THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION

Volume 4 of 6

CITY OF KINGSVILLE, TEXAS

September 2018
Revision 0

STATE OF TEXAS
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HANSON PROJECT NO. 16L0438-0003

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 5

ALTERNATIVE LINER AND OVERLINER

POINT OF COMPLIANCE DEMONSTRATIONS

ATTACHMENT 5

ALTERNATIVE LINER AND OVERLINER DESIGN AND POINT OF COMPLIANCE DEMONSTRATIONS

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CONTENTS

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For pages i - iv

1 INTRODUCTION

1.1 Purpose and Scope

This attachment is submitted to allow the use of a geosynthetic clay liner (GCL) as an alternative to the Subtitle D two-foot thick soil liner component of the liner system and demonstrate that the proposed alternative liner and overliner will meet the point of compliance (POC) requirements specified in Title 30 Texas Administrative Code (TAC) §330.331 (a).

This Alternate Liner Design Demonstration (ALD) was performed in accordance with the procedures presented in the *Texas Water Commission Alternate Liner Design Handbook, A Performance Standard As Authorized by 31 Texas Administrative Code (TAC) §330.202 (Version 1, August 1993),* using the Hydrologic Evaluation of Landfill Performance (HELP) and Mutimed Exposure Assessment (MULTIMED) computer models. This is achieved by demonstrating that the predicted concentrations of selected leachate chemical constituents do not exceed maximum contaminant levels (as listed in Table 1 in §330.331(a)(1)) in the uppermost aquifer at the POC. The concentration of various constituents at the POC is determined by calculating a dilution attenuation factor (DAF), which is determined by the following equation.

$$\text{DAF} = \frac{\text{Co, Initial Constituent Concentration of Leachate Within the Landfill}}{\text{Cp, Constituent Concentration at the POC}}$$

The DAF represents the factor by which the constituent concentration is expected to decrease between the landfill and the POC. When the constituent's concentration in leachate is divided by the model predicted DAF, the resulting concentration must be less than the allowable maximum contaminant levels (MCLs) in groundwater for the chemical parameters listed in Table 1 included in Title 30 TAC §330.331(a)(1).

The scope of this attachment includes both an alternative liner for future sectors and the proposed alternative liner and overliner for the pre-Subtitle D areas.

1.2 Proposed Alternative Liner

The layout of the proposed alternative liner is shown in Appendix A-Point of Compliance Figures, A.1 Permit Amendment Application MSW-235C Landfill Completion Site Plan. The proposed alternative liner system consists of a 60-mil high density polyethylene (HDPE) geomembrane placed over a GCL overlain by a geocomposite leachate collection layer covered with a 2-foot-thick layer of protective soil cover. The components of the proposed alternative liner are shown in Appendix B.1 HELP Model/MULTIMED Model-Summary of Cases 1-8 for both interim and closed conditions. Details of the alternate liner are in Appendix D.1 and Appendix D.2.

1.3 Proposed Overliner System

The layout of the proposed overliner system is shown in Appendix A Point of Compliance Figures, A.1 Permit Amendment Application MSW-235C Landfill Completion Site Plan. The proposed alternative overliner system consists of a 60-mil high density polyethylene (HDPE) geomembrane placed over GCL overlain by a geocomposite leachate collection layer covered with a 2-foot thick layer of protective soil cover. The overliner will be placed over pre-Subtitle D areas to separate the existing waste and the vertical expansion area. The overliner system areas include Sectors 8A and 8B. The components of the proposed overliner system are shown in Appendix B.11 Help Model/MULTIMED Model-Summary of Cases 1OL-8OL for both interim and closed conditions. Details of the overliner system are in Appendix D.3 and Appendix D.4.

1.4 Site Geology and Hydrogeology

A geologic and hydrogeologic site exploration program was conducted for the proposed City of Kingsville Landfill. Details of these investigations are included in Attachment 4 Geology Report.

2 ALTERNATE LINER DEMONSTRATION METHODS

2.1 HELP Model

The HELP Model Version 3.07 was used to estimate the amount of leachate generated by the landfill and the percolation through the proposed alternative liner system and overliner system. The HELP model is a water-balance model developed by the U.S. Army Corps of Engineers Waterways Experiment Station for the Environmental Protection Agency (EPA). The model uses climate, soil, and landfill design data to perform a solution technique that accounts for the effects of surface storage, run-off, infiltration, percolation, soil moisture storage, evapotranspiration, and lateral drainage.

2.2 MULTIMED MODEL

The MULTIMED Model Version 1.01 was used to assess contaminant fate and transport between the landfill base and the Point of Compliance (POC). MULTIMED was developed by the Athens Environmental Research Laboratory for the EPA. MULTIMED estimates the capacity of the hydrogeologic system modeled to dilute and attenuate contaminate concentrations. The model can be used to simulate fate and transport processes in both unsaturated and saturated subsurface environments. In this application, only the saturated environment was modeled to provide a conservative analysis.

2.3 LANDFILL CONFIGURATIONS

Sixteen HELP Model simulations were completed to estimate percolation rates through the alternate liner and overliner system. Both interim and closed landfill conditions were modeled in accordance with the Texas Water Commission Alternate Liner Design Handbook. The landfill configurations modeled for the alternative liner are summarized in Appendix B.1. HELP Model/MULTIMED Model-Summary of Cases 1-8 and in Appendix B.2 HELP Model Case Summary. The landfill configurations modeled for the overliner system are summarized in Appendix B.11 HELP Model/MULTIMED Model-Summary of Cases 1OL-8OL and B.12 HELP Mode Case Summary. The resulting percolation rate for each HELP Model simulation was then used to estimate the DAF using MULTIMED for each of the 16 cases. MULTIMED model analysis is in Appendix C. Calculations of the DAF are in Appendix D. The locations used for the POC demonstrations were chosen to represent the shortest distance to the POC. The analysis locations were selected to model the scenario at the toe of the landfill, midway up the slope, at the slope transition, and peak in order to consider the effect of the waste column thickness on the calculated DAF. Point of Compliance Figures are in Appendix A. DAFs were also computed at the four locations for each landfill configuration to show a direct relationship with the distance from the POC to the analysis point. Leachate Data is in Appendix E. MULTIMED Model output is in Appendix F. Aquifer Specific Data, geology, and hydrogeology are in

Appendices C.7.1 through C.7.11. The upper clay (light olive green clay) is ubiquitous under the site with a minimum proven thickness of 38 feet thick, the Chicot Aquifer is approximately 220 feet below ground surface, and the Evangeline Aquifer is approximately 500 feet below ground surface. The light olive green clay layer serves as aquiclude between the uppermost acquifer below the landfill site and the Chicot acquifer. To provide a conservative assumption given the bottom of the landfill and the groundwater, the percolation through the alternate liner and overliner system was assumed to be conveyed directly to the upper strata and therefore travel time, dilution, and attenuation are not accounted for in this analysis for upper soils.

2.4 SLOPE STABILITY ANALYSIS

The alternative liner and overliner system were analyzed for slope stability by performing two dimensional, effective stress slope stability analyses for the final, closed geometry, using the computer program SLIDE. The slope stability calculations are presented in Part III Attachment 4, Appendix 2-Section 7 WASTE MASS STABILITY and Appendix F: Graphical Representation of Mass Stability Analyses Results.

3 MODEL INPUT PARAMETERS

Detailed HELP and MULTIMED information is presented in Appendices A through F. HELP Model input parameters and results are summarized in Appendices B.1, B.2, B.11, and B.12 for both the analysis of the alternative liner (interim and closed conditions) and overliner system (interim and closed conditions). In general, conservative assumptions were made in determining the percolation rate and dilution attenuation factor (DAF). A list of major assumptions used in the MULTIMED demonstrations are presented in Table 3-1. The table also compares the actual site conditions to the assumptions used for modeling. The criteria used to develop the percolation rate for each landfill case were selected to maximize the percolation rate. As discussed in Section 2.3, a major conservative assumption is not accounting for the approximately 38 feet of low permeability light olive green clay separating the bottom of the landfill and the uppermost groundwater zone. The estimated percolation through the alternative liner and overliner system is modeled to be conveyed directly to the strata below the bottom of the landfill at each evaluation section location; and the water table is assumed to be at the bottom of the liner as a conservative approach. If less conservative assumptions were used, the DAF calculated using MULTIMED for each landfill case would be significantly larger.

The MULTIMED model input parameters are detailed in Appendix C. By making the assumptions listed in Table 3-1, a single MULTIMED simulation accounts for all 24 constituents identified by the EPA as requiring landfill design protection criteria. The required minimum DAFs for the 24 EPA constituents are given in Table 2-Leachate Evaluation, page 24 of the *Texas Water Commission Alternate Liner Design* Handbook; the same table of constituents listed in Table 1 in Title 30 TAC §330.331(a)(1). The largest DAF listed in the table is 260. Therefore, if MULTIMED results in a DAF higher than 260 for a generic chemical that is conservatively modeled with no carbon absorption, no biodegradation, and no decay, it is concluded that the proposed alternative liner and overliner system design is acceptable. The actual DAF for a specific chemical would be higher than the result calculated by MULTIMED under these circumstances since actual physical processes of absorption, biodegradation, and decay would act to reduce chemical concentrations at the POC to less than those predicted by MULTIMED. The model result is then expressed in terms of the DAF, which is defined as the ratio of the input concentration to the concentration at the POC. MULTIMED can be used to find the DAF by using an input concentration of 1.0 mg/L. The DAF is the reciprocal of the resulting concentration of POC. The POCs for this demonstration are sin Appendix F.

Table 3-1
Major Assumption Used to Determine MULTIMED Model Input Parameters

Input Parameters	Assumption	Actual Site Conditions
Model Source Type	Steady state	Assumed amount of leachate percolation is released continuously. This is a very conservative assumption.
Biodegradation	No biodegradation	Biodegradation is active in hydrogeologic environments
Chemical Decay	No chemical deay	Chemical decay will occur with most contaminants in hydrogeologic environments

4 POINT OF COMPLIANCE DEMONSTRATION RESULTS

The HELP and MULTIMED models were used to evaluate the proposed design of the alternative liner and overliner system by estimating constituent concentrations at the POC for the landfill cases discussed in Section 2.3. The percolation rates obtained from the HELP Model cases included in Appendix C.3 and Appendix C.4 were used as input for the MULTIMED model to determine the DAF. Conservatively, the constituent concentrations at the base of the landfill liner and at the POC were used to calculate the DAF.

