
	10,311	cy for infiltration layer						
	Soil available on-site for installation							
			$	2.50	/ cy =	$	25,778	

2.2.2c Flexible Membrane Cover - HDPE

				185,600	sf			
			$	0.50	/ sf =	$	92,800	

2.2.2f Drainage Layer - Drainage Geocomposite Material (single-sided 200 mil)

				185,600	sf			
			$	0.55	/ sf =	$	102,080	

2.2.2g Erosion Layer

	2.0	ft thick						
	185,600	sf						
	13,748	cy for erosion layer						
	Soil available on-site for installation							
			$	2.75	/ cy =	$	37,807	

2.2.2h Vegetation

	4.26	ac @	$	1,000	/ ac =	$	4,260	

2.3 Site Grading

	21.3	ac @	$	500	/ ac =	$	10,650	

CITY OF WACO LANDFILL
CLOSURE COST ESTIMATE CALCULATIONS

2.4 Site Fencing and Security

If the site were closed prior to entire permitted footprint being filled, site fencing and security for the entire landfill would already be in place. Nevertheless, to ensure adequacy of the fencing for access control, an allowance was included in this estimate.

				Allowance =	$	10,000

2.5 Landfill Gas Monitoring and Control System **(See Note 3)**

0.0	ac @	$	-	/ ac =	$	-

2.6 Groundwater Monitoring System **(See Note 4)**

2.6.1 Groundwater Monitoring Well Installation

0.0	per well @	$	-	/ well =	$	-

2.6.2 Piezometer and Monitor Well Plugging and Abandonment

0.0	per well @	$	-	/ well =	$	-

2.7 Leachate Management

The forced closure scenario assumes that the LCS has been installed. No expenses are projected for this item.

2.8 Stormwater Management

Downchutes	800	lf @	$	200.00	/ lf =	$	160,000
Drainage Swales	5,250	lf @	$	15.00	/ lf =	$	78,750
Drainage Pond Excavation	19,800	cy @	$	3.50	/ cy =	$	69,300
Drainage Pond Outlet Structure					Lump Sum =	$	5,000
					Stormwater Management Subtotal =	$	313,050
					Construction Costs Subtotal =	**$**	**1,968,041**

3.0 Storage and Processing Unit Closure Costs (Citizen's Collection Station)

3.1 Waste Disposal

6.0	roll-off containers (MSW)					
30	cy per container					
180	cy of MSW					
		$	1.67	/ cy =	$	301

3.2 Material Removal and Disinfection **(See Note 5)**

Material						
Tires	1.0	Tire trailer @	$	2,500	/ trailer =	$	2,500
Metals	3.0	Containers @	$	50	/ container =	$	150
Cardboard/Plastics/others	2.0	Containers @	$	50	/ container =	$	100
White Goods	1.0	Containers @	$	50	/ container =	$	50
Disinfection (MSW Containers)	6.0	Containers @	$	100	/ container =	$	600
Disinfection (Facility)					Lump Sum =	$	500
					Subtotal =	$	3,900

3.3 Demolition and Disposal **(See Note 6)**

8.0	Containers @	$	50	/ container =	$	400
				Storage and Processing Unit Closure Costs Subtotal =	**$**	**4,601**

Note 1: As discussed in Section 2 of Attachment 9, this assumes approximately 21.3 acres of waste-in-place in Sector 1.
Note 2: Aerial coverage of topographic survey only required for filled, excavated, and stockpiled areas.
Note 3: Based on landfill gas emissions from landfills of similar size and characteristics, it is assumed that the estimated emissions from the landfill at this stage of development will be below regulatory thresholds that would warrant installation of a LFG control system.
Note 4: Under a forced closure scenario, it is assumed the compliance boundary will not change, and the existing groundwater monitoring system will be sufficient at closure. This also assumes that no piezometers or monitoring wells will be required to be abandoned.
Note 5: Offsite disposal costs of all materials (tires, metals, containers, white goods, etc.) are included, with exception to MSW (see Item 3.1), as well as transporation costs for offsite removal/disposal of the containers, as applicable. Both the contents and containers for metals and white goods will be disposed at a metal salvage yard, concurrently. Disinfection of the MSW containers will occur after disposal at the landfill working face (Item 3.1).
Note 6: This includes disposal of roll-off containers at a metal salvage yard, after disinfection of MSW containers and disposal of cardboard, plastic, and other recycable materials (Item 3.2). It is also assumed there will be no demolition required on-site.

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

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 9
FINAL CLOSURE AND POST-CLOSURE PLAN

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, TX 76710

Prepared by:

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Appendices

9A Closure Plan Form
9B Post-Closure Care Plan Form

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9.1 Final Closure Schedule

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The GP or his/her qualified representative will observe all destructive and non-destructive testing of repairs and will record the number of each repair, type, date and test outcome. Repairs that pass the non-destructive tests will be taken as an indication of an adequate repair. Repairs more than 150 ft long will also be required to have a destructive test performed. Repairs that fail the initial retest will be redone and retested until a passing test results. All work and testing of repairs will be fully documented in a repair log.

