Table 3-3 Leachate Sump Operating Plan

Leachate Level Description	Condition	Action Required
Leachate level between lip of sump and pump intake at the bottom of the sump.	System is functioning as designed. The drainage geocomposite leachate collection layer installed on the floor of the landfill is designed to convey the estimated peak leachate flow rate without the leachate level within the geocomposite exceeding the thickness of the geocomposite. The operation of the leachate sump and the conveyance capacity of the geocomposite leachate collection layer work in tandem to maintain compliance with the design standard listed in §330.331(a)(1).	The depth of leachate in the sump is monitored by a landfill personnel at least 1 time per week. Leachate flow to the sump and sump pump capacity are listed in Table 4-1. The sump design is discussed in Section 3.4.
Leachate level between the lip of the sump and 0.02 inches (0.05 cm) above the lip of the sump.	The 0.02-inch design standard listed in Appendix IIIK per §330.331(a)(1) has not been exceeded.	For these two conditions, the sump operation will be monitored daily until the leachate is pumped out by the Operator. For both conditions, the leachate levels in the sump will be recorded daily. If it is determined that the pump is malfunctioning, it will be removed and replaced immediately. In addition, the pumps will be replaced when it is determined that a larger capacity pump is needed based on existing conditions.
Leachate level over 0.025 inches above the lip of the sump.	The design standard listed in Appendix IIIK per §330.331(a)(1) has been exceeded.	

drainage area, swale, or channel. This method uses physical (measurable) characteristics (e.g., flow lengths, slopes, surface roughness coefficients, channel cross sections) of a watershed to estimate peak discharges.

3.2.6.2 Snyder Unit Hydrograph Method

The Snyder unit hydrograph method has been used mainly for non-landfill drainage areas (e.g., offsite drainage areas). The method is applicable to drainage areas with a wide range of characteristics. Several different methods have been developed to estimate Snyder unit hydrograph parameters (watershed lag and peaking coefficient). Espey "10-Minute" method was used in this project to estimate Snyder unit hydrograph parameters. The Espey "10-Minute" method was developed using flow records from 41 different watersheds in Texas and other states. The main advantage of the Espey "10-Minute" method is that it is one of the most widely used and accepted methods for determining hydrograph input values for small-size drainage areas.

3.2.6.3 Hydrograph Routing

The Muskingum-Cunge Method (RD record in HEC-1) was used for routing of the flood wave through the drainage channels. This method is capable of accounting for hydrograph attenuation based on physical channel properties such as length, bottom slope, channel shape, and channel roughness.

Hydrographs at pond outlets were generated by routing the combined incoming flow hydrographs through the ponds. Pond routings (RS - Storage Routing record in HEC-1) were performed by using storage/elevation relationships for each pond by defining pond surface area versus depth. Additionally, discharge structure (low level outlet and spillway) characteristics of each pond are used for pond routing.

3.3 Hydraulic Analysis

3.3.1 Swale and Channel Analysis

Drainage structure details are illustrated on Drawings IIIH.3 through IIIH.6. The swales and channels are designed to convey the peak flow rate generated by the design storm event. These swales and channels will also reduce maintenance at the site after closure by minimizing erosion. All perimeter channels are designed with a minimum freeboard of 6 inches for the 25-year design storm. Given the site's location in a region with low average annual precipitation, this freeboard is considered adequate.

Hydraulic analyses of the swales and channels are conducted using Manning's uniform flow formula. The uniform flow assumption is applicable to long prismatic channels of uniform slope, as proposed at the site.

Client: City of Del Rio
Project: Major Permit Amendment
Description: Perimeter Channel Design

Date: 8/1/2024
Job No: DELR2000302
By: T. Metaferia
Checked By: B. Hindman

Purpose - To design perimeter channels to contain stormwater runoff from the 25-year frequency storm events.

Perimeter channels have been designed to contain stormwater runoff from the 25-year frequency storm events.

Channel	Station		Flow Rate (cfs)	Bottom Slope %	Bottom Width (ft)	Side Slope (ft/ft) Right	Left	Normal Depth (ft)	Min Freeboard (in)	Flow Vel. (fps)	Fronde No.	Vel. Head (ft)	Specific Energy (ft)	Flow Area (sq.ft.)	Top width of Flow (ft)
CH1	0+00.00	31+29.16	246.2	0.25%	12	3	3	2.97	6.00	3.96	0.48	0.24	3.22	62.22	29.84
CH2	0+00.00	7+67.69	323.4	0.65%	10	2	2	3.07	6.00	5.76	0.66	0.52	3.87	56.16	23.44
	7+67.69	8+72.43	323.4	1.50%	10	2	2	2.46	6.00	8.81	1.14	1.20	3.37	36.73	19.84
	8+72.43	9+35.38	323.4	1.30%	10	2	2	2.56	6.00	8.37	1.07	1.09	3.65	38.66	20.23
	9+35.38	11+53.65	323.4	0.85%	10	2	2	2.86	6.00	7.19	0.87	0.80	3.66	45.01	21.45
	11+53.65	24.+63.99	87.8	0.46%	10	2	2	1.67	6.00	3.95	0.60	0.24	1.91	22.24	16.67
CH3	0+00.00	10+66.16	70.3	0.43%	10	3	3	1.44	6.00	3.41	0.57	0.18	1.62	20.59	18.63
CH4	0+00.00	15+71.63	99.4	0.35%	10	3	2	1.87	6.00	3.61	0.53	0.20	2.08	27.52	19.37
CH5	0+00.00	6+64.79	84.0	0.50%	6	3	3	1.84	6.00	3.96	0.63	0.24	2.08	21.21	17.05
CH6	0+00.00	2+59.26	12.8	1.00%	0	3	3	1.14	6.00	3.29	0.77	0.17	1.31	3.89	6.84
CH7A[4]	0+00.00	3+55.95	12.2	0.10%	10	3	3	0.82	6.00	1.20	0.26	0.02	0.84	10.17	14.90
CH7B	0+00.00	11+34.72	123.2	0.68%	3	3	3	2.41	6.00	4.99	0.74	0.39	2.80	24.67	17.47
	0+00.00	12+21.50	123.2	0.20%	3	3	3	3.14	6.00	3.16	0.42	0.16	3.29	38.96	21.83
CH8	0+00.00	2+20.77	6.6	1.00%	0	3	3	0.90	6.00	2.82	0.74	0.12	1.03	2.45	5.43

Note:

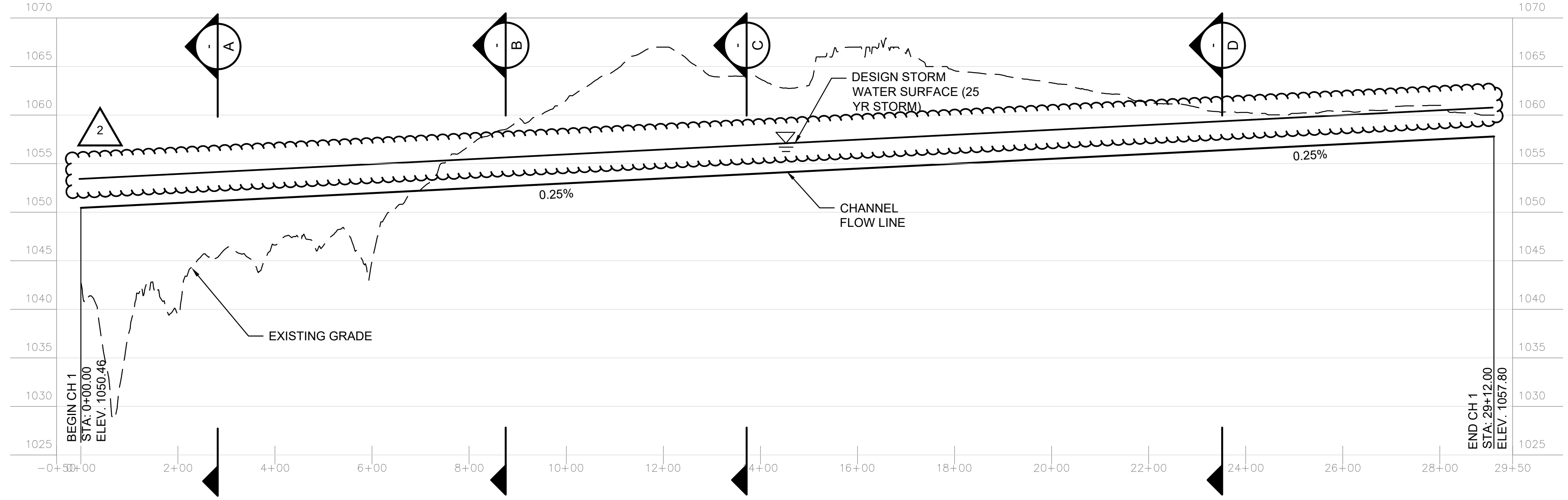
1. Calculations were performed using Bentley FlowMaster.
2. n = 0.03 (Manning Coefficient) is used for the calculations.
3. Flow rates used for the perimeter channel design were taken from the HEC-1 analysis included in Appendix IIIH-B.
4. The drainag area for Channel 7A is shown on sheet IIIH-C-4. Q=CIA was used to calulate the flow rate for Channel 7A. The flow rate for 7B is obtained from HEC-1 analysis included in Appendix IIIH-B which includes the Channel 7A area.

Channel Erosion Control Design:

Channel erosion controls have been designed for flow velocities resulted from the 25-year frequency flow rates. As shown on above velocities in the perimeter channels range from 2.53 ft/s

The following was used to select the type of channel lining material.

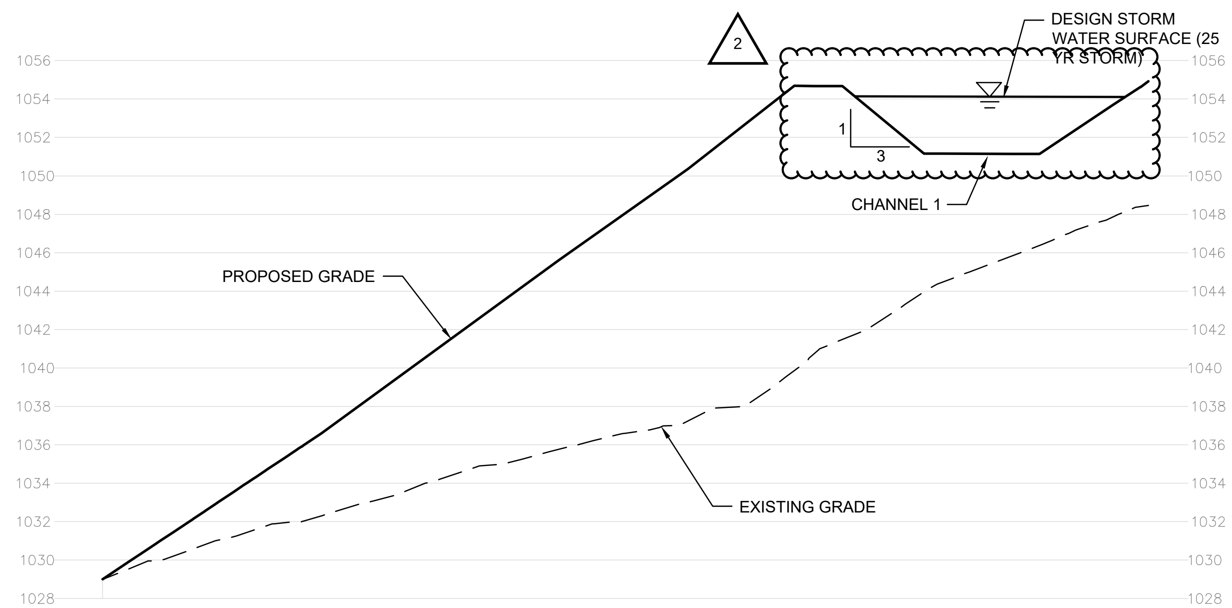
- Vegetation - used in all areas where velocities are less than 5 ft/s for channels.
- Turf reinforcement matting - used in channels for velocities between 5 ft/s and 13 ft/s.