A summary of the calculated DAF is presented below and in Appendix D.

Location	Interim Case DAF	Closed Case DAF
Alternative Liner Location 1	33,979	85,106
Alternative Liner Location 2	57,471	201,288
Alternative Liner Location 3	80,645	282,566
Alternative Liner Location 4	286,533	1,003,814

Location	Interim Case DAF	Closed Case DAF
Overliner Location 1	18,797	65,833
Overliner Location 2	77,640	232,450
Overliner Location 3	158,253	473,934
Overliner Location 4	615,385	1,842,639

The results demonstrate that the proposed alternative liner design and overliner design meets or exceeds the requirements of Title 30 TAC §330.331(a)(1). The DAF calculated by the use of HELP and MULTIMED are well in excess of the 260 minimum criterion. The actual DAFs are expected to be substantially higher than the DAFs predicted by this modeling demonstration because the model input was conservatively estimated as discussed in previous sections of this report.

APPENDIX A

POINT OF COMPLIANCE FIGURES

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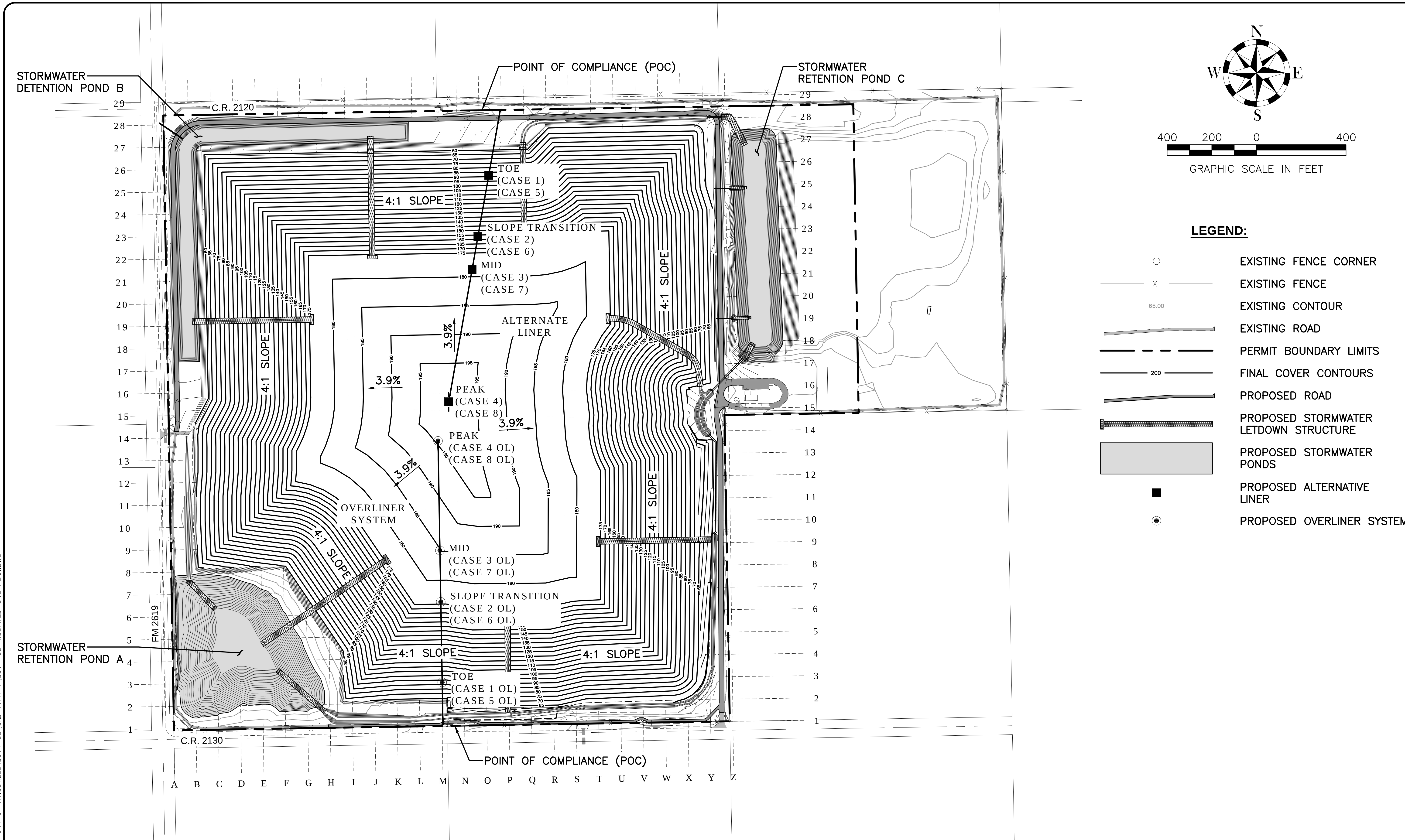

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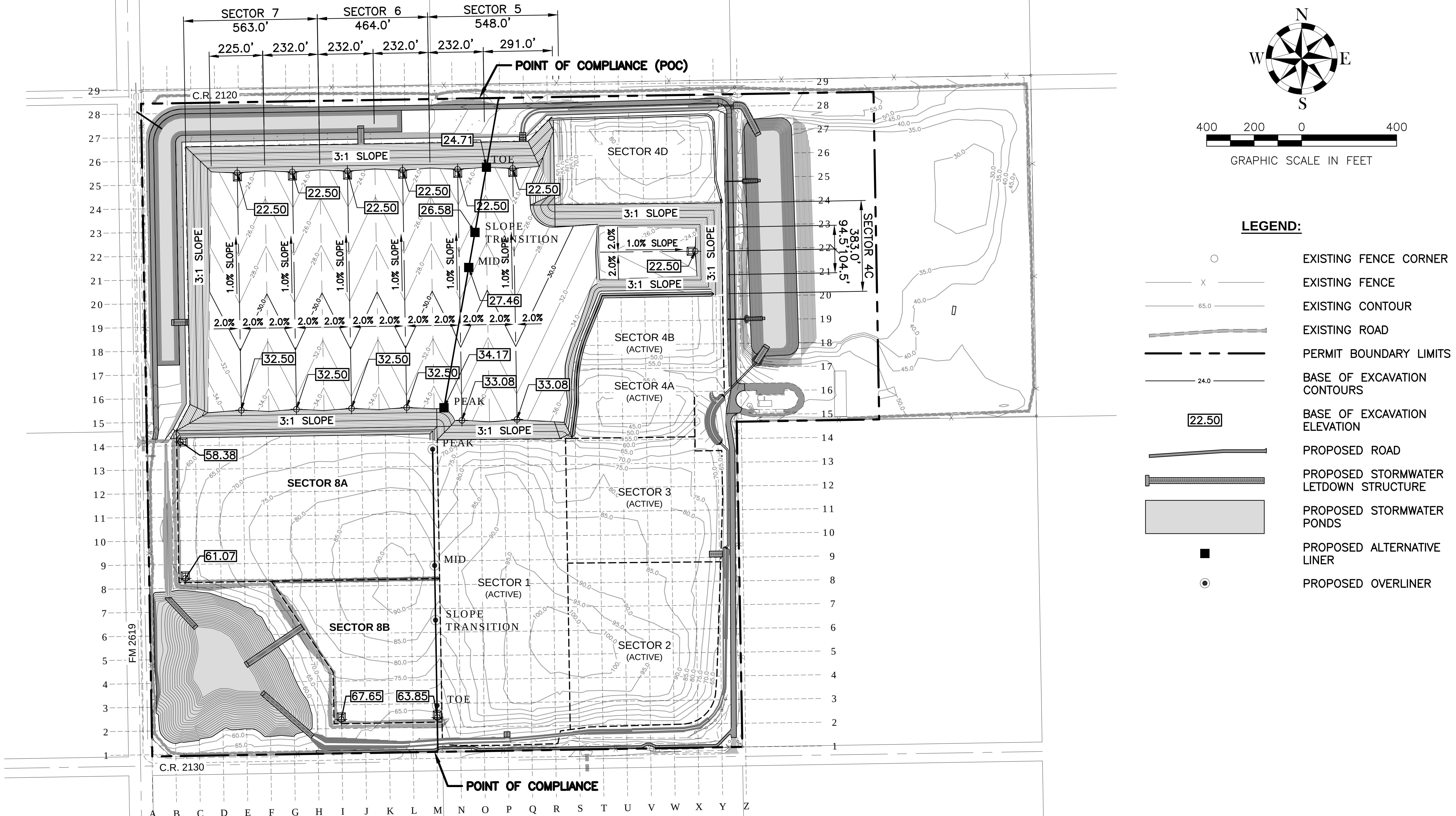
PART III, ATTACHMENT 5, APPENDIX A
LANDFILL COMPLETION SITE PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.1



LEGEND:

- EXISTING FENCE CORNER
- EXISTING FENCE
- EXISTING CONTOUR
- EXISTING ROAD
- PERMIT BOUNDARY LIMITS
- BASE OF EXCAVATION CONTOURS
- BASE OF EXCAVATION ELEVATION
- PROPOSED ROAD
- PROPOSED STORMWATER LETDOWN STRUCTURE
- PROPOSED STORMWATER PONDS
- PROPOSED ALTERNATIVE LINER
- PROPOSED OVERLINER