2.3.8 Geocomposite and Erosion Layer Testing

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development and stress imparted to the geomembrane. If possible, cover should be placed during the coolest weather available. Small wrinkles should be isolated and covered as quickly as possible to prevent their growth. In no case will the geomembrane be allowed to fold over on itself.

2.3.8.1 Geocomposite

A single-sided and double-sided geocomposite will be installed over the geomembrane on the landfill topslope and sideslopes, respectively. The geocomposite will conform to the material and performance properties specified by the GP, consistent with project construction plans and technical specifications. The geocomposite transmissivity shall meet or exceed a transmissivity of 3.7x10-4 m^2/sec at a gradients of 0.05 and 0.25, for topslope and sideslopes, respectively (see Attachment 12, Appendix 12A – Leachate Generation Model Narrative) and the non-woven geotextile heat-bonded to the geonet shall comply with the minimum material properties presented in the calculations provided in Attachment 12, Appendix 12B. The drainage geocomposite manufacturer (or supplier), will conduct quality control testing at the minimum frequencies and test methods presented in Table 9-2-5 and certify that all materials delivered comply with project specifications. The material certifications shall be reviewed by the GP and approved for the project prior to acceptance of any of the material.

Table 9-2-5. Manufacturer's Testing Schedule for Geocomposite

PRODUCT	TEST	METHOD	MINIMUM FREQUENCY
Resin	Density	ASTM D1505 or D792	1 per batch and every resin lot
	Melt Flow Index	ASTM D1238	
Geonet	Density	ASTM D1505 or D792	1 per 100,000 ft^2 and every resin lot
	Mass/Area	ASTM D1603	
	Thickness	ASTM D5199	
Geotextile	Mass/Area	ASTM D5261	1 per 100,000 ft^2 and every resin lot
	Grab Tensile Strength	ASTM D4632	
	Trapezoidal Tear Strength	ASTM D4533	
	Apparent Opening Size	ASTM D4751	
	Permittivity	ASTM D4491	
Geocomposite	Transmissivity	ASTM D4716	One test per product type

Additionally, conformance testing will be performed for transmissivity (ASTM D4716) and ply adhesion (D413) by an independent third-party laboratory chosen by the GP. Conformance testing for these parameters will be performed at least once per product type and project.

2.3.8.2 Erosion Layer

The erosion layer will consist of a 24-inch-thick soil layer, with the top 6 inches capable of sustaining vegetation in accordance with §330.457(a)(3). The required thickness of the layer will be verified by settlement plates or survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface area. A minimum of two verification points is required. The selected grid will be the same for both beginning and finished elevations of the erosion layer, so that minimum thickness can be calculated and verified. All elevation calculations necessary for thickness determination will be included as part of the supporting documentation in the FCSER.

Drainage aggregate where sideslope geocomposite daylights (see Attachment 6C, Drawing 6C.2) at drainage swales or landfill toe-of-slope will consist of durable particles of crushed stone, natural gravel, or lightweight aggregate free of silt, clay, or other unsuitable materials. The aggregate shall have a loss of mass due to calcium carbonate of less than 15 percent (in accordance with J&L Test Designation S-105-89 or ASTM D3042 modified to use a solution of hydrochloric acid having a pH of 5). The drainage aggregate will meet the following gradation:

Sieve Size Square Opening	Percent Passing
2 inches	100
½ inch	0 – 5

The drainage aggregate shall be tested for gradation and calcium carbonate, in accordance with ASTM C136 and J&L Test Designation S-105-89 or ASTM D3042 modified, respectively, at the supply source at a minimum of 1 test per source/3,000 cubic yards, whichever is greater. The physical characteristics of the aggregate shall be evaluated through visual inspection and laboratory classification testing before construction and visual inspection during construction. The drainage aggregate may be tested during construction at the discretion of the CQA Monitor. The test results for the drainage aggregate will be included in the FCSER.

The erosion layer and geocomposite termination drainage aggregate does not require compaction control; however, it should be stable for construction and disposal traffic. The erosion layer will be deployed in "fingers" along the geomembrane or geocomposite to control the amount of slack and minimize wrinkles and/or folds. Soil cover will generally be placed in an up-slope direction on sideslopes so that stress imparted to the geocomposite and geomembrane is minimized. Care will be exercised in placement of the erosion layer and drainage aggregate so as not to shift, wrinkle or damage any underlying geosynthetic layers, and the placement methods will be documented.

2.4 FINAL COVER SYSTEM EVALUATION REPORT

Upon completion of each area of final cover construction and evaluation, the GP will prepare and submit in triplicate the FCSER, prepared in accordance with this plan, to the TCEQ for review and approval. This report will be submitted along with a construction documentation report.

Each FCSER will include a discussion of the construction of the final cover elements, a cover placement map which shows the covered area being submitted for approval and areas covered by all previous FCSER submittals with the dates of acceptance by the TCEQ. The map should depict the site grid system, graphic scale, and north arrow. The FCSER will be signed and/or sealed by the GP performing the evaluation and a representative of the site operator.