CH1 IIIH-C-4 CHANNEL 1 PROFILE

SCALE IN FEET (HORIZONTAL) 0 150 300

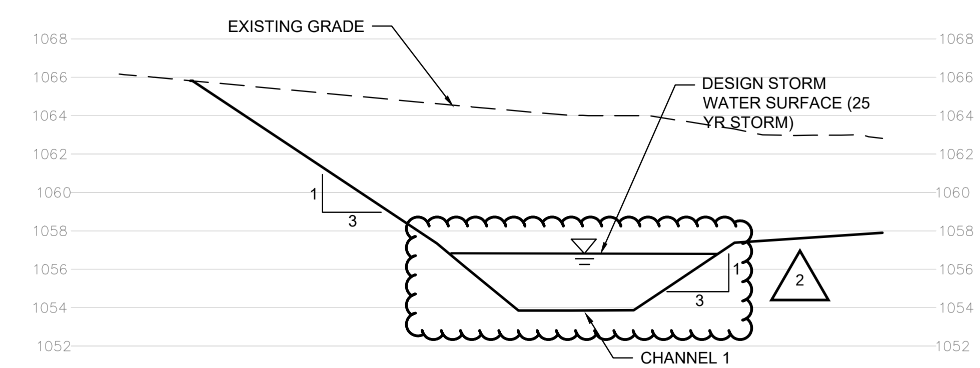
SCALE IN FEET (VERTICAL) 0 5 10



A SECTION

SCALE IN FEET (HORIZONTAL) 0 10 20

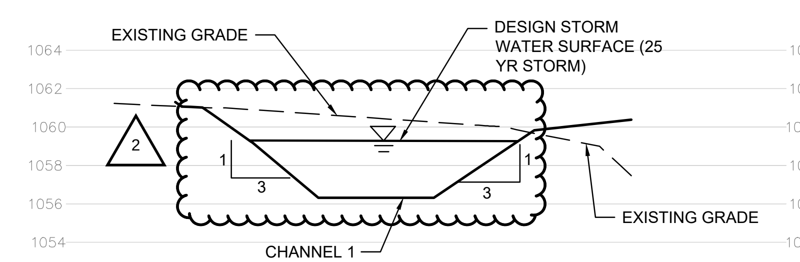
SCALE IN FEET (VERTICAL) 0 5 10



C SECTION

SCALE IN FEET (HORIZONTAL) 0 10 20

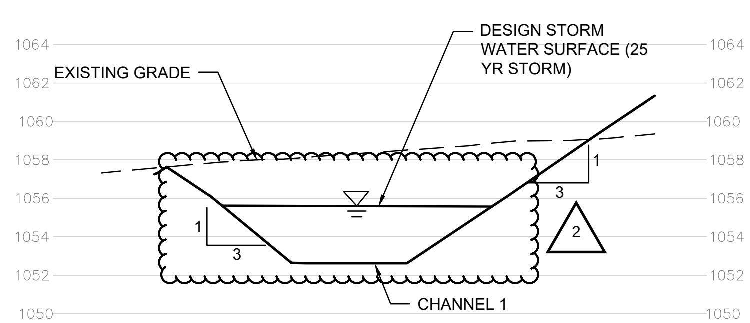
SCALE IN FEET (VERTICAL) 0 5 10



D SECTION

SCALE IN FEET (HORIZONTAL) 0 10 20

SCALE IN FEET (VERTICAL) 0 5 10



B SECTION

SCALE IN FEET (HORIZONTAL) 0 10 20

SCALE IN FEET (VERTICAL) 0 5 10

Channel	Station	Flow Rate (cfs)	Bottom Slope %	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
CH1	0+00.00 31+29.16	246.2	0.25%	12	2.97	3.96

THE FOLLOWING WAS USED TO SELECT THE TYPE OF CHANNEL LINING MATERIAL
- VEGETATION WILL BE USED IN ALL AREAS WHERE VELOCITIES ARE LESS THAN 5 FT/S.
- TURF REINFORCEMENT MATTING WILL BE USED IN CHANNEL SECTIONS THAT HAVE VELOCITIES BETWEEN 5 FT/S AND 13 FT/S.

FOR PERMITTING PURPOSES ONLY

CP&Y an STV Company
TEXAS REGISTERED ENGINEERING FIRM TBPE F-1741

CITY OF Del Rio TEXAS

STATE OF TEXAS TEWODROS METAFERIA 123183 LICENSED PROFESSIONAL ENGINEER 08/12/2025

NO.	REVISION	BY	DATE
1.	3RD TECHNICAL NOD	STV	05/ 2025
2.	ADDITIONAL INFORMATION REQUEST	STV	08/2025

VERIFY SCALE 0 1" BAR LENGTH EQUALS ONE INCH ON ORIGINAL DRAWING. VERIFY LENGTH ON THIS SHEET AND ADJUST SCALE ACCORDINGLY.

CITY OF DEL RIO LANDFILL NO. 207C
MAJOR PERMIT AMENDMENT

CHANNEL 1 PROFILE AND CROSS SECTIONS

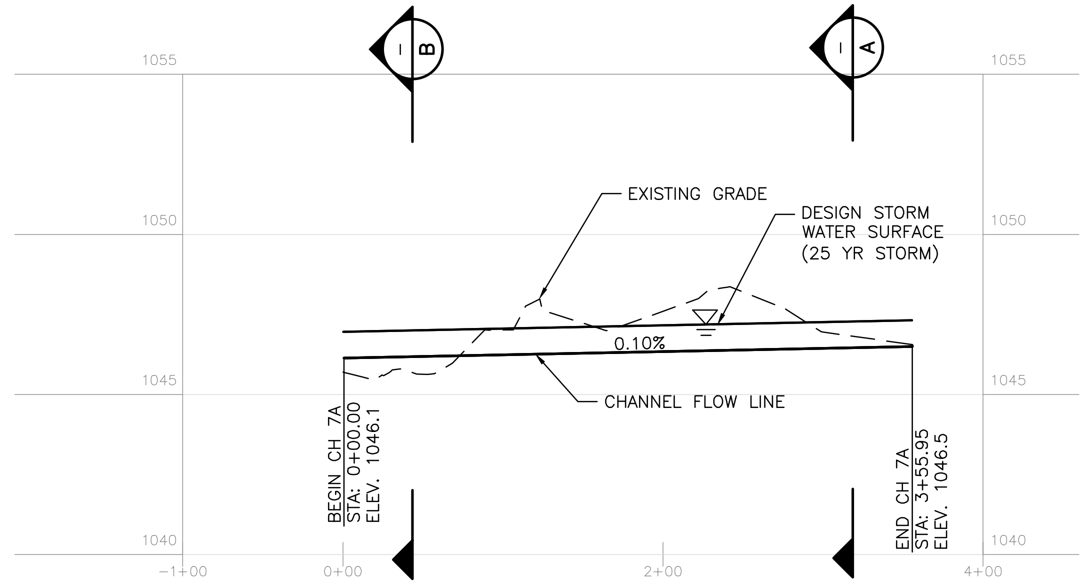
DESIGN: T. METAFERIA
DRAWN: T. METAFERIA
REVIEW: B. HINDMAN
CP&Y: DELR200302
CLIENT: CITY OF DEL RIO

FIGURE
IIIH-C-5

PRINTED BY: MetafeT
FILE PATH: C:\pwworking\stv\pw_stv\tmetaferia\d0942276\DELR2000302 Figure IIIH-C-5.dwg

Channel	Station		Flow Rate (cfs)	Bottom Slope %	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
CH7A	0+00.00	3+55.95	12.2	0.10%	10	0.82	1.20

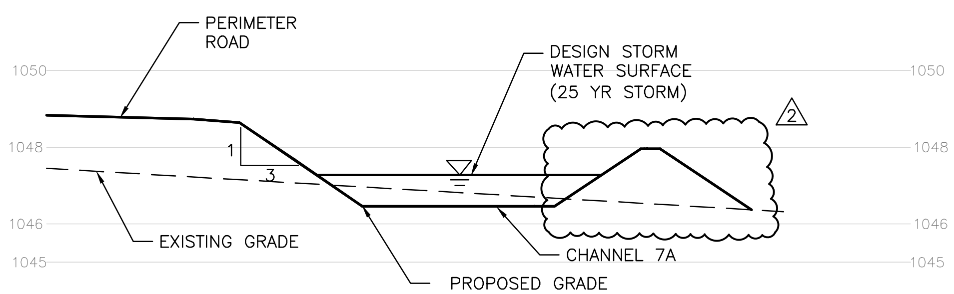
THE FOLLOWING WAS USED TO SELECT THE TYPE OF CHANNEL LINING MATERIAL
- VEGETATION WILL BE USED IN ALL AREAS WHERE VELOCITIES ARE LESS THAN 5 FT/S.
- TURF REINFORCEMENT MATTING WILL BE USED IN CHANNEL SECTIONS THAT HAVE VELOCITIES BETWEEN 5 FT/S AND 13 FT/S.