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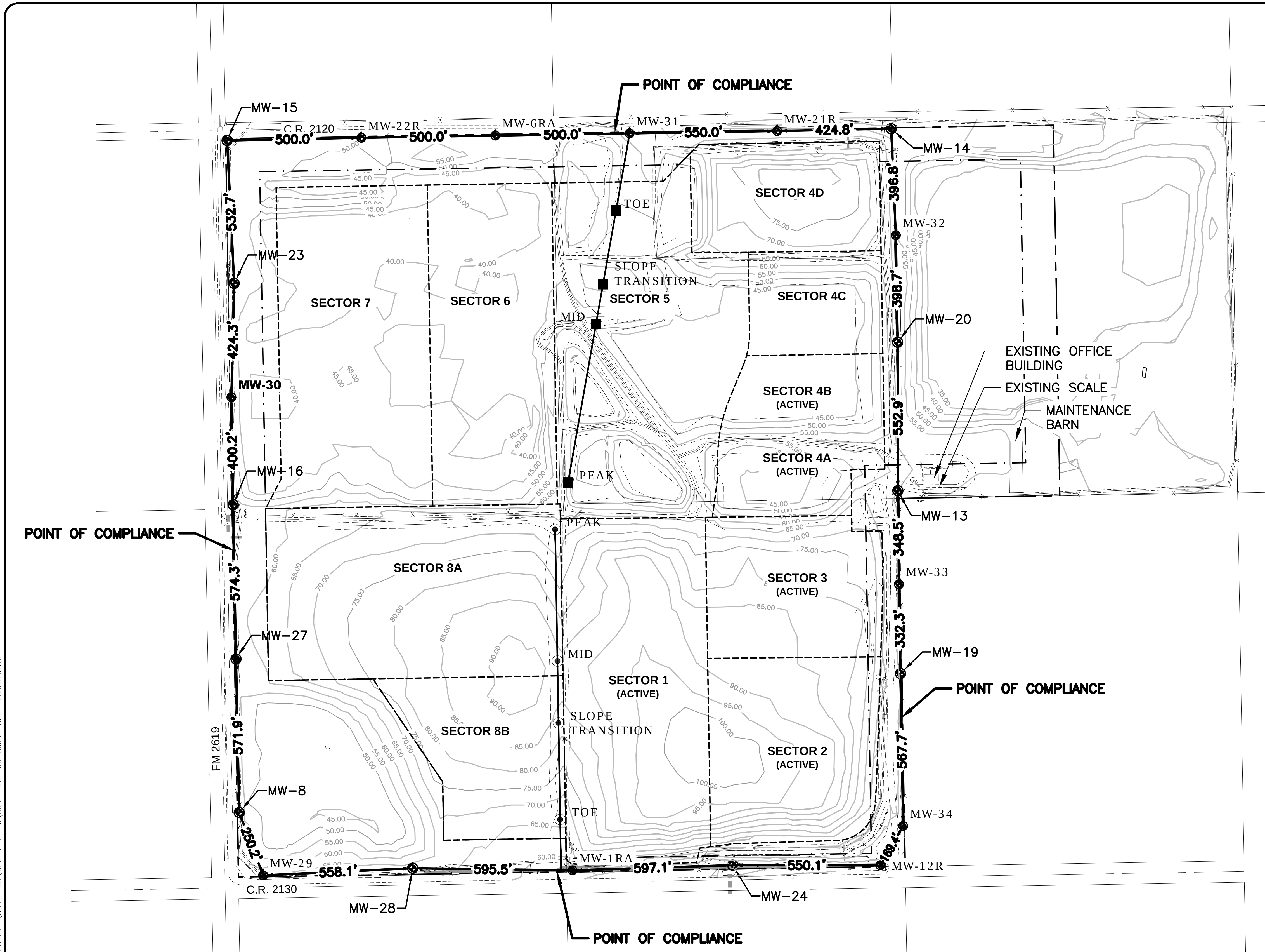
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.2



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GRAPHIC SCALE IN FEET

LEGEND:

MW-20	MONITOR WELL LOCATION
	EXISTING FENCE
65.00	EXISTING SURFACE CONTOUR (2015)
	SECTOR OUTLINE
	PERMIT BOUNDARY (175.89 ACRES)
	BUFFER ZONE
400.2'	POINT OF COMPLIANCE
	PROPOSED ALTERNATIVE LINER
	PROPOSED OVERLINER

SITE COORDINATES		
MONITOR WELL LOCATIONS		
MW	Northing	Easting
MW-8	17051473.78	1203673.74
MW-13	17052672.16	1206127.95
MW-14	17054020.04	1206103.02
MW-15	17053976.10	1203628.61
MW-16	17052619.76	1203651.21
MW-19	17051991.35	1206137.50
MW-20	17053225.01	1206127.20
MW-23	17053444.05	1203654.88
MW-24	17051277.99	1205512.42
MW-27	17052045.52	1203661.75
MW-28	17051266.46	1204320.24
MW-1RA	17051258.70	1204915.66
MW-32	17053623.64	1206120.29
MW-6RA	17053994.38	1204628.44
MW-12R	17051277.38	1206062.51
MW-21R	17054011.48	1205678.30
MW-22R	17053986.24	1204128.51
MW-29	17051239.92	1203762.81
MW-30	17053019.90	1203644.60
MW-31	17054002.53	1205128.38
MW-33	17052323.65	1206132.04
MW-34	17051423.79	1206147.64

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL POINT OF COMPLIANCE LOCATIONS
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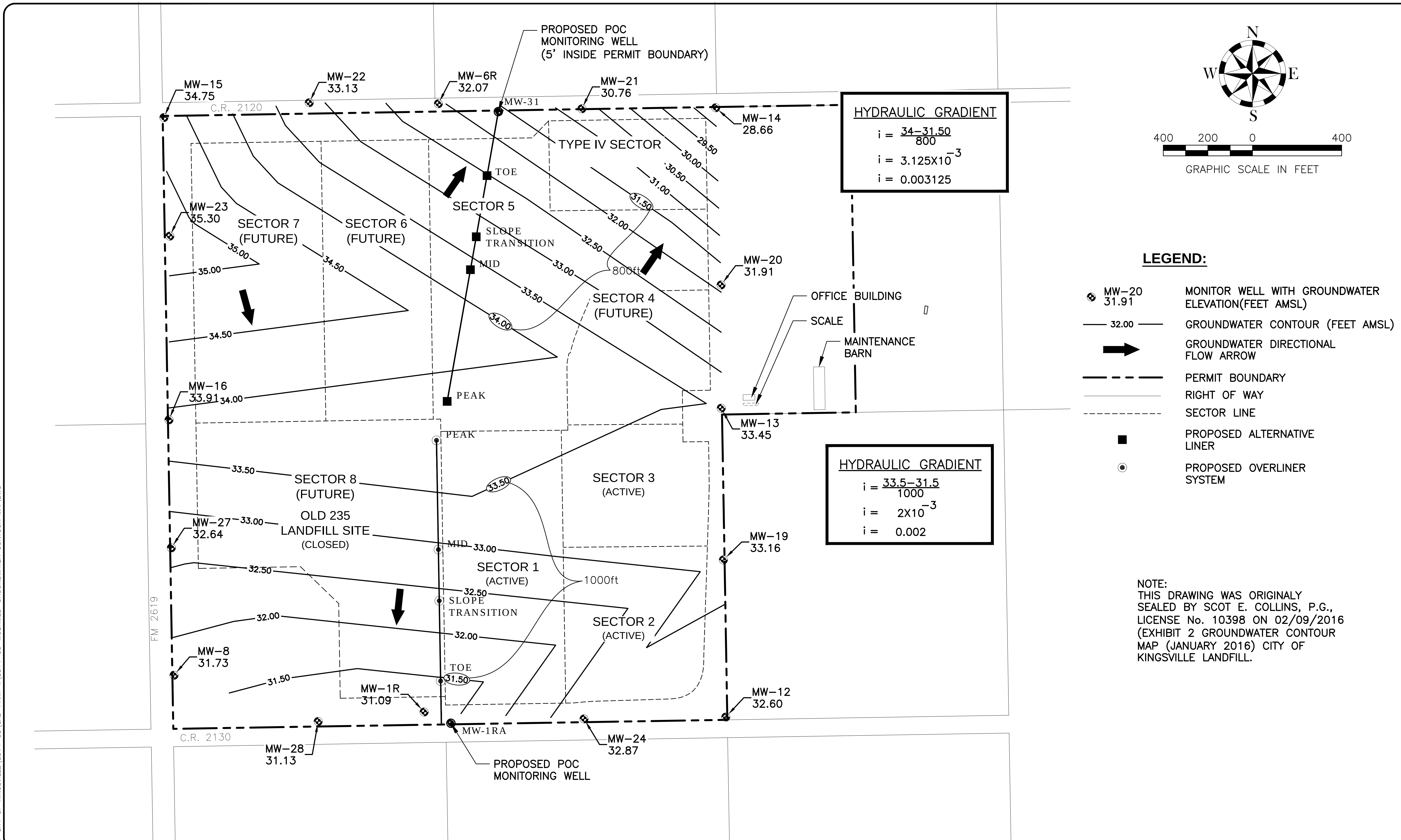
FIGURE:
III.5-A.3



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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL GROUNDWATER CONTOUR MAP/HYDRAULIC GRADIENT
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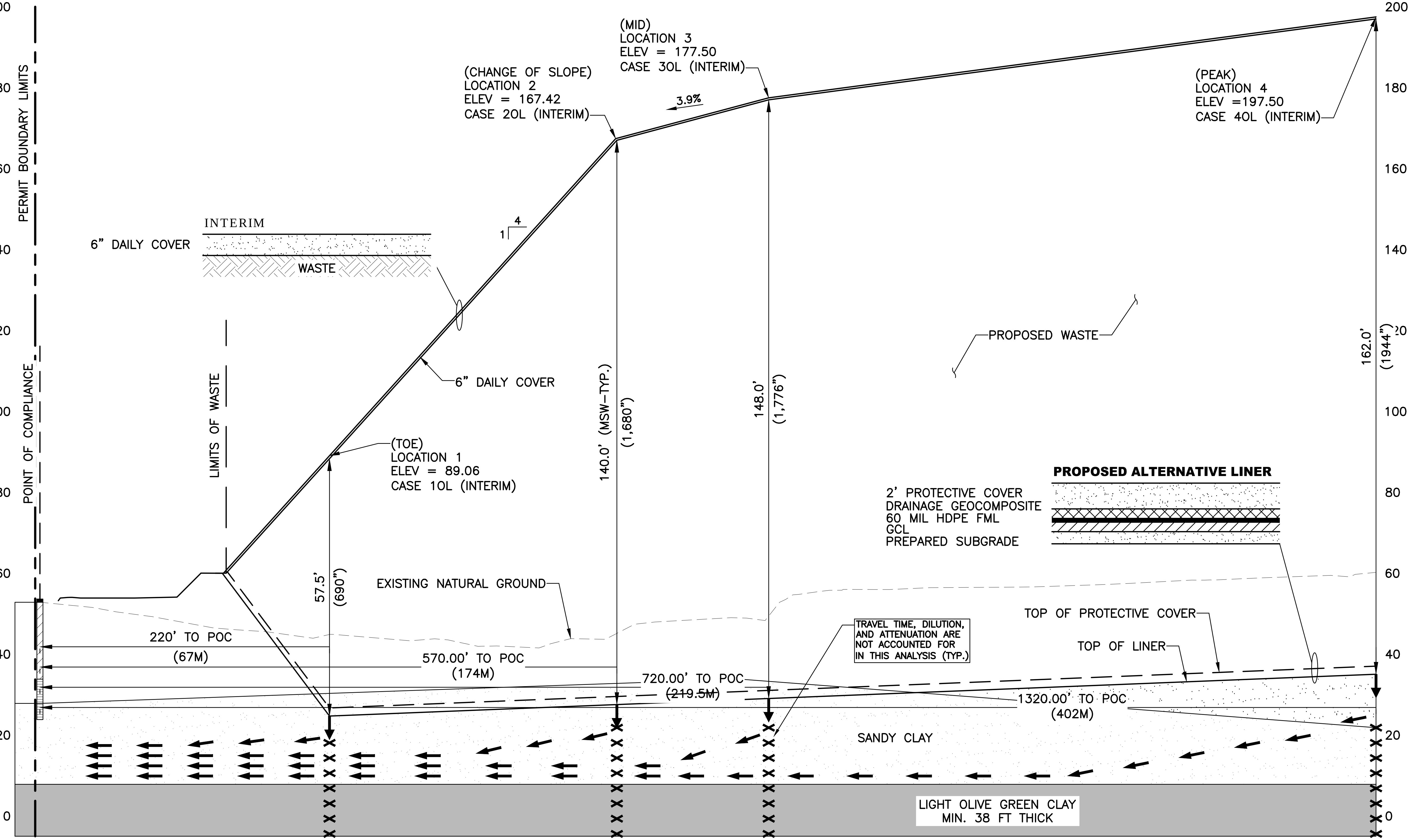
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.4