The construction documentation will contain a narrative describing the work performed and the testing procedures performed prior to and during construction, record drawings, and results of field and laboratory testing. The FCSER will include the following:

- All field and laboratory test documentation for infiltration layer soils, including test and sample locations plotted on plan view drawings representing each 6 inch lift;
- Geomembrane manufacturer's certifications, documentation of all manufacturer's and independent testing, geomembrane seaming and repair logs, seam testing results, and a site map showing locations of panels, repairs, and tests;
- Geocomposite manufacturer's certification and testing documentation; and
- Survey documentation for the thickness of the infiltration layer and erosion layer.

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

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 10
SOILS AND LINER QUALITY CONTROL PLAN

Prepared for:

CITY OF WACO

Solid Waste Services
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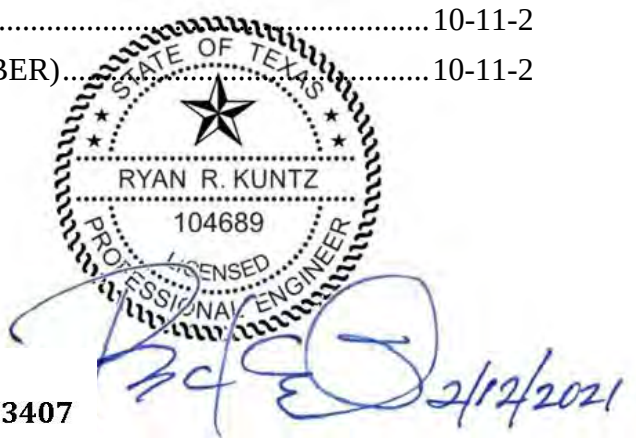

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When the base of the cell excavation extends below the SHWT, the stability of the liner system against hydrostatic uplift is considered for two cases: (1) short-term, i.e., during construction and filling operations; and (2) long-term, i.e., after filling and into post-closure. Short-term stability against uplift of the liner system will be required by installation of an active underdrain system when excavation is below the SHWT. Underdrain systems constructed beneath the landfill cells prevent development of excessive hydrostatic uplift pressures until an adequate thickness of soils and waste ballast is achieved. Long-term stability against uplift of the liner systems is provided by the weight of the clay liner, liner protective cover, soil ballast, waste materials, and final cover system components, or collectively, ballast. Once an adequate thickness of ballast is provided, underdrain systems, if employed to provide short-term stability, are decommissioned upon approval from the TCEQ. The assumptions and calculations for the ballast evaluation and underdrain design are described in Section 11.5 (see also Appendix 10C) and Appendix 10D, respectively.

2.5.1 Control of Seepage During Construction (Short-Term Groundwater Control)

The base of the proposed excavation will be located in the Taylor Group (Wolfe City Formation), shale-marl, portions of which may be below the seasonal high groundwater table. Hydraulic conductivity test results for the geologic stratum at the Site are summarized in Attachment 5 – Geotechnical/Stability Analysis and the laboratory results of the hydraulic conductivity results are provided in Attachment 4 – Geology and Groundwater Report, Appendix III-4.F.

If groundwater seepage is observed in measureable quantities that could be detrimental to the overlying liner or softening of the subgrade, the GP will provide a summary of his observations of the seepage, the methods and procedures used to control the seepage and stabilize the foundation soils, and verification that the seepage has been controlled prior to liner placement. If groundwater seepage is observed from an area during construction that will be detrimental to the overlying liner or if excavation is below the SHWT, an underdrain system to control groundwater will be employed for that cell area, and the design of the underdrain system will be designed by a Professional Engineer licensed in the State of Texas using the calculation methodology presented in Appendix 10D. Any underdrain system installed within a respective cell will be documented in the SLER and GLER for the respective constructed cell. The underdrain design presented in Appendix 10D is based on the assumed SHWT map described in Section 2.5.2 and presented in Appendix 10B. This design represents the worst case scenario of groundwater seepage and can be used directly for design of an underdrain system for all future disposal cells/areas of the landfill.

As discussed in Section 2.5, when installed, an underdrain system may be decommissioned upon approval of TCEQ once an adequate thickness of ballast is achieved for long-term stability against hydrostatic uplift. A Ballast Evaluation Report (BER) will be prepared and submitted to TCEQ, as discussed in Section 11.5, when ballast or dewatering (i.e., for cells/areas with an installed underdrain system) is no longer necessary in accordance with §330.337(j).

2.5.2 Seasonal High Groundwater Table

A SHWT map has been developed based on standard standpipe piezometers and vibrating wire piezometers (VWPs) installed at the site during the subsurface and groundwater investigation (see Attachment 4, Section 6). Based on the observations presented in Attachment 4, the shallow occurrences of groundwater do not appear to be uniform across the site and may occur in isolated pockets; there exists a continuously saturated groundwater zone that occurs at deeper elevations below the base of the proposed excavation grades; and the shallow and deep occurrences of groundwater do not appear to be hydraulically connected. However, as a conservative approach to sizing underdrain components for short-term groundwater control and evaluating long-term groundwater control (waste or soil ballast), if needed, the SHWT map was developed with a culmination of high water level readings from both the shallow standpipe piezometers/VWPs and deep VWPs installed at the site during the groundwater investigation. This SHWT map, provided in Appendix 10B, depicts the measurement points, including the seasonal high groundwater table (SHWT) levels, and future excavation grades. As shown on the map, portions of the excavation grades extend below this assumed SHWT.