CH7A IIIH-C-4 CHANNEL 7A PROFILE

0 60 120 SCALE IN FEET (HORIZONTAL)

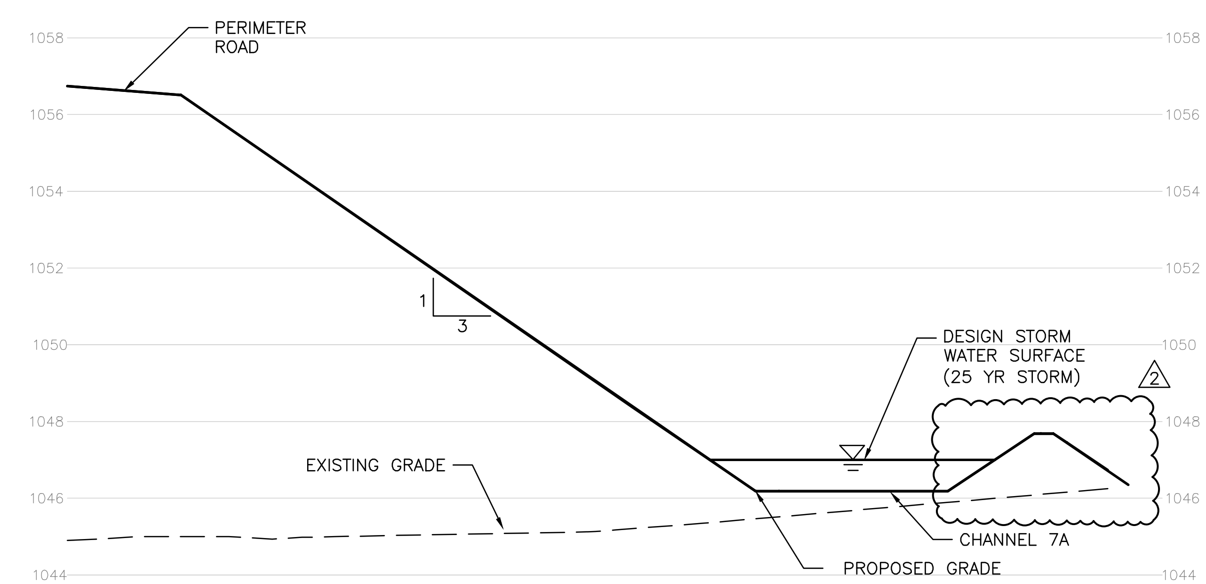
0 3 6 SCALE IN FEET (VERTICAL)



A SECTION

0 5 10 SCALE IN FEET (HORIZONTAL)

0 2.5 5 SCALE IN FEET (VERTICAL)



B SECTION

0 5 10 SCALE IN FEET (HORIZONTAL)

0 2.5 5 SCALE IN FEET (VERTICAL)

FOR PERMITTING PURPOSES ONLY

CP&Y an STV Company
TEXAS REGISTERED ENGINEERING FIRM TBPE F-1741

CITY OF Del Rio TEXAS

08/12/2025
STATE OF TEXAS TEWODROS METAFERIA 123183 LICENSED PROFESSIONAL ENGINEER

NO.	REVISION	BY	DATE
1.	2nd TECHNICAL NOD	STV	03/ 2025
1.	ADDITIONAL INFORMATION REQUEST	STV	08/ 2025

VERIFY SCALE 0 1" BAR LENGTH EQUALS ONE INCH ON ORIGINAL DRAWING. VERIFY LENGTH ON THIS SHEET AND ADJUST SCALE ACCORDINGLY.

CITY OF DEL RIO LANDFILL NO. 207C MAJOR PERMIT AMENDMENT

CHANNEL 7A PROFILE AND CROSS SECTION

DESIGN: T. METAFERIA
DRAWN: T. METAFERIA
REVIEW: B. HINDMAN
CP&Y: DELR200302
CLIENT: CITY OF DEL RIO

FIGURE
IIIH-C-11

PRINTED BY: MetafeT
FILE PATH: C:\pwworking\stv\pw_stv\tmetaferia\d0942276\DELR200302 Figure IIIH-C-11.dwg

Table 3-3 Leachate Sump Operating Plan

Leachate Level Description	Condition	Action Required
Leachate level between lip of sump and pump intake at the bottom of the sump.	System is functioning as designed. The drainage geocomposite leachate collection layer installed on the floor of the landfill is designed to convey the estimated peak leachate flow rate without the leachate level within the geocomposite exceeding the thickness of the geocomposite. The operation of the leachate sump and the conveyance capacity of the geocomposite leachate collection layer work in tandem to maintain compliance with the design standard listed in §330.331(a)(1).	The depth of leachate in the sump is monitored by a landfill personnel at least 1 time per week. Leachate flow to the sump and sump pump capacity are listed in Table 4-1. The sump design is discussed in Section 3.4.
Leachate level between the lip of the sump and 0.02 inches (0.05 cm) above the lip of the sump.	The 0.02-inch design standard listed in Appendix IIIK per §330.331(a)(1) has not been exceeded.	For these two conditions, the sump operation will be monitored daily until the leachate is pumped out by the Operator. For both conditions, the leachate levels in the sump will be recorded daily. If it is determined that the pump is malfunctioning, it will be removed and replaced immediately. In addition, the pumps will be replaced when it is determined that a larger capacity pump is needed based on existing conditions.
Leachate level over 0.02 inches above the lip of the sump.	The design standard listed in Appendix IIIK per §330.331(a)(1) has been exceeded.	

drainage area, swale, or channel. This method uses physical (measurable) characteristics (e.g., flow lengths, slopes, surface roughness coefficients, channel cross sections) of a watershed to estimate peak discharges.

3.2.6.2 Snyder Unit Hydrograph Method

The Snyder unit hydrograph method has been used mainly for non-landfill drainage areas (e.g., offsite drainage areas). The method is applicable to drainage areas with a wide range of characteristics. Several different methods have been developed to estimate Snyder unit hydrograph parameters (watershed lag and peaking coefficient). Espey "10-Minute" method was used in this project to estimate Snyder unit hydrograph parameters. The Espey "10-Minute" method was developed using flow records from 41 different watersheds in Texas and other states. The main advantage of the Espey "10-Minute" method is that it is one of the most widely used and accepted methods for determining hydrograph input values for small-size drainage areas.

3.2.6.3 Hydrograph Routing

The Muskingum-Cunge Method (RD record in HEC-1) was used for routing of the flood wave through the drainage channels. This method is capable of accounting for hydrograph attenuation based on physical channel properties such as length, bottom slope, channel shape, and channel roughness.