ALTERNATIVE LINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12x10^{-4} CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-INTERIM
LANDFILL WITH ALTERNATIVE LINER
CITY OF KINGSVILLE LANDFILL
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KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.5

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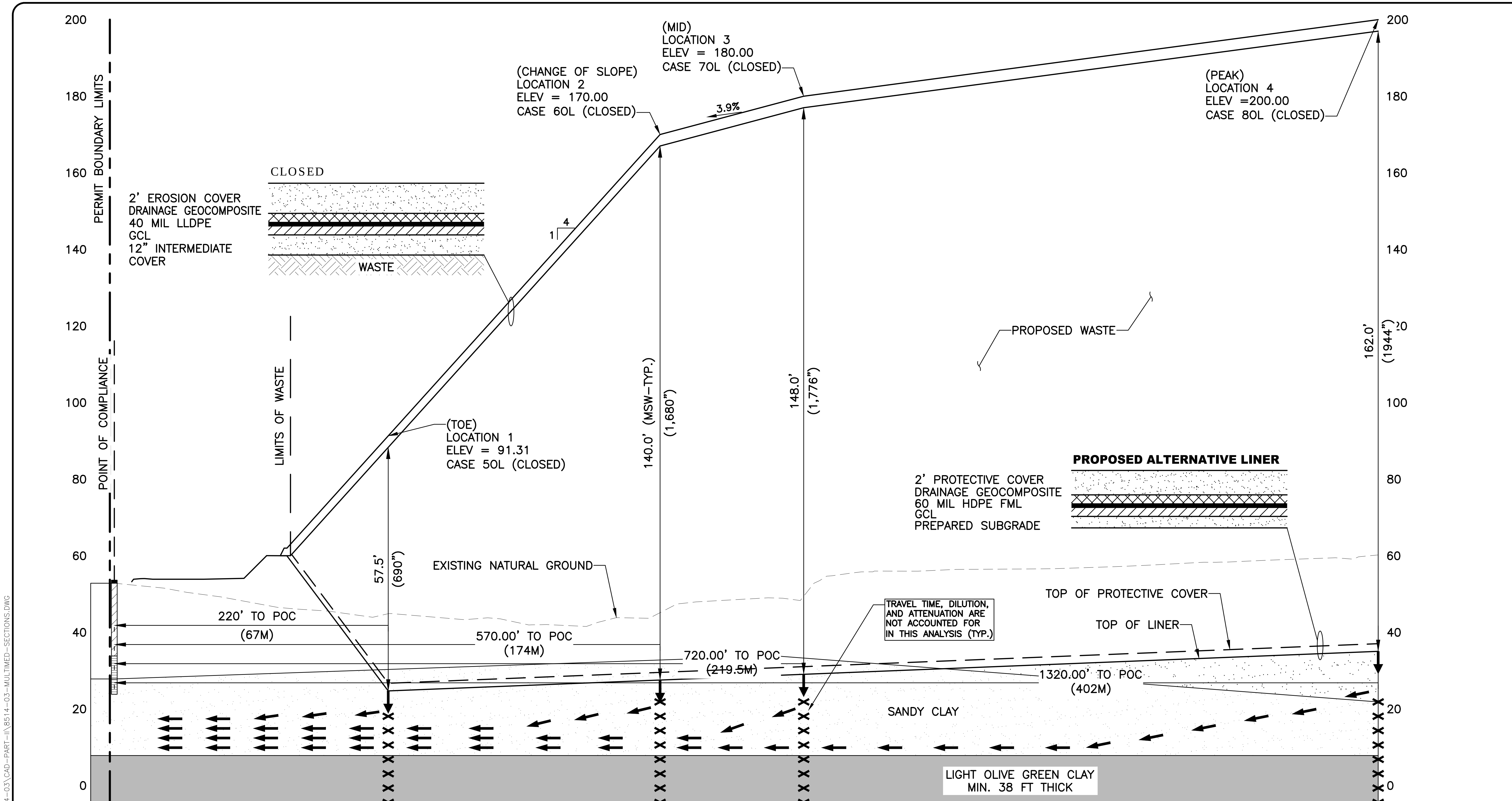

ALTERNATIVE LINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12×10^{-4} CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-CLOSED LANDFILL WITH ALTERNATIVE LINER
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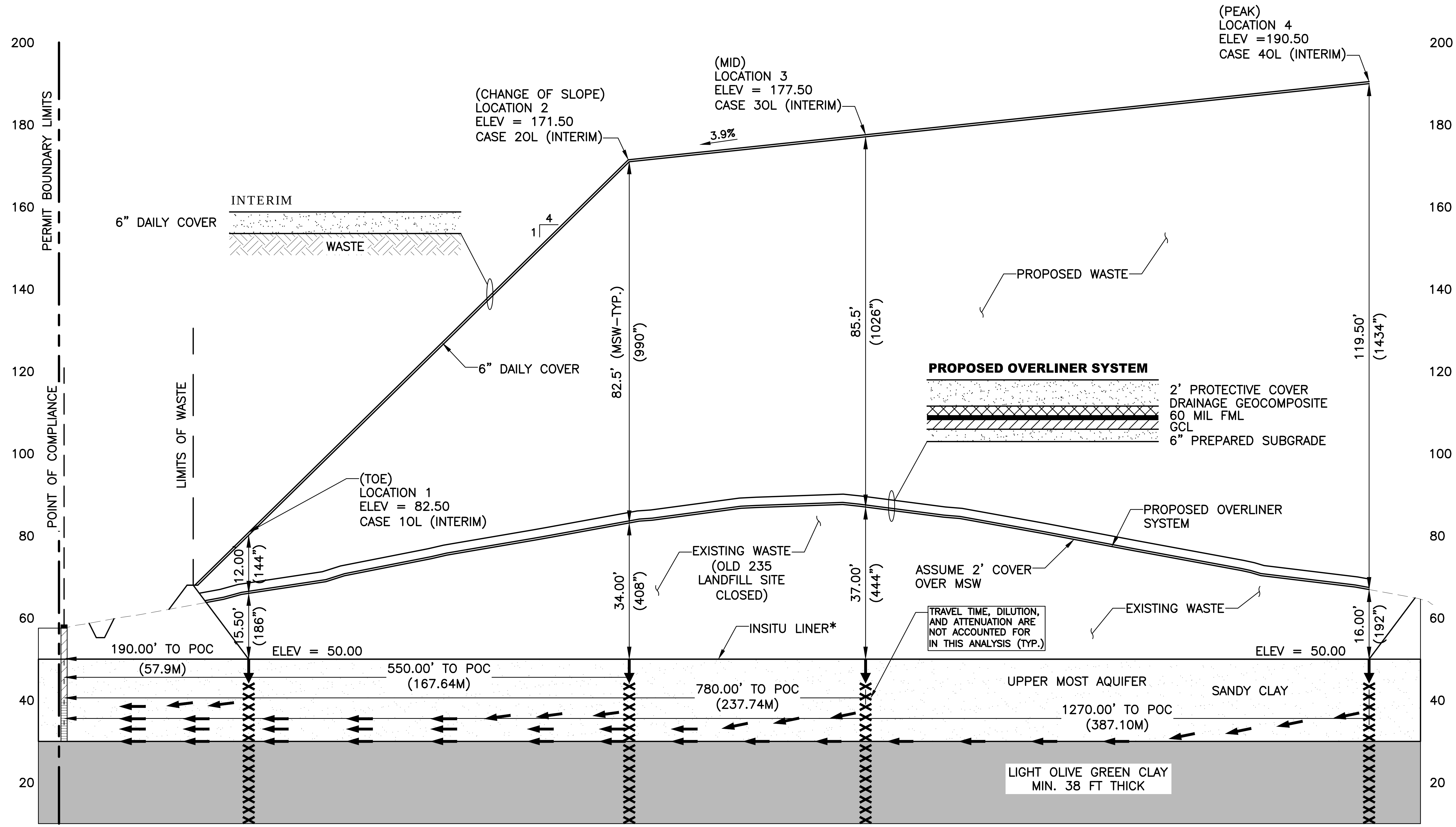
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.6



*OVERLINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE INSITU LINER (ASSUMED EQUAL TO PERCOLATION THROUGH OVERLINER).
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12×10^{-4} CM/SEC
HYDRAULIC GRADIENT = i = 0.002

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-INTERIM
LANDFILL WITH ALTERNATIVE AND OVERLINER
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KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.7