As noted in this SLQCP, the SHWT map will be reviewed and updated, if necessary, prior to the design of each cell based on the most recent data available at the time of design. If the groundwater elevations at monitoring points has increased since the last cell construction, the SHWT map will be revised upward to reflect those increases. An updated SHWT map will be presented in the SLER and GLER. In addition, observations of the subgrade soil characteristics and indications of groundwater seepage (if any) and potential impacts to the dewatering and ballast calculations will also be documented in the SLER and GLER.

- All test documentation for leachate collection and protective cover layers (GLER);
- For geomembrane, include manufacturer's certifications, documentation of all manufacturer's and independent testing, seam tests (non-destructive and destructive seam testing), and seaming and repair records (GLER);
- Manufacturer's certification and testing documentation for all geosynthetics (SLER/GLER); and
- Survey documentation of the thickness of the soil liner (SLER), a geomembrane drawing showing locations of panels, repairs, and destructive tests (GLER), leachate collection (GLER), and protective cover layers (GLER).

11.4 INTERIM STATUS REPORT

For any liner that will remain uncovered with waste for a period exceeding 6 months, Interim Status Reports will be prepared and submitted to the TCEQ, in accordance with 30 TAC §330.341(d). Any damaged areas will be repaired promptly. A new report shall be submitted on the new construction for all liners that need repair due to damage.

11.5 BALLAST EVALUATION REPORT (BER)

If ballast or an underdrain system are required during cell construction, the Owner/Operator will submit a Ballast Evaluation Report (BER) following confirmation that an adequate thickness of ballast has been placed or dewatering through the use of an underdrain is no longer necessary. An underdrain system may be decommissioned upon approval of TCEQ once an adequate thickness of ballast is achieved for long-term stability against hydrostatic uplift, as described in Section 2.5. If a BER is required, it will be prepared and submitted to the TCEQ, in accordance with the requirements set forth in 30 TAC §330.337(j).

The BER will incorporate the following components:

- Summary of soil stratigraphy and soil properties exposed on the bottom and sideslopes of the constructed cell.
- Adjusted seasonal high water table based on groundwater monitoring well data and other site observations.
- Calculation of ballast required, and type of ballast to be used (soil and/or waste), as described in Section 11.5.1.
- Discussion of whether an underdrain system or other dewatering system will be installed, as described in Section 2.5. In the event a dewatering system is required, the design of the dewatering system will be submitted with the SLER, GLER and BER and maintained in the Site Operating Record.

- Method of controlling uplift forces during construction (low-permeability foundation soil, dewatering, or combination).

- Monitoring of dewatering system, if required, to demonstrate that hydrostatic forces did not develop during liner construction.

- Subgrade and top-of-liner elevations, as reported in the respective SLER and confirmation of liner weight.

- Certification that ballast met the criteria established in Section 11.5.1 and in the liner quality control plan.

- The BER will be signed and sealed by an independent licensed professional engineer performing the evaluation and will include the signature of the facility operator or their authorized representative.

A BER should be submitted to the TCEQ after sufficient ballast is in place to demonstrate adequate uplift resistance against the long-term seasonal high groundwater table for a given waste phase. If the TCEQ provides no response within 14 days of the date of receipt of the BER, the Owner may discontinue the operation of the underdrain system, in the event a dewatering system is installed.

11.5.1 Ballast Calculations (Long-Term Groundwater Controls)

Calculations will be prepared that demonstrate that the weight of the liner system, including ballast, is sufficient to offset any unbalanced upward or inward hydrostatic forces on the liner by a factor of 1.2 (for soil ballast) or 1.5 (for waste ballast). Sample ballasting calculations are provided in Appendix 10C. The unit weight values used in the sample calculations are assumptions only. Field-verified values will be incorporated into the BER.

11.5.2 Soil as Ballast

If soil is to be used as ballast, it will be placed after liner system construction. Soil ballast may include the protective cover, leachate collection system, additional soil over the liner or waste, and intermediate and final cover soils. For soil ballast placed during cell construction, the SLER should include a statement that the soil ballast, or a component of the ballast (i.e. protective cover or additional soil over protective cover) will be documented in the GLER, which will include the following field confirmations and calculations:

- Determine the density of the soil used as ballast. An estimate of soil density will be developed using geotechnical properties developed during soil construction.

- Initial and final survey of the area to receive soil as ballast, which should be accomplished at the same frequency required in this SLQCP for the liner. The top of clay survey or geomembrane survey may be used as the initial survey for soil ballast.

- Calculate the thickness of soil utilized as ballast (from survey), to determine the resulting confining pressure from the soil ballast. The calculated confining pressure for soil ballast will be reduced by a factor-of-safety of 1.2 in accordance with 30 TAC §330.337(b)(1).

11.5.3 Waste as Ballast – 40,000 Pound or Greater Compactor

If waste is a component used for ballast, the approval of the GLER must first be received from TCEQ prior to ballasting. The BER must include (in addition to the items described in Section 11.4) the following documentation and calculations:

- Certification from the landfill operator that the wheeled compactor used to compact the waste weighs no less than 40,000 pounds, and that the compactor was utilized during the entire period of placing the waste ballast.