Hydrographs at pond outlets were generated by routing the combined incoming flow hydrographs through the ponds. Pond routings (RS - Storage Routing record in HEC-1) were performed by using storage/elevation relationships for each pond by defining pond surface area versus depth. Additionally, discharge structure (low level outlet and spillway) characteristics of each pond are used for pond routing.

3.3 Hydraulic Analysis

3.3.1 Swale and Channel Analysis

Drainage structure details are illustrated on Drawings IIIH.3 through IIIH.6. The swales and channels are designed to convey the peak flow rate generated by the design storm event. These swales and channels will also reduce maintenance at the site after closure by minimizing erosion. All perimeter channels are designed with a minimum freeboard of 6 inches for the 25-year design storm. Given the site's location in a region with low average annual precipitation, this freeboard is considered adequate.

Hydraulic analyses of the swales and channels are conducted using Manning's uniform flow formula. The uniform flow assumption is applicable to long prismatic channels of uniform slope, as proposed at the site.

Client: City of Del Rio
Project: Major Permit Amendment
Description: Perimeter Channel Design

Date: 8/1/2024
Job No: DELR2000302
By: T. Metaferia
Checked By: B. Hindman

Purpose - To design perimeter channels to contain stormwater runoff from the 25-year frequency storm events.

Perimeter channels have been designed to contain stormwater runoff from the 25-year frequency storm events.

Channel	Station		Flow Rate (cfs)	Bottom Slope %	Bottom Width (ft)	Side Slope (ft/ft)		Normal Depth (ft)	Min Freeboard (in)	Flow Vel. (fps)	Fronde No.	Vel. Head (ft)	Specific Energy (ft)	Flow Area (sq.ft.)	Top width of Flow (ft)
						Right	Left								
CH1	0+00.00	31+29.16	246.2	0.25%	12	3	3	2.97	6.00	3.96	0.48	0.24	3.22	62.22	29.84
CH2	0+00.00	7+67.69	323.4	0.65%	10	2	2	3.07	6.00	5.76	0.66	0.52	3.87	56.16	23.44
	7+67.69	8+72.43	323.4	1.50%	10	2	2	2.46	6.00	8.81	1.14	1.20	3.37	36.73	19.84
	8+72.43	9+35.38	323.4	1.30%	10	2	2	2.56	6.00	8.37	1.07	1.09	3.65	38.66	20.23
	9+35.38	11+53.65	323.4	0.85%	10	2	2	2.86	6.00	7.19	0.87	0.80	3.66	45.01	21.45
	11+53.65	24.+63.99	87.8	0.46%	10	2	2	1.67	6.00	3.95	0.60	0.24	1.91	22.24	16.67
CH3	0+00.00	10+66.16	70.3	0.43%	10	3	3	1.44	6.00	3.41	0.57	0.18	1.62	20.59	18.63
CH4	0+00.00	15+71.63	99.4	0.35%	10	3	2	1.87	6.00	3.61	0.53	0.20	2.08	27.52	19.37
CH5	0+00.00	6+64.79	84.0	0.50%	6	3	3	1.84	6.00	3.96	0.63	0.24	2.08	21.21	17.05
CH6	0+00.00	2+59.26	12.8	1.00%	0	3	3	1.14	6.00	3.29	0.77	0.17	1.31	3.89	6.84
CH7A[4]	0+00.00	3+55.95	12.2	0.10%	10	3	3	0.82	6.00	1.20	0.26	0.02	0.84	10.17	14.90
CH7B	0+00.00	11+34.72	123.2	0.68%	3	3	3	2.41	6.00	4.99	0.74	0.39	2.80	24.67	17.47
	0+00.00	12+21.50	123.2	0.20%	3	3	3	3.14	6.00	3.16	0.42	0.16	3.29	38.96	21.83
CH8	0+00.00	2+20.77	6.6	1.00%	0	3	3	0.90	6.00	2.82	0.74	0.12	1.03	2.45	5.43

Note:

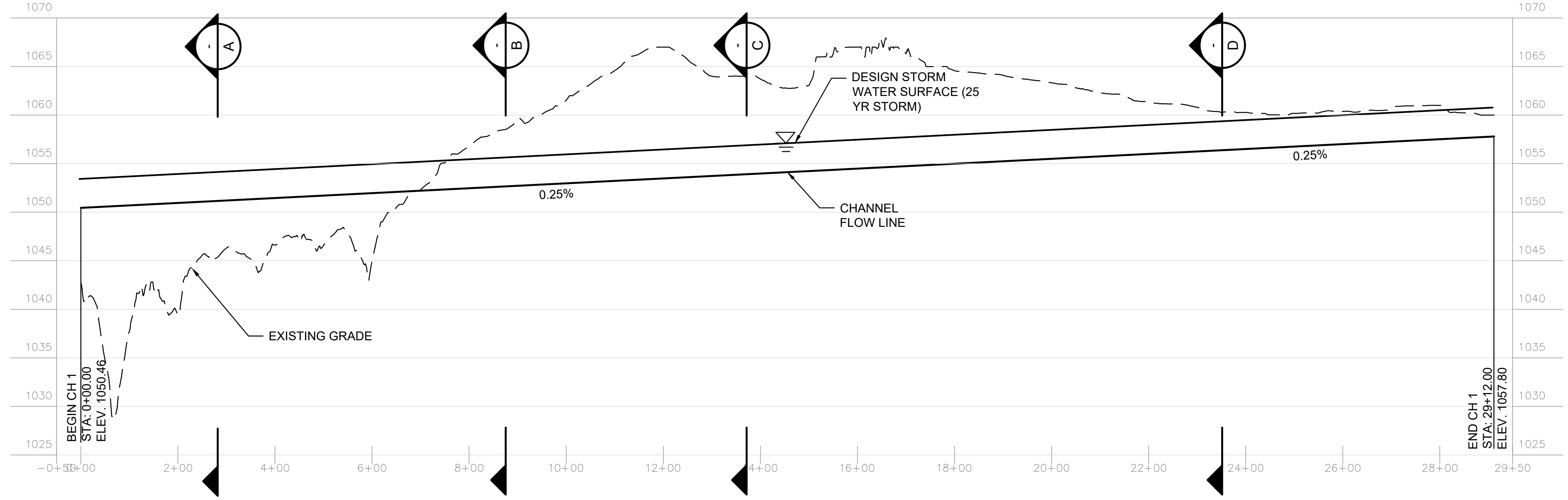
1. Calculations were performed using Bentley FlowMaster.
2. n = 0.03 (Manning Coefficient) is used for the calculations.
3. Flow rates used for the perimeter channel design were taken from the HEC-1 analysis included in Appendix IIIH-B.
4. The drainag area for Channel 7A is shown on sheet IIIH-C-4. Q=CIA was used to calulate the flow rate for Channel 7A. The flow rate for 7B is obtained from HEC-1 analysis included in Appendix IIIH-B which includes the Channel 7A area.