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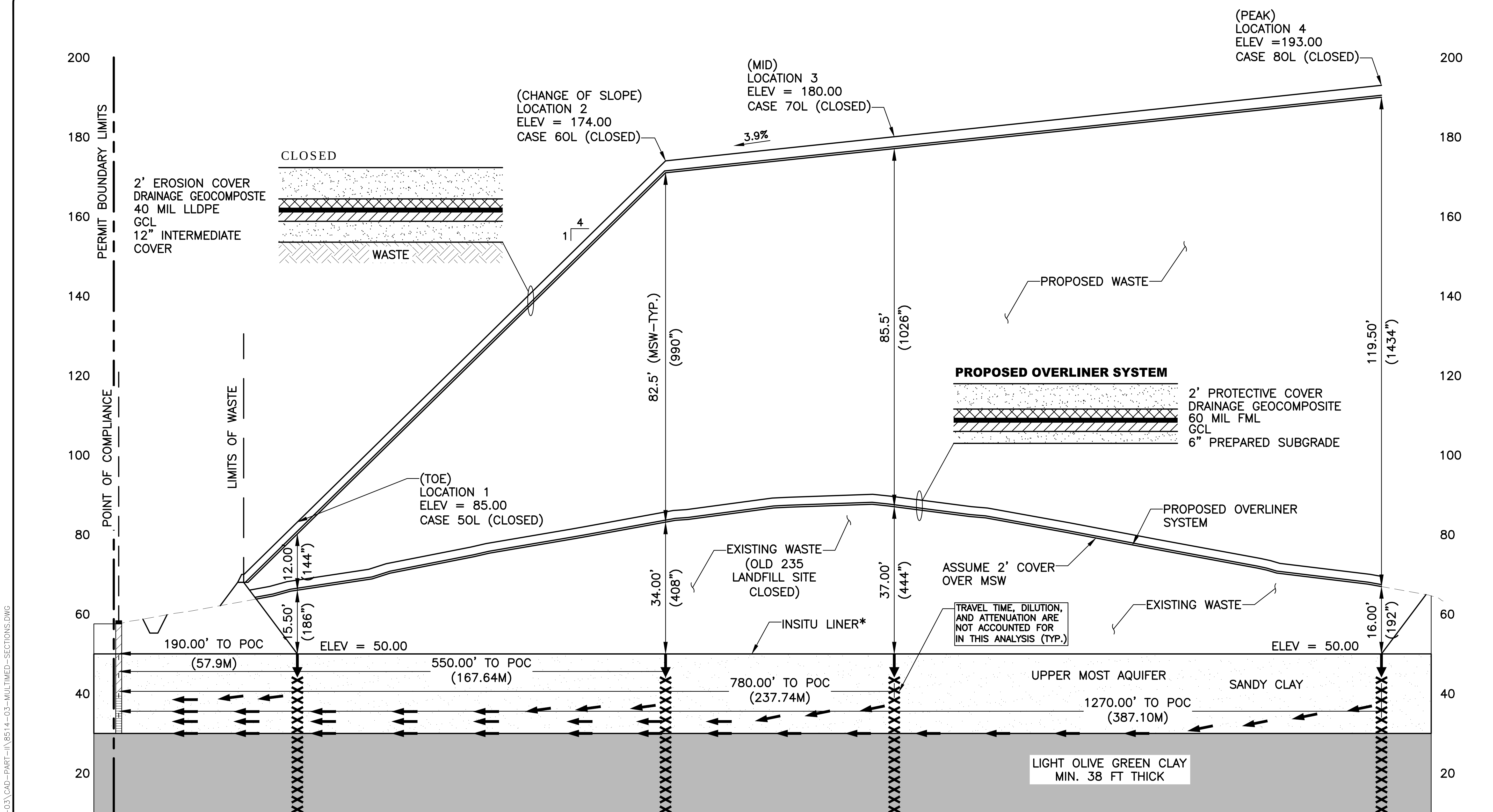

*OVERLINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE INSITU LINER (ASSUMED EQUAL TO PERCOLATION THROUGH OVERLINER).
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12×10^{-4} CM/SEC
HYDRAULIC GRADIENT = i = 0.002

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

HANSON

Hanson Professional Services Inc.
4501 Gollihar Rd.
Corpus Chrisiti, Texas 78411

TBPE F-417
TBPLS F-10039500
TBPG F-50556
TBAE F-BR 2458

Phone: (361) 814-9900
(800) 677-2831
www.hanson-inc.com
Offices Nationwide

PART III, ATTACHMENT 5, APPENDIX A
LANDFILL TYPICAL PROFILE-CLOSED
LANDFILL WITH ALTERNATIVE AND OVERLINER
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-A.8

SEP 11, 2018 2:51 PM TORRE01809
I:\16JOBS\16L0438\8514-CITY OF KINGSVILLE\8514-03\CAD-PART-II\8514-03-MULTIMED-SECTIONS.DWG

APPENDIX B

HELP MODEL ANALYSIS ALTERNATIVE LINER

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

APPENDIX B.1

HELP MODEL/MULTIMED MODEL-SUMMARY OF CASES 1-8

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

Project No. 8514-3 Permit Amendment

Description: HELP Model/MULTIMED Model-Summary of Cases 1-8

Date: 3/01/17

By: JCG

Case 1-Interim Landfill (Location 1)- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover),57.5 feet of waste with 250 foot drain length at 2%, and 6 inches of daily soil cover.

Case 2-Interim Landfill (Location 2)- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 140 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

Case 3-Interim Landfill (Location 3)- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 148 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

Case 4-Interim Landfill (Location 4)- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 162 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

Case 5-Closed Landfill (Location 1) - A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 57.5 feet of waste with 250 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

Case 6-Closed Landfill (Location 2)- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 140 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

Case7-Closed Landfill (Location 3)- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 12 inch protective soil layer (Protective Cover), 148 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

Case 8-Closed Landfill (Location 4)- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 162 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

APPENDIX B.2

HELP MODEL CASE SUMMARY

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose c. Garza, P.E.

HELP MODEL CASE SUMMARY

Case Alternative Liner	Average Precipitation (IN/YR)	Average Runoff (IN/YR)	Average Evapotranspiration (IN/YR)	Average Percolation Through Liner (CF/YR)	Peak Percolation Through Liner (CF/DAY)	*Peak Percolation Through Liner (M/YR)
Interim Landfill HELP Information						
Location 1 • 57.5 feet of waste (Case 1)						
20 yr	25.74	2.391	21.632	0.004	0.000050	1.28E-07
Location 2 • 140 feet of waste (Case 2)						
20 yr	25.74	2.135	21.716	0.004	0.00007	1.79E-07
Location 3 • 148 feet of waste (Case 3)						
20 yr	25.74	2.197	21.691	0.004	0.00007	1.79E-07
Location 4 • 162 feet of waste (Case 4)						
20 yr	25.74	1.907	21.787	0.005	0.00007	1.79E-07
Closed Landfill HELP Information						
Location 1 • 57.5 feet of waste (Case 5)						
30 yr	27.20	1.880	21.749	0.001	0.00002	5.11E-08
Location 2 • 140 feet of waste (Case 6)						
30 yr	27.20	1.680	21.481	0.004	0.00002	5.11E-08
Location 3 • 148 feet of waste (Case 7)						
30 yr	27.20	1.711	21.470	0.004	0.00002	5.11E-08
Location 4 • 162 feet of waste (Case 8)						
30 yr	27.20	1.533	21.495	0.004	0.00002	5.11E-08

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00005 FT^3/Day-Acre)x(1 Acre/43,560 FT^2)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= 1.28×10^{-7} M/YR

APPENDIX B.3

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1-LOCATION 1

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE120Y.OUT

```
*******************************************************************************
*******************************************************************************
**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                    **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                        **
**                 USAE WATERWAYS EXPERIMENT STATION                         **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE1.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE120Y.OUT


TIME: 16:43      DATE:  3/13/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 1 (Location 1)

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


     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  13
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4300 VOL/VOL
          FIELD CAPACITY             =      0.3210 VOL/VOL
          WILTING POINT              =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2393 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
          THICKNESS                  =    690.00   INCHES
```

CASE120Y.OUT

```
POROSITY                    =     0.6710 VOL/VOL
FIELD CAPACITY              =     0.2920 VOL/VOL
WILTING POINT               =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.2905 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =    24.00   INCHES
POROSITY                    =     0.4300 VOL/VOL
FIELD CAPACITY              =     0.3210 VOL/VOL
WILTING POINT               =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.3244 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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  =     0.0152 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000     CM/SEC
SLOPE                       =     2.00   PERCENT
DRAINAGE LENGTH             =   250.0    FEET


                        LAYER  5
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =     0.06   INCHES
POROSITY                    =     0.0000 VOL/VOL
FIELD CAPACITY              =     0.0000 VOL/VOL
WILTING POINT               =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =     0.24   INCHES
POROSITY                    =     0.7500 VOL/VOL
FIELD CAPACITY              =     0.7470 VOL/VOL
```

CASE120Y.OUT

```
WILTING POINT                 =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.300000003000E-08 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
          AND A SLOPE LENGTH OF  100. FEET.

 SCS RUNOFF CURVE NUMBER            =    89.50
 FRACTION OF AREA ALLOWING RUNOFF   =    80.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =    12.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =     2.124  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =     6.606  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =     1.788  INCHES
 INITIAL SNOW WATER                 =     0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =   209.820  INCHES
 TOTAL INITIAL WATER                =   209.820  INCHES
 TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR


             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI        TEXAS

      STATION LATITUDE                          =  27.77 DEGREES
      MAXIMUM LEAF AREA INDEX                   =   2.00
      START OF GROWING SEASON (JULIAN DATE)     =     0
      END OF GROWING SEASON (JULIAN DATE)       =   367
      EVAPORATIVE ZONE DEPTH                    =  12.0  INCHES
      AVERAGE ANNUAL WIND SPEED                 =  12.00 MPH
      AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  76.00 %
      AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  78.00 %
      AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  76.00 %
      AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  76.00 %


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

          NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
-------     -------     -------     -------     -------     -------
  1.63        1.69        1.20        1.57        3.29        3.12
  2.26        2.78        5.31        2.92        1.61        1.17


 NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
          COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS

      NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
```

CASE120Y.OUT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.015	0.067	0.006	0.104	0.281	0.288
	0.380	0.193	0.784	0.181	0.073	0.020
STD. DEVIATIONS	0.043	0.081	0.009	0.237	0.504	0.348
	0.817	0.198	0.914	0.274	0.212	0.070
EVAPOTRANSPIRATION						
TOTALS	0.939	2.086	1.297	1.241	1.988	2.114
	2.037	1.875	3.620	2.256	1.089	1.091
STD. DEVIATIONS	0.543	0.911	0.701	0.915	1.322	1.388
	1.606	1.312	1.225	1.220	0.757	0.583
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0660	0.0208	0.0717	0.0580	0.0362	0.0534
	0.1446	0.1781	0.1018	0.4110	0.4038	0.1914
STD. DEVIATIONS	0.0860	0.0317	0.1423	0.1051	0.0619	0.1057
	0.2593	0.3508	0.2000	0.5937	0.7436	0.3248
PERCOLATION/LEAKAGE THROUGH LAYER 6						
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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