- Certification from the landfill operator that the type of waste placed in the lower 5 feet was free of brush and large bulky items, which would damage the underlying system or which cannot be compacted to the required density.

- Initial and final survey of the area to receive waste as ballast to determine the thickness of waste. The survey of the top of protective cover can be used as the initial survey.

- Calculation of the confining pressure of the waste by assuming a density of 1,200 pounds per cubic yard in accordance with 30 TAC §330.337(h)(2). The confining pressure for the waste ballast will be reduced by a factor-of-safety of 1.5.

11.5.4 Waste as Ballast – Less Than 40,000 Pound Compactor

If a less than 40,000 pound compactor is used, calculations to determine the in-place density of waste will be performed. These calculations will include the following:

- Initial survey of the area to receive waste as ballast. The survey of the top of the protective cover may be used for this initial survey.

- Weight of waste placed, based on actual measurements of truck weights at the scalehouse.

- Survey of the top of waste to document that the thickness calculated in the GLER has been placed.

- Calculate the volume of waste used as ballast from the survey. The actual density of the placed waste will be calculated by dividing the previously recorded weight by the volume of waste determined by the survey. The calculated density will be used in the ballast calculations. In the event the calculated density is greater than 1,200 pounds per cubic yard, a density of 1,200 pounds per cubic yard will be used for the ballast calculations. As previously stated, the confining pressure for the waste ballast will be reduced by a factor of safety of 1.5 in accordance with 30 TAC §330.337(h)(2).

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

PART III
SITE DEVELOPMENT PLAN -ATTACHMENT 12
LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN

Prepared for:

CITY OF WACO

Solid Waste Services
501 Schroeder Drive
Waco, TX 76710

Prepared by:

SCS ENGINEERS
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Revision 0 – April 2020
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APPENDIX 12A

LEACHATE GENERATION MODEL (HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP) OUTPUT FILES)

- Leachate Generation Model Narrative
- Climatological Data
- Help Model Summary Sheets
- HELP Output Files (Without Leachate Recirculation)
- HELP Output Files (With Leachate Recirculation)

LEACHATE GENERATION MODEL NARRATIVE

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

PART III
SITE DEVELOPMENT PLAN
ATTACHMENT 12, APPENDIX A
LEACHATE GENERATION MODEL NARRATIVE

Prepared for:

CITY OF WACO

Public Works Department
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Waco, TX 76701

Prepared by:

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Revision 0 – July 2019
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conditions, the hydraulic conductivity was assumed to be 1.0 x 10^{-3} cm/s (i.e., HELP default) for the top 100 ft of waste. For the remaining lower thickness of waste, where the waste has been compacted and in-place for longer periods, 5.0 x 10^{-4} cm/s was used as hydraulic conductivity

Lower hydraulic conductivity of landfilled MSW is attributed to increased overburden stress and increased finer particles resulting from degradation. Reddy et. al. (2011) reported two orders of magnitude reduction in hydraulic conductivity of synthetic MSW with degradation. In another study, hydraulic conductivities of 1 x 10^{-4} cm/s to 1 x 10^{-7} cm/s are reported for MSW for uncompacted MSW and MSW at 90 feet depth, respectively (Reddy et. al., 2009).

1.4.3.5 Daily and Intermediate Cover

The daily cover for active condition consists of a 6-inch-thick layer of soil and the intermediate cover for the interim condition has an additional 6-inch layer of soil for a total thickness of 12 inches. The daily and intermediate cover were assumed to be clayey soil, with a hydraulic conductivity of 1.7 x 10^{-5} cm/s. Default soil characteristics were used for the daily and intermediate cover soils (HELP default texture 15).

1.4.3.6 Final Cover

Final cover on the landfill topslope and sideslopes from top to bottom will consist of a 24-inch thick erosion layer, a geocomposite drainage layer, a 40-mil geomembrane, and an 18-inch thick infiltration layer (compacted clay). The geocomposite will be installed to drain infiltrating water from the final cover. Both topslope and sideslope cover systems were evaluated in the HELP modeling. The minimum manufactured thickness of the geocomposite will be 200-mil (approximately 0.20 inches). To evaluate the hydraulic performance of the geocomposite layer, the hydraulic conductivity value used in the HELP model was adjusted until the maximum depth of stormwater percolating through the erosion layer to the geocomposite (for peak daily flow) was less than or approximately equal to the thickness of the geocomposite (i.e., less than 0.20 inches). In this manner water flow above the geomembrane was confined in the geocomposite layer only. Based on this evaluation the minimum allowable transmissivity was calculated based on the hydraulic conductivity to be 3.7x10^{-4} m^2/sec (i.e., T_{min} = k x t x 2.54 cm/in x 0.0001 m^2/cm^2, where T_{min} = Transmissivity [minimum, m^2/sec], k = hydraulic conductivity [cm/sec], and t = Geocomposite Thickness [inches]) at gradients of 0.05 and 0.25 for topslope and sideslopes, respectively. For the sideslope geocomposite analysis, the average annual drainage collected from the topslope over the modeling period was input into the sideslope model, as subsurface inflow into the geocomposite drainage layer. This approach models the conveyance of water flow within the geocomposite associated with the topslope and sideslope flow combined (i.e., water collected from the topslope flows into the sideslope geocomposite). The result of the sideslope cover system analysis demonstrates that the maximum depth of stormwater within the geocomposite is limited to the thickness of the geocomposite (i.e., 0.20 inches) for a maximum drainage length of 375 feet. As a result, the final cover design includes daylighting the geocomposite at drainage swales and the landfill perimeter top of slope located no greater than 375 feet apart, as shown in Attachment 6C, Drawing 6C.2.