Channel Erosion Control Design:

Channel erosion controls have been designed for flow velocities resulted from the 25-year frequency flow rates. As shown on above velocities in the perimeter channels range from 2.53 ft/s

The following was used to select the type of channel lining material.

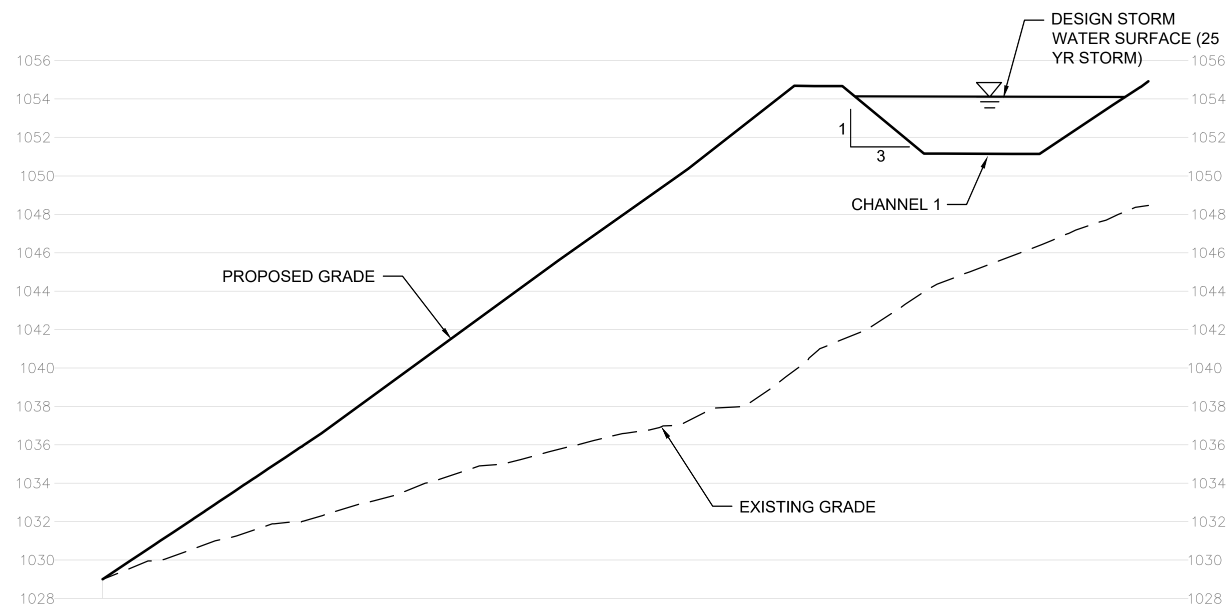
- Vegetation - used in all areas where velocities are less than 5 ft/s for channels.
- Turf reinforcement matting - used in channels for velocities between 5 ft/s and 13 ft/s.



CH1 IIIH-C-4 CHANNEL 1 PROFILE

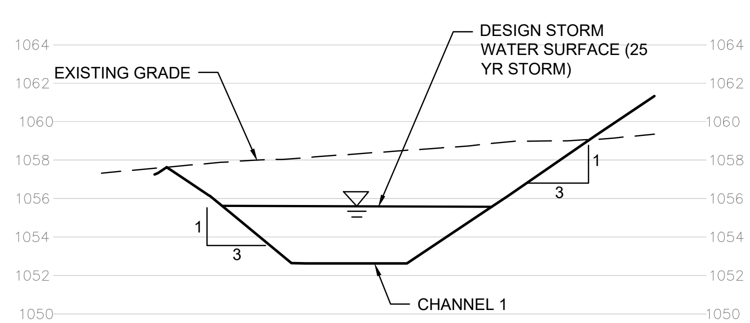
SCALE IN FEET (HORIZONTAL) 0 150 300

SCALE IN FEET (VERTICAL) 0 5 10



A SECTION

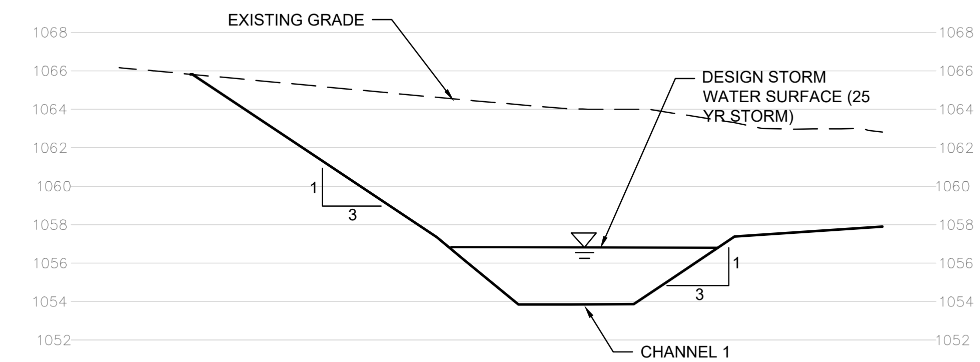
SCALE IN FEET (HORIZONTAL) 0 10 20 SCALE IN FEET (VERTICAL) 0 5 10



B SECTION

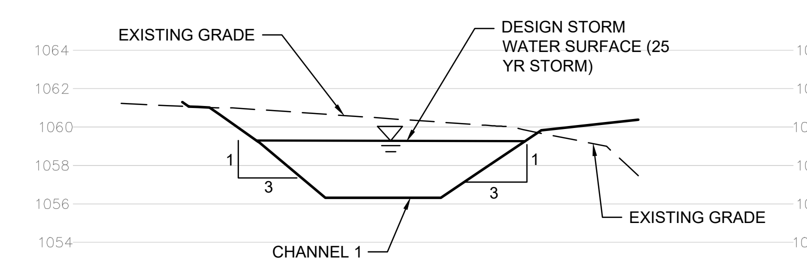
SCALE IN FEET (HORIZONTAL) 0 10 20

SCALE IN FEET (VERTICAL) 0 5 10



C SECTION

SCALE IN FEET (HORIZONTAL) 0 10 20 SCALE IN FEET (VERTICAL) 0 5 10



D SECTION

SCALE IN FEET (HORIZONTAL) 0 10 20

SCALE IN FEET (VERTICAL) 0 5 10

Channel	Station		Flow Rate (cfs)	Bottom Slope %	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
CH1	0+00.00	31+29.16	246.2	0.25%	12	2.97	3.96

THE FOLLOWING WAS USED TO SELECT THE TYPE OF CHANNEL LINING MATERIAL
- VEGETATION WILL BE USED IN ALL AREAS WHERE VELOCITIES ARE LESS THAN 5 FT/S.
- TURF REINFORCEMENT MATTING WILL BE USED IN CHANNEL SECTIONS THAT HAVE VELOCITIES BETWEEN 5 FT/S AND 13 FT/S.