CASE120Y.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0005	0.0002	0.0005	0.0004	0.0003	0.0004
	0.0010	0.0013	0.0007	0.0029	0.0030	0.0014
STD. DEVIATIONS	0.0006	0.0002	0.0010	0.0008	0.0004	0.0008
	0.0018	0.0025	0.0015	0.0042	0.0055	0.0023

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.74 (5.706)	93448.9	100.00
RUNOFF	2.391 (1.2854)	8679.79	9.288
EVAPOTRANSPIRATION	21.632 (3.6809)	78522.88	84.028
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.73689 (1.43677)	6304.902	6.74690
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (0.001)		
CHANGE IN WATER STORAGE	-0.016 (0.5277)	-58.66	-0.063

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.138	7761.3745
DRAINAGE COLLECTED FROM LAYER 4	0.16595	602.40332
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00005
AVERAGE HEAD ON TOP OF LAYER 5	0.037	
MAXIMUM HEAD ON TOP OF LAYER 5	0.072	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.4 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3879

```
MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1490

 ***  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.

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

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

               FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1            1.4211         0.2369

                  2          200.1899         0.2901

                  3            7.7040         0.3210

                  4            0.0020         0.0100

                  5            0.0000         0.0000

                  6            0.1800         0.7500

               SNOW WATER      0.000

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

APPENDIX B.4

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER
09/12/18

CASE220Y.OUT

```
*****************************************************************************
*****************************************************************************
**                                                                         **
**                                                                         **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
**             HELP MODEL VERSION 3.07   (1 NOVEMBER 1997)                 **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                  USAE WATERWAYS EXPERIMENT STATION                      **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                         **
**                                                                         **
*****************************************************************************
*****************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE2.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE220Y.OUT


TIME:  16:53      DATE:   3/13/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 2 (LOCATION 2)

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


     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  13
           THICKNESS                  =     6.00    INCHES
           POROSITY                   =     0.4300 VOL/VOL
           FIELD CAPACITY             =     0.3210 VOL/VOL
           WILTING POINT              =     0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2391 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =  1680.00    INCHES
```

Page 1

```
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                         LAYER  3
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3245 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                         LAYER  4
                         --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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  =      0.0205 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    500.0    FEET


                         LAYER  5
                         --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                         LAYER  6
                         --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
```

CASE220Y.OUT

```
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

```
NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
       SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
       FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
       AND A SLOPE LENGTH OF  350. FEET.

SCS RUNOFF CURVE NUMBER              =     88.80
FRACTION OF AREA ALLOWING RUNOFF     =     80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      2.124  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      6.606  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.788  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =    498.905  INCHES
TOTAL INITIAL WATER                  =    498.905  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       CORPUS CHRISTI        TEXAS

    STATION LATITUDE                           =  27.77 DEGREES
    MAXIMUM LEAF AREA INDEX                    =   2.00
    START OF GROWING SEASON (JULIAN DATE)      =      0
    END OF GROWING SEASON (JULIAN DATE)        =    367
    EVAPORATIVE ZONE DEPTH                     =  12.0  INCHES
    AVERAGE ANNUAL WIND SPEED                  =  12.00 MPH
    AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  76.00 %
    AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  78.00 %
    AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  76.00 %
    AVERAGE 4TH QUARTER RELATIVE HUMIDITY      =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    KINGSVILLE      TEXAS
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

Page 3

CASE220Y.OUT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.012	0.055	0.003	0.092	0.254	0.252
	0.350	0.170	0.716	0.149	0.066	0.016
STD. DEVIATIONS	0.037	0.071	0.006	0.216	0.479	0.315
	0.770	0.181	0.864	0.234	0.199	0.057
EVAPOTRANSPIRATION						
TOTALS	0.932	2.093	1.304	1.251	1.993	2.128
	2.048	1.899	3.628	2.264	1.098	1.076
STD. DEVIATIONS	0.540	0.899	0.714	0.930	1.317	1.382
	1.634	1.319	1.222	1.208	0.786	0.592
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0714	0.0325	0.0735	0.0598	0.0433	0.0680
	0.1629	0.1994	0.1144	0.4250	0.4282	0.2290
STD. DEVIATIONS	0.0918	0.0521	0.1373	0.1034	0.0700	0.1461
	0.3040	0.4252	0.2386	0.5913	0.7365	0.4175
PERCOLATION/LEAKAGE THROUGH LAYER 6						
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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

CASE220Y.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0010	0.0005	0.0010	0.0009	0.0006	0.0010
	0.0023	0.0028	0.0017	0.0060	0.0063	0.0033
STD. DEVIATIONS	0.0013	0.0008	0.0020	0.0015	0.0010	0.0021
	0.0043	0.0061	0.0035	0.0084	0.0108	0.0059

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.74 (5.706)	93448.9	100.00
RUNOFF	2.135 (1.1936)	7751.57	8.295
EVAPOTRANSPIRATION	21.716 (3.6903)	78829.24	84.355
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.90751 (1.54789)	6924.269	7.40968
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0.002)		
CHANGE IN WATER STORAGE	-0.015 (0.5511)	-56.19	-0.060

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.088	7578.4883
DRAINAGE COLLECTED FROM LAYER 4	0.16062	583.03455
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.071	
MAXIMUM HEAD ON TOP OF LAYER 5	0.141	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	1.7 FEET	
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3901	

CASE220Y.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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.

****

****

FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	1.4393	0.2399
2	489.2699	0.2912
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

****
****

APPENDIX B.5

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3- LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE320Y.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**             DEVELOPED BY ENVIRONMENTAL LABORATORY                        **
**             USAE WATERWAYS EXPERIMENT STATION                            **
**         FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                  **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE3.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE320Y.OUT


TIME:   9:42    DATE:   3/ 3/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 3 (LOCATION 3)

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


     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  13
          THICKNESS                 =      6.00   INCHES
          POROSITY                  =      0.4300 VOL/VOL
          FIELD CAPACITY            =      0.3210 VOL/VOL
          WILTING POINT             =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.2391 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                 =   1776.00   INCHES
```

Page 1

```
POROSITY                   =      0.6710 VOL/VOL
FIELD CAPACITY             =      0.2920 VOL/VOL
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3245 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER  20
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 =      0.0205 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   10.0000000000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    500.0    FEET


                        LAYER  5
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
             MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                        LAYER  6
                        --------

             TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.24   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
```

```
                                   CASE320Y.OUT
      WILTING POINT                =        0.4000 VOL/VOL
      INITIAL SOIL WATER CONTENT   =        0.7500 VOL/VOL
      EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


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

    NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
             SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
             FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.%
             AND A SLOPE LENGTH OF  200. FEET.

    SCS RUNOFF CURVE NUMBER             =     89.00
    FRACTION OF AREA ALLOWING RUNOFF    =     80.0    PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
    EVAPORATIVE ZONE DEPTH              =     12.0    INCHES
    INITIAL WATER IN EVAPORATIVE ZONE   =      2.124  INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE  =      6.606  INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE  =      1.788  INCHES
    INITIAL SNOW WATER                  =      0.000  INCHES
    INITIAL WATER IN LAYER MATERIALS    =    526.937  INCHES
    TOTAL INITIAL WATER                 =    526.937  INCHES
    TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

    NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
             CORPUS CHRISTI        TEXAS

         STATION LATITUDE                          =  27.77 DEGREES
         MAXIMUM LEAF AREA INDEX                   =   2.00
         START OF GROWING SEASON (JULIAN DATE)     =      0
         END OF GROWING SEASON (JULIAN DATE)       =    367
         EVAPORATIVE ZONE DEPTH                    =  12.0  INCHES
         AVERAGE ANNUAL WIND SPEED                 =  12.00 MPH
         AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  76.00 %
         AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  78.00 %
         AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  76.00 %
         AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  76.00 %


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

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   1.63        1.69        1.20        1.57        3.29        3.12
   2.26        2.78        5.31        2.92        1.61        1.17


    NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR     CORPUS CHRISTI       TEXAS

         NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

                                      Page 3
```

CASE320Y.OUT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.013	0.058	0.004	0.095	0.261	0.260
	0.358	0.176	0.733	0.155	0.067	0.017
STD. DEVIATIONS	0.038	0.074	0.007	0.221	0.486	0.324
	0.783	0.186	0.879	0.241	0.202	0.058
EVAPOTRANSPIRATION						
TOTALS	0.931	2.093	1.302	1.250	1.993	2.121
	2.045	1.896	3.629	2.258	1.099	1.074
STD. DEVIATIONS	0.537	0.898	0.710	0.928	1.312	1.384
	1.629	1.315	1.227	1.202	0.786	0.593
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0691	0.0357	0.0747	0.0581	0.0416	0.0640
	0.1587	0.1953	0.1104	0.4160	0.4200	0.2277
STD. DEVIATIONS	0.0916	0.0544	0.1437	0.1048	0.0687	0.1397
	0.2950	0.4190	0.2386	0.5831	0.7316	0.4157
PERCOLATION/LEAKAGE THROUGH LAYER 6						
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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0010	0.0006	0.0011	0.0009	0.0006	0.0009
	0.0023	0.0028	0.0016	0.0059	0.0062	0.0032
STD. DEVIATIONS	0.0013	0.0009	0.0020	0.0015	0.0010	0.0021
	0.0042	0.0060	0.0035	0.0083	0.0108	0.0059

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.74 (5.706)	93448.9	100.00
RUNOFF	2.197 (1.2161)	7975.32	8.534
EVAPOTRANSPIRATION	21.691 (3.6830)	78736.87	84.257
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.87134 (1.53436)	6792.955	7.26917
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0.002)		
CHANGE IN WATER STORAGE	-0.015 (0.5521)	-56.24	-0.060

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.106	7646.4312
DRAINAGE COLLECTED FROM LAYER 4	0.16174	587.13318
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.071	
MAXIMUM HEAD ON TOP OF LAYER 5	0.142	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.9 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3893