For the purposes of this model, it has been assumed that the erosion layer will consist of a clayey soil with a hydraulic conductivity of 1.7 x 10^{-5} cm/s, consistent with soil modeled from daily and

intermediate cover described in Section 1.4.3.5. The geomembrane was modeled for good installation quality, 4 defect per acre, and a pinhole density of 1 hole/acre (Berger and Schroeder, 2013). The infiltration layer will consist of compacted soil with a hydraulic conductivity of 1.0 x 10^{-5} cm/s or less. Default soil characteristics from the HELP model were selected to represent the layers within the final cover system.

1.5 LEACHATE RECIRCULATION

As previously mentioned, the active and interim conditions, described in Section 1.4.1 of this appendix, were also modeled for leachate recirculation. For both scenarios, the weather data described in Section 1.4.2 was used in the model. These conditions are considered representative of the worst case below-grade and above-grade conditions for which leachate generation and resulting leachate head would be affected by leachate recirculation.

A synthetic storm duration of 10 years was modeled for the active condition. A synthetic storm duration of 50 years was modeled for the interim conditions, which is greater than the estimated site life of the landfill (note, see Part III narrative, Section 2.2 for estimated site life of the landfill). Since the maximum time leachate recirculation can take place is less than 50 years, and in accordance with standard engineering practice, this duration is appropriate for analysis of the impacts on the leachate collection system associated with leachate recirculation. Furthermore, this duration conservatively approximates the longest time period for which the below-grade and above-grade waste disposal will likely occur for a given sector of the landfill.

Incorporating the above assumptions, for both the active and interim conditions, the percentage of leachate recirculated was increased within the HELP model until the calculated leachate head on the liner was less than or equal to the compressed thickness of the geocomposite. The model results for leachate recirculation are summarized in the HELP Model Summary Sheet (with leachate recirculation) provided in this appendix.

The allowable leachate recirculation volume is provided in the table below. Based on the results of the leachate recirculation demonstration, the allowable leachate recirculation volume for below-grade and above-grade waste disposal is represented by the active, 10-foot waste condition and interim, 170-foot waste condition, respectively. As shown, during periods of leachate recirculation, leachate head on the liner is maintained within the compressed thickness of the geocomposite. However, it should be noted that in all cases, actual leachate recirculation will also be controlled by the ability of the landfill operator to meet the 30-centimeter maximum leachate head over the bottom liner criteria, as verified by monitoring of the leachate levels at the sumps, as described in Attachment 12, Section 3.5.

ALLOWABLE LEACHATE RECIRCULATION

Fill Condition	Average Annual Recirculation (cf/yr/ac) [1]	Peak Leachate Head (in)	Allowable Recirculation (gallons/yr/ac)[2]
Below-Grade	80,200	0.22	599,900
Above-Grade	26,690	0.19	199,640

[1] Referenced from the HELP Model Output (with leachate recirculation) provided in this appendix.
[2] The allowable recirculation values pertain to areas draining to a common sump.

1.6 HELP MODEL RESULTS

The HELP model results are presented in the attached HELP Model Summary Sheets for both "without leachate recirculation" and "with leachate recirculation." Additionally, the HELP model output files are also provided in this appendix. As presented in the HELP model output, the depth of leachate over the bottom liner is predicted to be confined to the geocomposite lateral drainage layer, which is well below the 30 centimeter regulatory requirement, whether during periods of with or without leachate recirculation.

1.7 REFERENCES

Berger, K. and Schroeder, P.R. "The Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for HELP-D Version 3.95 D", Version 3.95 D, Institute of Soil Science, University of Hamburg, Germany, 2013.

Reddy, K., Hettiarachchi, H., Gangathulasi, J., and Bogner, J.E. "Geotechnical Properties of Fresh Municipal Solid Waste at Orchard Hills Landfill, USA", Waste Management, 29, pp. 952-959, 2009.

Reddy, K., Hettiarachchi, H., Gangathulasi, J., and Bogner, J.E. "Geotechnical Properties of Municipal Solid Waste at Different Phases of Biodegradation", Waste Management, 31, pp. 2275-2286, 2011.