FOR PERMITTING PURPOSES ONLY

CP&Y an STV Company
TEXAS REGISTERED ENGINEERING FIRM TBPE F-1741

City of Del Rio Texas

STATE OF TEXAS TEWODROS METAFERIA 123183 LICENSED PROFESSIONAL ENGINEER 08/12/2025

NO.	REVISION	BY	DATE
1.	3RD TECHNICAL NOD	STV	05/2025
2.	ADDITIONAL INFORMATION REQUEST	STV	08/2025

VERIFY SCALE 0 1" BAR LENGTH EQUALS ONE INCH ON ORIGINAL DRAWING. VERIFY LENGTH ON THIS SHEET AND ADJUST SCALE ACCORDINGLY.

CITY OF DEL RIO LANDFILL NO. 207C MAJOR PERMIT AMENDMENT

CHANNEL 1 PROFILE AND CROSS SECTIONS

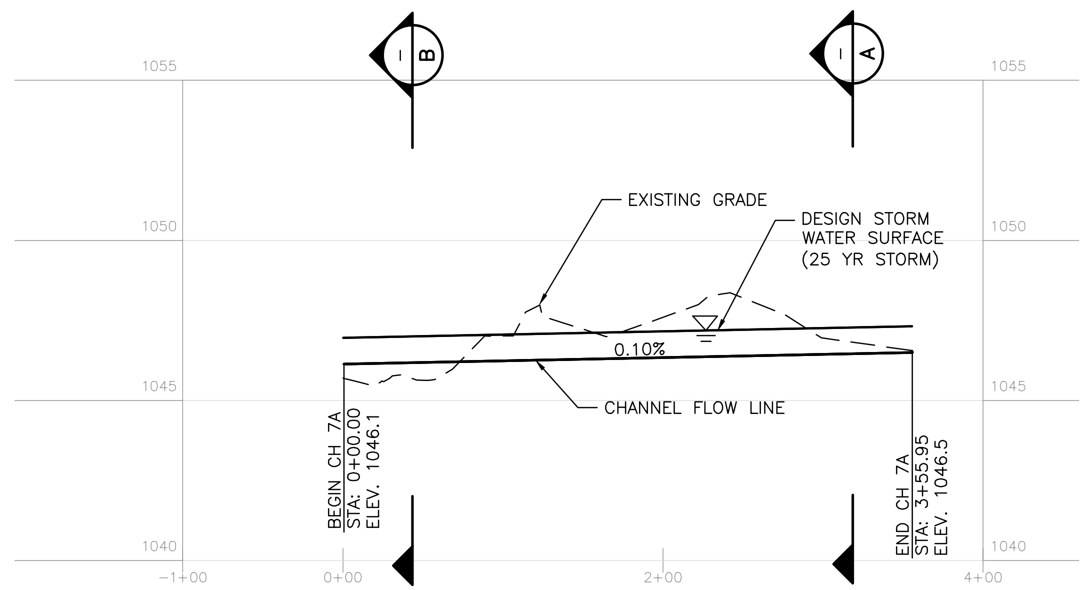
DESIGN: T. METAFERIA
DRAWN: T. METAFERIA
REVIEW: B. HINDMAN
CP&Y: DELR200302
CLIENT: CITY OF DEL RIO

FIGURE IIIH-C-5

PRINTED BY: MetafeT
FILE PATH: C:\pwworking\stv\pw_stv\tmetaferia\d0942276\DELR200302 Figure IIIH-C-5.dwg

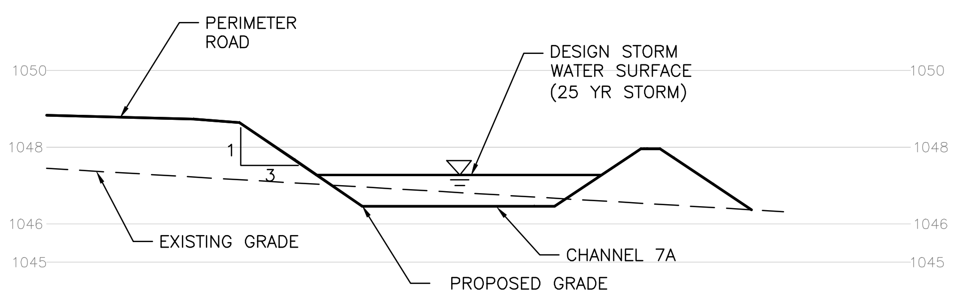
Channel	Station		Flow Rate (cfs)	Bottom Slope %	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
CH7A	0+00.00	3+55.95	12.2	0.10%	10	0.82	1.20

THE FOLLOWING WAS USED TO SELECT THE TYPE OF CHANNEL LINING MATERIAL
- VEGETATION WILL BE USED IN ALL AREAS WHERE VELOCITIES ARE LESS THAN 5 FT/S.
- TURF REINFORCEMENT MATTING WILL BE USED IN CHANNEL SECTIONS THAT HAVE VELOCITIES BETWEEN 5 FT/S AND 13 FT/S.



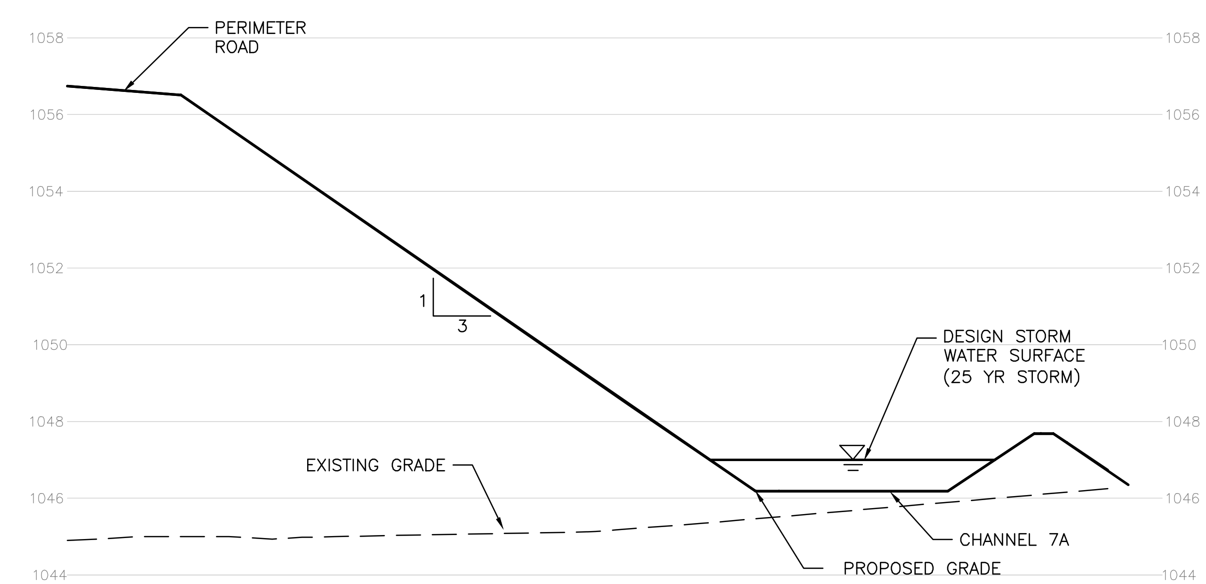
CH7A
IIIH-C-4
CHANNEL 7A PROFILE

0 60 120
SCALE IN FEET (HORIZONTAL)
0 3 6
SCALE IN FEET (VERTICAL)