CASE320Y.OUT

```
MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.1490

 ***  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.

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



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

               FINAL WATER STORAGE AT END OF YEAR   20
    ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1            1.4394         0.2399

                 2          517.3019         0.2913

                 3            7.7040         0.3210

                 4            0.0020         0.0100

                 5            0.0000         0.0000

                 6            0.1800         0.7500

              SNOW WATER      0.000

******************************************************************************
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APPENDIX B.6

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 4-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE420Y.OUT

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♠
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:        C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\MDATA\CASE4.D10
OUTPUT DATA FILE:             C:\HELP3\MDATA\CASE420Y.OUT


TIME:  17: 0     DATE:   3/13/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 4 (LOCATION 4)

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


     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  13
           THICKNESS                  =       6.00   INCHES
           POROSITY                   =       0.4300 VOL/VOL
           FIELD CAPACITY             =       0.3210 VOL/VOL
           WILTING POINT              =       0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =       0.2210 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =    1944.00   INCHES
```

```
POROSITY                      =       0.6710 VOL/VOL
FIELD CAPACITY                =       0.2920 VOL/VOL
WILTING POINT                 =       0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.2914 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                     =      24.00   INCHES
POROSITY                      =       0.4300 VOL/VOL
FIELD CAPACITY                =       0.3210 VOL/VOL
WILTING POINT                 =       0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.3246 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.330000003000E-04 CM/SEC


                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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    =       0.0206 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   10.0000000000     CM/SEC
SLOPE                         =       2.00   PERCENT
DRAINAGE LENGTH               =     500.0    FEET


                        LAYER  5
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                     =       0.06   INCHES
POROSITY                      =       0.0000 VOL/VOL
FIELD CAPACITY                =       0.0000 VOL/VOL
WILTING POINT                 =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY           =       1.00   HOLES/ACRE
FML INSTALLATION DEFECTS      =       2.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                     =       0.24   INCHES
POROSITY                      =       0.7500 VOL/VOL
FIELD CAPACITY                =       0.7470 VOL/VOL
```

```
                                          CASE420Y.OUT
    WILTING POINT                   =       0.4000 VOL/VOL
    INITIAL SOIL WATER CONTENT  =       0.7500 VOL/VOL
    EFFECTIVE SAT. HYD. COND.   =   0.300000003000E-08 CM/SEC




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

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
           FAIR STAND OF GRASS, A SURFACE SLOPE OF  4.%
           AND A SLOPE LENGTH OF  600. FEET.

  SCS RUNOFF CURVE NUMBER                =      88.00
  FRACTION OF AREA ALLOWING RUNOFF       =      80.0    PERCENT
  AREA PROJECTED ON HORIZONTAL PLANE     =       1.000  ACRES
  EVAPORATIVE ZONE DEPTH                 =      12.0    INCHES
  INITIAL WATER IN EVAPORATIVE ZONE      =       1.920  INCHES
  UPPER LIMIT OF EVAPORATIVE STORAGE     =       6.606  INCHES
  LOWER LIMIT OF EVAPORATIVE STORAGE     =       1.788  INCHES
  INITIAL SNOW WATER                     =       0.000  INCHES
  INITIAL WATER IN LAYER MATERIALS       =     575.790  INCHES
  TOTAL INITIAL WATER                    =     575.790  INCHES
  TOTAL SUBSURFACE INFLOW                =       0.00   INCHES/YEAR




             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           CORPUS CHRISTI       TEXAS

       STATION LATITUDE                         =  27.77 DEGREES
       MAXIMUM LEAF AREA INDEX                  =   2.00
       START OF GROWING SEASON (JULIAN DATE)    =      0
       END OF GROWING SEASON (JULIAN DATE)      =    367
       EVAPORATIVE ZONE DEPTH                   =  12.0  INCHES
       AVERAGE ANNUAL WIND SPEED                =  12.00 MPH
       AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  76.00 %
       AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  78.00 %
       AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  76.00 %
       AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  76.00 %


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

           NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
-------      -------      -------      -------      -------      -------
  1.63         1.69         1.20         1.57         3.29         3.12
  2.26         2.78         5.31         2.92         1.61         1.17


  NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
           COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS

       NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)
```

CASE420Y.OUT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.010	0.044	0.002	0.080	0.229	0.222
	0.322	0.145	0.650	0.131	0.058	0.013
STD. DEVIATIONS	0.032	0.059	0.004	0.198	0.452	0.284
	0.721	0.160	0.809	0.208	0.182	0.047
EVAPOTRANSPIRATION						
TOTALS	0.926	2.091	1.307	1.259	2.002	2.140
	2.063	1.908	3.649	2.262	1.101	1.080
STD. DEVIATIONS	0.553	0.908	0.722	0.938	1.315	1.392
	1.651	1.324	1.215	1.209	0.795	0.582
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.0726	0.0392	0.0796	0.0589	0.0482	0.0756
	0.1774	0.2168	0.1255	0.4497	0.4595	0.2524
STD. DEVIATIONS	0.0955	0.0557	0.1545	0.1063	0.0799	0.1563
	0.3182	0.4582	0.2771	0.6082	0.7549	0.4589
PERCOLATION/LEAKAGE THROUGH LAYER 6						
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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

CASE420Y.OUT

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0010	0.0006	0.0011	0.0009	0.0007	0.0011
	0.0025	0.0031	0.0018	0.0064	0.0068	0.0036
STD. DEVIATIONS	0.0014	0.0009	0.0022	0.0016	0.0011	0.0023
	0.0045	0.0065	0.0041	0.0087	0.0111	0.0065

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.74 (5.706)	93448.9	100.00
RUNOFF	1.907 (1.1083)	6921.00	7.406
EVAPOTRANSPIRATION	21.787 (3.6980)	79085.98	84.630
LATERAL DRAINAGE COLLECTED FROM LAYER 4	2.05535 (1.61442)	7460.923	7.98396
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.005	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0.002)		
CHANGE IN WATER STORAGE	-0.005 (0.5759)	-18.99	-0.020

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.016	7318.0361
DRAINAGE COLLECTED FROM LAYER 4	0.16131	585.57281
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.071	
MAXIMUM HEAD ON TOP OF LAYER 5	0.142	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	1.4 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3947

CASE420Y.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1490

*** 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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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	1.4410	0.2402
2	566.3580	0.2913
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

****
****

APPENDIX B.7

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE530Y.OUT

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:      C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\MDATA\CASE5.D10
OUTPUT DATA FILE:           C:\HELP3\MDATA\CASE530Y.OUT


TIME:   8:21     DATE:   3/14/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 5 (LOCATION 1)

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


     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  13
          THICKNESS                  =     24.00   INCHES
          POROSITY                   =      0.4300 VOL/VOL
          FIELD CAPACITY             =      0.3210 VOL/VOL
          WILTING POINT              =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2719 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-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  20
          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  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    250.0    FEET


                        LAYER  3
                        --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  18
THICKNESS                   =    690.00   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. COND.  = 0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  13
THICKNESS                  =    24.00   INCHES
POROSITY                   =     0.4300 VOL/VOL
FIELD CAPACITY             =     0.3210 VOL/VOL
WILTING POINT              =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-04 CM/SEC


                        LAYER  8
                        --------

               TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER  20
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 =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  10.0000000000     CM/SEC
SLOPE                      =     2.00   PERCENT
DRAINAGE LENGTH            =   250.0    FEET


                        LAYER  9
                        --------

               TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                  =     0.06   INCHES
POROSITY                   =     0.0000 VOL/VOL
FIELD CAPACITY             =     0.0000 VOL/VOL
WILTING POINT              =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY      = 3 - GOOD


                        LAYER 10
                        --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
THICKNESS                  =     0.24   INCHES
POROSITY                   =     0.7500 VOL/VOL
FIELD CAPACITY             =     0.7470 VOL/VOL
WILTING POINT              =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
```

CASE530Y.OUT

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER	=	85.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.674	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	219.926	INCHES
TOTAL INITIAL WATER	=	219.926	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE	=	27.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	0	
END OF GROWING SEASON (JULIAN DATE)	=	367	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	12.00	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

CASE530Y.OUT

56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37	1.81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2.99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.007	0.022	0.005	0.051	0.188	0.174
	0.342	0.218	0.608	0.191	0.067	0.007
STD. DEVIATIONS	0.022	0.041	0.026	0.171	0.500	0.243
	0.789	0.366	0.822	0.318	0.265	0.028
EVAPOTRANSPIRATION						
TOTALS	1.093	1.768	1.331	1.252	1.966	2.071
	1.754	2.186	3.474	2.435	1.312	1.107
STD. DEVIATIONS	0.665	0.864	0.621	0.803	1.191	1.228
	1.256	1.504	1.237	1.136	0.899	0.681
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0698	0.2237	0.1155	0.0457	0.1805	0.3327
	0.3318	0.3490	0.8839	0.7081	0.2403	0.0780
STD. DEVIATIONS	0.1315	0.2604	0.1270	0.1234	0.2785	0.4691
	0.5455	0.5857	0.9977	0.7204	0.3203	0.1153
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 8						
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 10
 ------------------------------------
   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


-------------------------------------------------------------------------------
            AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  3
 -------------------------------------
   AVERAGES                0.0005  0.0017  0.0008  0.0003  0.0013  0.0139
                           0.0206  0.0177  0.1061  0.0240  0.0018  0.0006

   STD. DEVIATIONS         0.0009  0.0020  0.0009  0.0009  0.0020  0.0415
                           0.1028  0.0537  0.2641  0.0529  0.0024  0.0008

 DAILY AVERAGE HEAD ON TOP OF LAYER  9
 -------------------------------------
   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

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


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                       INCHES            CU. FEET      PERCENT
                                 -------------------  -------------  ---------
 PRECIPITATION                     27.20   (  5.704)     98722.7     100.00

 RUNOFF                             1.880  (  1.2157)     6825.49      6.914

 EVAPOTRANSPIRATION                21.749  (  3.7373)    78947.65     79.969

 LATERAL DRAINAGE COLLECTED         3.55912 (  1.91851)   12919.604   13.08676
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH        0.00001 (  0.00001)       0.023    0.00002
   LAYER  4

 AVERAGE HEAD ON TOP                0.016 (   0.026)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED         0.00001 (  0.00001)       0.022   0.00002
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH        0.00000 (  0.00000)       0.001    0.00000
   LAYER 10

 AVERAGE HEAD ON TOP                0.000 (   0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE            0.008  (  0.4489)       29.91      0.030
```

CASE530Y.OUT

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            PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
  ------------------------------------------------------------------------
                                            (INCHES)      (CU. FT.)
                                           ----------   -------------
      PRECIPITATION                           5.07         18404.102