HELP OUTPUT FILES
(WITHOUT LEACHATE RECIRCULATION)

SCS Engineers
TBPE Reg. # F-3407

Inclusive of pages 12A-19 to 12A-58(11)

```
**************************************************************************
**************************************************************************
**                                                                      **
**                                                                      **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE            **
**                                                                      **
**              HELP Version 3.95 D          (10 August 2012)           **
**                              developed at                            **
**        Institute of Soil Science, University of Hamburg, Germany     **
**                                 based on                             **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)           **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY               **
**                    USAE WATERWAYS EXPERIMENT STATION                 **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY          **
**                                                                      **
**                                                                      **
**************************************************************************
**************************************************************************


TIME:  13.04     DATE:  10.2.2021


PRECIPITATION DATA FILE:      M:\Proj\Waco\16216088…\…\Waco-50.d4
TEMPERATURE DATA FILE:        M:\Proj\Waco\16216088…\…\Waco-50.d7
SOLAR RADIATION DATA FILE:    M:\Proj\Waco\16216088…\…\Waco-50.d13
EVAPOTRANSPIRATION DATA F. 1: M:\Proj\Waco\16216088…\…\Waco-Final Cover.d11
SOIL AND DESIGN DATA FILE  1: M:\Proj\Waco\16216088…\…\Case 5_2(2-3-21).d10
OUTPUT DATA FILE:             M:\Proj\Waco\16216088…\…\Case 5_2.out


**************************************************************************

     TITLE:  Waco New LF - Case 5 - Final Cover – Sideslope

**************************************************************************


                          WEATHER DATA SOURCES
--------------------------------------------------------------------------


         NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR    WACO                TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.02        2.36        2.68        3.42        4.51        3.06
       1.84        1.92        3.04        3.60        2.49        2.32
```

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING

COEFFICIENTS FOR WACO TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.20	50.50	58.10	67.10	74.20	81.90
85.90	85.60	79.20	68.80	57.00	49.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR WACO TEXAS
AND STATION LATITUDE = 31.37 DEGREES