A
SECTION

0 5 10
SCALE IN FEET (HORIZONTAL)
0 2.5 5
SCALE IN FEET (VERTICAL)



B
SECTION

0 5 10
SCALE IN FEET (HORIZONTAL)
0 2.5 5
SCALE IN FEET (VERTICAL)

FOR PERMITTING PURPOSES ONLY

CP&Y an STV Company
TEXAS REGISTERED ENGINEERING FIRM TBPE F-1741

CITY OF Del Rio TEXAS

08/12/2025
STATE OF TEXAS
TEWODROS METAFERIA
123183
LICENSED PROFESSIONAL ENGINEER

1.	ADDITIONAL INFORMATION REQUEST	STV	08/ 2025
1.	2nd TECHNICAL NOD	STV	03/ 2025
NO.	REVISION	BY	DATE

VERIFY SCALE 0 1"
BAR LENGTH EQUALS ONE INCH ON ORIGINAL DRAWING. VERIFY LENGTH ON THIS SHEET AND ADJUST SCALE ACCORDINGLY.

CITY OF DEL RIO LANDFILL NO. 207C
MAJOR PERMIT AMENDMENT

CHANNEL 7A PROFILE AND CROSS SECTION

DESIGN: T. METAFERIA
DRAWN: T. METAFERIA
REVIEW: B. HINDMAN
CP&Y: DELR200302
CLIENT: CITY OF DEL RIO

FIGURE
IIIH-C-11

PRINTED BY: MetafeT
FILE PATH: C:\pwworking\stv\pw_stv\tmetaferia\d0942276\DELR2000302 Figure IIIH-C-11.dwg

5.0 SLOPE STABILITY ANALYSIS

5.1 General

This slope stability analysis has been developed to analyze excavation slope and landfill completion slopes using critical sections for each condition. Slide2 was used to analyze the stability of excavation slopes and the final configuration of the site. Slide is an industry standard computer program developed by Rocscience Inc. and has been used widely in several slope stability application for dams, embankments, excavations, retaining walls and soil slopes.

The input file for the program includes:

- Slope surface geometry.
- Subsurface information to identify different types of soil materials in horizontal and vertical directions so that each subsurface segment is identified with corresponding soil strength parameters.
- Groundwater information. The program is capable of modeling multiple groundwater surfaces that may be applicable to various subsurface soil components identified in the second bullet.
- Material strength information. Each soil section (horizontal or vertical) identified in the second bullet is assigned with strength parameters including cohesion and friction angle.
- Model control and simulation user interface of the model that allows selection of the method of analysis (e.g., Simplified Bishop) and identifying simulation control parameters.

Automatic failure surface generation functions, that use either initiation/termination ranges of the failure surface or use search boxes to define failure surface location, are used to locate the critical failure surface. The two methods employed for this slope stability analysis are described below.

- Simplified Janbu Method - This method uses the method of slices to determine the stability of the mass above a failure surface.
- Simplified Bishop Method - This method uses the method of slices to discretize the soil mass for determining the factor of safety.

In general, the stability of various worst case critical sections were analyzed under static condition for short-term (construction) and long-term (after construction) safety. The slope stability analyses are provided in Appendix IIIL-A.

The stability analysis has been conducted by demonstrating that, for each analyzed section, the forces resisting slope movement are greater than those potentially causing movement. The ratio of forces resisting movement to those creating movement is referred to as the factor of safety (FS). A slope is considered stable when the FS is equal to or greater than 1.0. For slope stability, an FS greater than 1.0 is preferred.

To account for increased uncertainty in the system, the FS value is adjusted accordingly. A factor of safety of 1.5 is applied to slopes expected to remain stable over the long term, including both excavation and final cover configurations. An FS of 1.3 is considered acceptable for total stress conditions that are temporary.

5.2 Configurations Analyzed

Slope stability analyses were conducted on critical cross sections to assess the stability of the excavation, interim fill, overliner, and final cover slopes. Section geometries were developed based on the proposed excavation and final contour plans. The selected sections represent the longest and steepest slopes for each condition—excavation, final cover, overliner, and interim fill—which are considered to represent the worst-case, most critical scenarios for landfill stability.

Evaluation locations were chosen to capture these critical conditions, with cross-section profiles that include both the landfill configuration and the underlying natural materials at and below the toe of the excavation. For the interim fill condition, a representative slope profile was assumed, which does not exceed the slope of the final cover.

The excavation, overliner, interim fill, and final cover configurations were modeled to reflect these worst-case critical slope conditions. Analyses were performed using both circular and block failure surfaces. The maximum design slopes include a 4 horizontal to 1 vertical (4H:1V) gradient for final cover slopes and a 3H:1V gradient for excavation slopes.

Figures showing the analyzed cross-section locations are included in the top-of-liner plan and final completion plan provided in Appendix IIIL-A. Additionally, the configurations analyzed are illustrated in the same appendix.

It is assumed that the horizontal length of an interim slope will not exceed that is included in Appendix IIIL-A. Should the horizontal length of an actual interim slope be greater during site operations, an additional analysis will be performed if deemed necessary by a registered engineer, and the results will be maintained in the Site Operating Record.

5.3 Input Parameters

The soil parameters were selected based on a review of the boring logs and laboratory test results from the subsurface investigation studies at the site, along with engineering judgment and experience with similar materials. To ensure representative properties for the various soil groups, the unit weight for Stratum II and III used in the model is based on the average unit weight for each stratum, as outlined in Tables 3-1, 3-2, and 3-3. Since groundwater is not present at the site, no groundwater surface is modeled.

Table 5-1 summarizes the unit weights and strength parameters used in the stability analyses for the evaluated landfill slopes, including excavation, overliner, interim fill, and final cover slopes. The selected strength parameters for both the liner and final cover systems are based on industry standards and are representative of the material properties that will be utilized during construction. These parameters will be verified during prior to construction.

5.4 Infinite Slope Stability Analysis

The infinite slope stability analysis for the liner and final cover system is detailed in Appendix IIIL-A. This analysis covers the stability of the anchor trench design, the stability of cover and drainage materials placed on anchored geosynthetics, and the shear forces within the liner system. Additionally, the final cover slope stability analysis specifically addresses the shear forces within the final cover system.

As demonstrated in the calculations presented in Appendix IIIL-A, both the liner and final cover systems are structurally stable when using industry-standard strength parameters. These parameters will be verified during the construction. Prior to the construction liner, overliner, and/or final cover, the POR will perform interface strength testing with the actual materials that will be used during.

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