****

LAYER DATA 1

VALID FOR 50 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 15

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4750	VOL/VOL
FIELD CAPACITY	=	0.3780	VOL/VOL
WILTING POINT	=	0.2650	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3789	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1700E-04	CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL

```
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0318 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       7.250     CM/SEC
SLOPE                       =      25.00   PERCENT
DRAINAGE LENGTH             =     375.0    FEET
SUBSURFACE INFLOW           =       2.59    INCHES/YR


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.4000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

            TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     18.00   INCHES
POROSITY                    =      0.4750 VOL/VOL
FIELD CAPACITY              =      0.3780 VOL/VOL
WILTING POINT               =      0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4750 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  15
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4750 VOL/VOL
FIELD CAPACITY              =      0.3780 VOL/VOL
WILTING POINT               =      0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3780 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1700E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1200.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
```

```
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    840.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.5000E-03 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  15
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4750 VOL/VOL
FIELD CAPACITY              =      0.3780 VOL/VOL
WILTING POINT               =      0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3780 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1700E-04 CM/SEC


                        LAYER  9
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.19   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       3.000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    340.0    FEET


                        LAYER 10
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
```

```
FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD

                          LAYER 11
                          --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  16
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4270 VOL/VOL
FIELD CAPACITY              =      0.4180 VOL/VOL
WILTING POINT               =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC

******************************************************************************

               GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                          VALID FOR  50 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                  SOIL DATA BASE USING SOIL TEXTURE #15 WITH A
                  GOOD STAND OF GRASS, A SURFACE SLOPE OF  25.%
                  AND A SLOPE LENGTH OF  375. FEET.

       SCS RUNOFF CURVE NUMBER             =     87.10
       FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
       EVAPORATIVE ZONE DEPTH              =     24.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE   =      9.093  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE  =     11.400  INCHES
       FIELD CAPACITY OF EVAPORATIVE ZONE  =      9.072  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE  =      6.360  INCHES
       SOIL EVAPORATION ZONE DEPTH         =     24.000  INCHES
       INITIAL SNOW WATER                  =      0.000  INCHES
       INITIAL INTERCEPTION WATER          =      0.000  INCHES
       INITIAL WATER IN LAYER MATERIALS    =    637.187  INCHES
       TOTAL INITIAL WATER                 =    637.187  INCHES
       TOTAL SUBSURFACE INFLOW             =      2.58   INCHES/YEAR

******************************************************************************

                        EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                          VALID FOR  50 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
```

```
     WACO                TEXAS
STATION LATITUDE                        =  31.37 DEGREES
MAXIMUM LEAF AREA INDEX                 =   3.50
START OF GROWING SEASON (JULIAN DATE)   =     55
END OF GROWING SEASON (JULIAN DATE)     =    336
EVAPORATIVE ZONE DEPTH                  =  24.0  INCHES
AVERAGE ANNUAL WIND SPEED               =  11.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  69.0  %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  69.0  %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  62.0  %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  69.0  %

*******************************************************************************


*******************************************************************************

                  FINAL WATER STORAGE AT END OF YEAR   50
-------------------------------------------------------------------------------

                   LAYER        (INCHES)       (VOL/VOL)
                   -----        --------       ---------
                     1            9.2719         0.3863

                     2            0.0020         0.0100

                     3            0.0000         0.0000

                     4            8.5500         0.4750

                     5            4.5360         0.3780

                     6          350.4000         0.2920

                     7          245.2800         0.2920

                     8            9.0720         0.3780

                     9            0.0019         0.0100

                    10            0.0000         0.0000

                    11           10.2480         0.4270

    TOTAL WATER IN LAYERS        637.362

    SNOW WATER                     0.000

    INTERCEPTION WATER             0.000

    TOTAL FINAL WATER            637.362

*******************************************************************************
```

```
******************************************************************************

                PEAK DAILY VALUES FOR YEARS    1 THROUGH   50
------------------------------------------------------------------------------

                                                 (INCHES)      (CU. FT.)
                                                ----------   -------------
     PRECIPITATION                                5.66         20545.799

     RUNOFF                                       3.123        11337.2002

     DRAINAGE COLLECTED FROM LAYER  2             0.60530       2197.24170

     PERCOLATION/LEAKAGE THROUGH LAYER  4         0.000003         0.00941

     AVERAGE HEAD ON TOP OF LAYER  3              0.031

     MAXIMUM HEAD ON TOP OF LAYER  3              0.196

     LOCATION OF MAXIMUM HEAD IN LAYER  2
          (DISTANCE FROM DRAIN)                   0.0 FEET

     DRAINAGE COLLECTED FROM LAYER  9             0.00000          0.00631

     PERCOLATION/LEAKAGE THROUGH LAYER 11         0.000000         0.00002

     AVERAGE HEAD ON TOP OF LAYER 10              0.000

     MAXIMUM HEAD ON TOP OF LAYER 10              0.014

     LOCATION OF MAXIMUM HEAD IN LAYER  9
          (DISTANCE FROM DRAIN)                   0.0 FEET

     SNOW WATER                                   2.59          9392.4756

     MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4561

     MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.2650


      ***  Maximum heads are computed using McEnroe's equations.  ***

           Reference:  Maximum Saturated Depth over Landfill Liner
                       by Bruce M. McEnroe, University of Kansas
                       ASCE Journal of Environmental Engineering
                       Vol. 119, No. 2, March 1993, pp. 262-270.

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 50

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.09	2.55	2.88	2.82	4.24	3.28
	1.61	2.02	2.85	3.09	2.28	2.20
STD. DEVIATIONS	1.16	1.39	1.58	1.71	2.31	2.14
	1.80	1.54	1.81	2.07	1.35	1.33
RUNOFF						
TOTALS	0.083	0.179	0.255	0.195	0.430	0.316
	0.195	0.111	0.242	0.502	0.156	0.169
STD. DEVIATIONS	0.126	0.281	0.328	0.307	0.601	0.521
	0.416	0.250	0.394	0.866	0.263	0.285
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	2.825	3.214	4.948	6.416	7.903	8.848
	10.150	9.273	7.323	5.080	3.489	2.836
STD. DEVIATIONS	0.232	0.248	0.382	0.363	0.319	0.379
	0.308	0.315	0.386	0.253	0.233	0.236
ACTUAL EVAPOTRANSPIRATION						
TOTALS	1.395	1.688	2.419	4.119	3.632	3.214
	1.788	1.662	2.305	1.585	1.322	1.399
STD. DEVIATIONS	0.451	0.517	0.764	1.000	1.630	1.534
	1.714	1.043	1.274	0.776	0.577	0.448
SUBSURFACE INFLOW INTO LAYER 2						
TOTALS	0.2200	0.2004	0.2200	0.2129	0.2200	0.2129
	0.2200	0.2200	0.2129	0.2200	0.2129	0.2200
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.5775	0.7407	0.8270	0.4102	0.2212	0.2336
	0.2280	0.2198	0.2139	0.2989	0.4406	0.7100

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  STD. DEVIATIONS        0.4176   0.6342   0.6823   0.3907   0.0102   0.1064
                         0.0445   0.0000   0.0087   0.2828   0.4987   0.5997


 PERCOLATION/LEAKAGE THROUGH LAYER  4
 -------------------------------------
  TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 LATERAL DRAINAGE COLLECTED FROM LAYER  9
 ----------------------------------------
  TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER 11
 -------------------------------------
  TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


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              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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 DAILY AVERAGE HEAD ON TOP OF LAYER  3
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  AVERAGES               0.0008   0.0011   0.0011   0.0006   0.0003   0.0003
                         0.0003   0.0003   0.0003   0.0004   0.0006   0.0010

  STD. DEVIATIONS        0.0006   0.0010   0.0010   0.0006   0.0000   0.0002
                         0.0001   0.0000   0.0000   0.0004   0.0007   0.0008

 DAILY AVERAGE HEAD ON TOP OF LAYER 10
 -------------------------------------
  AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 50

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.90 (5.608)	115783.9	100.00
RUNOFF	2.833 (1.2622)	10282.85	8.881
POTENTIAL EVAPOTRANSPIRATION	72.306 (1.0943)	262470.91	
ACTUAL EVAPOTRANSPIRATION	26.528 (3.6899)	96296.37	83.169
SUBSURFACE INFLOW INTO LAYER 2	2.59170	9407.881	8.12538
LATERAL DRAINAGE COLLECTED FROM LAYER 2	5.12125 (1.35736)	18590.146	16.05589
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00003 (0.00001)	0.115	0.00010
AVERAGE HEAD ON TOP OF LAYER 3	0.001 (0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.00003 (0.00001)	0.106	0.00009
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (0.00000)	0.009	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.004 (1.2891)	12.89	0.011

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