      RUNOFF                                  2.585         9382.1035

      DRAINAGE COLLECTED FROM LAYER  2        0.91251       3312.41650

      PERCOLATION/LEAKAGE THROUGH LAYER  4    0.000012         0.04380

      AVERAGE HEAD ON TOP OF LAYER  3        14.568

      MAXIMUM HEAD ON TOP OF LAYER  3        18.997

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)            87.9 FEET

      DRAINAGE COLLECTED FROM LAYER  8        0.00001          0.03665

      PERCOLATION/LEAKAGE THROUGH LAYER 10    0.000000         0.00002

      AVERAGE HEAD ON TOP OF LAYER  9         0.000

      MAXIMUM HEAD ON TOP OF LAYER  9         0.000

      LOCATION OF MAXIMUM HEAD IN LAYER  8
            (DISTANCE FROM DRAIN)             0.0 FEET

      SNOW WATER                              0.02            73.7433


      MAXIMUM VEG. SOIL WATER (VOL/VOL)               0.4285

      MINIMUM VEG. SOIL WATER (VOL/VOL)               0.2210

       ***  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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               FINAL WATER STORAGE AT END OF YEAR   30
   ----------------------------------------------------------------------
                LAYER        (INCHES)       (VOL/VOL)
                -----        --------       ---------
                  1           6.7730          0.2822
```

2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	201.4800	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
SNOW WATER	0.000	

****
****

APPENDIX B.8

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE630Y.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE6.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE630Y.OUT


TIME:   8:29     DATE:   3/14/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 6 (LOCATION 2)

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


     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  13
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2754 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-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  20
           THICKNESS                  =      0.20   INCHES
```

CASE630Y.OUT

```
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. COND.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    500.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1680.00   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. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                        LAYER  8
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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 =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   10.0000000000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    500.0    FEET


                        LAYER  9
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                        LAYER 10
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.24   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
WILTING POINT              =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 350. FEET.

SCS RUNOFF CURVE NUMBER	=	84.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.757	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	509.089	INCHES
TOTAL INITIAL WATER	=	509.089	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE	=	27.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	0	
END OF GROWING SEASON (JULIAN DATE)	=	367	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	12.00	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37	1.81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2.99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.005	0.016	0.004	0.047	0.169	0.145
	0.325	0.191	0.568	0.161	0.044	0.004
STD. DEVIATIONS	0.016	0.032	0.020	0.171	0.495	0.206
	0.770	0.339	0.843	0.294	0.176	0.018
EVAPOTRANSPIRATION						
TOTALS	1.081	1.760	1.314	1.251	1.928	2.038
	1.728	2.139	3.444	2.384	1.304	1.109
STD. DEVIATIONS	0.675	0.902	0.615	0.801	1.168	1.210
	1.204	1.461	1.229	1.106	0.896	0.689
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0809	0.2406	0.1121	0.0567	0.2251	0.3948
	0.3796	0.4275	0.9447	0.7920	0.2900	0.0857
STD. DEVIATIONS	0.1435	0.2996	0.1230	0.1528	0.3265	0.5469
	0.6067	0.6486	0.9618	0.8406	0.4048	0.1200
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 8						
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

CASE630Y.OUT

```
                      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER 10
 ------------------------------------
   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


-------------------------------------------------------------------------------
            AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  3
 -------------------------------------
   AVERAGES           0.0012   0.0038   0.0016   0.0008   0.0104   0.0589
                      0.0681   0.0899   0.3548   0.1774   0.0241   0.0012

   STD. DEVIATIONS    0.0020   0.0047   0.0017   0.0022   0.0324   0.1912
                      0.2573   0.2432   0.7287   0.4575   0.1013   0.0017

 DAILY AVERAGE HEAD ON TOP OF LAYER  9
 -------------------------------------
   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   30
-------------------------------------------------------------------------------
                                      INCHES             CU. FEET     PERCENT
                                -------------------  -------------  ---------
 PRECIPITATION                    27.20   (   5.704)     98722.7     100.00

 RUNOFF                            1.680  (  1.1902)      6099.48      6.178

 EVAPOTRANSPIRATION               21.481  (  3.7202)     77976.52     78.985

 LATERAL DRAINAGE COLLECTED        4.02954 (  2.05403)    14627.235    14.81649
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH       0.00002 (  0.00003)        0.077     0.00008
   LAYER  4

 AVERAGE HEAD ON TOP               0.066 (    0.096)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED        0.00002 (  0.00003)        0.073     0.00007
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH       0.00000 (  0.00000)        0.004     0.00000
   LAYER 10

 AVERAGE HEAD ON TOP               0.000 (    0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE           0.005   (  0.4311)        19.37      0.020
```

CASE630Y.OUT

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             PEAK DAILY VALUES FOR YEARS     1 THROUGH   30
   ------------------------------------------------------------------------
                                                 (INCHES)      (CU. FT.)
                                                ----------   -------------
      PRECIPITATION                                5.07        18404.102

      RUNOFF                                       2.585        9382.0957

      DRAINAGE COLLECTED FROM LAYER  2             0.45365      1646.75024

      PERCOLATION/LEAKAGE THROUGH LAYER  4         0.000023        0.08305

      AVERAGE HEAD ON TOP OF LAYER  3             22.812

      MAXIMUM HEAD ON TOP OF LAYER  3             31.119

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)                158.8 FEET

      DRAINAGE COLLECTED FROM LAYER  8             0.00002         0.07910

      PERCOLATION/LEAKAGE THROUGH LAYER 10         0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  9              0.000

      MAXIMUM HEAD ON TOP OF LAYER  9              0.000

      LOCATION OF MAXIMUM HEAD IN LAYER  8
            (DISTANCE FROM DRAIN)                  0.0 FEET

      SNOW WATER                                   0.02           73.7433


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.4300

      MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.2210

       ***  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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                FINAL WATER STORAGE AT END OF YEAR    30
    ----------------------------------------------------------------------
                LAYER          (INCHES)        (VOL/VOL)
                -----          --------        ---------
                  1             6.7691          0.2820
```

CASE630Y.OUT

2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	490.5600	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
SNOW WATER	0.000	

****
****

APPENDIX B.9

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7-LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE730Y.OUT

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\MDATA\CASE7.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE730Y.OUT


TIME:  10:27     DATE:   3/ 3/2017


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     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 7 (LOCATION 3)

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


     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  13
           THICKNESS                  =     24.00    INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2734 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-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  20
           THICKNESS                  =      0.20    INCHES
```

Page 1

```
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. COND.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    500.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1776.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
```

CASE730Y.OUT

```
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                        LAYER  8
                        --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER  20
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 =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   10.0000000000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    500.0    FEET


                        LAYER  9
                        --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                        LAYER 10
                        --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.24   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
WILTING POINT              =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
```

CASE730Y.OUT

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 12.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	84.80	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.709	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	537.073	INCHES
TOTAL INITIAL WATER	=	537.073	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE	=	27.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	0	
END OF GROWING SEASON (JULIAN DATE)	=	367	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	12.00	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

CASE730Y.OUT

56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37	1.81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2.99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.005	0.017	0.004	0.048	0.172	0.150
	0.327	0.197	0.576	0.165	0.045	0.004
STD. DEVIATIONS	0.017	0.034	0.021	0.172	0.495	0.212
	0.771	0.344	0.849	0.296	0.177	0.019
EVAPOTRANSPIRATION						
TOTALS	1.078	1.759	1.312	1.250	1.927	2.039
	1.733	2.138	3.441	2.378	1.302	1.114
STD. DEVIATIONS	0.678	0.893	0.613	0.800	1.166	1.215
	1.208	1.465	1.222	1.103	0.899	0.690
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0770	0.2413	0.1130	0.0569	0.2266	0.3893
	0.3734	0.4229	0.9423	0.7940	0.2864	0.0853
STD. DEVIATIONS	0.1384	0.3007	0.1237	0.1480	0.3277	0.5341
	0.6049	0.6418	0.9643	0.8378	0.4003	0.1205
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 8						
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

CASE730Y.OUT

```
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER 10
 ------------------------------------
   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


-------------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  3
 -------------------------------------
   AVERAGES             0.0011   0.0038   0.0016   0.0008   0.0105   0.0584
                        0.0675   0.0853   0.3606   0.1844   0.0215   0.0012

   STD. DEVIATIONS      0.0020   0.0047   0.0018   0.0022   0.0325   0.1892
                        0.2555   0.2308   0.7392   0.4599   0.0994   0.0017

 DAILY AVERAGE HEAD ON TOP OF LAYER  9
 -------------------------------------
   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

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


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET     PERCENT
                               -------------------   -------------  ---------
 PRECIPITATION                 27.20   (   5.704)      98722.7     100.00

 RUNOFF                         1.711  (  1.1947)       6210.31      6.291

 EVAPOTRANSPIRATION            21.470  (  3.7084)      77936.37     78.945

 LATERAL DRAINAGE COLLECTED     4.00840 (  2.03256)    14550.508    14.73877
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH    0.00002 (  0.00003)        0.078     0.00008
   LAYER  4

 AVERAGE HEAD ON TOP            0.066 (    0.097)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED     0.00002 (  0.00003)        0.073    0.00007
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH    0.00000 (  0.00000)        0.004     0.00000
   LAYER 10

 AVERAGE HEAD ON TOP            0.000 (    0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE        0.007  (  0.4345)         25.43      0.026
```

CASE730Y.OUT

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


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

          PEAK DAILY VALUES FOR YEARS     1 THROUGH    30
  ------------------------------------------------------------------------
                                            (INCHES)      (CU. FT.)
                                          ----------   -------------
  PRECIPITATION                              5.07        18404.102

  RUNOFF                                     2.585        9382.0957

  DRAINAGE COLLECTED FROM LAYER  2           0.45365      1646.75073

  PERCOLATION/LEAKAGE THROUGH LAYER  4       0.000023        0.08307

  AVERAGE HEAD ON TOP OF LAYER  3           22.816

  MAXIMUM HEAD ON TOP OF LAYER  3           31.124

  LOCATION OF MAXIMUM HEAD IN LAYER  2
        (DISTANCE FROM DRAIN)             158.8 FEET

  DRAINAGE COLLECTED FROM LAYER  8           0.00002         0.07912

  PERCOLATION/LEAKAGE THROUGH LAYER 10       0.000000        0.00002

  AVERAGE HEAD ON TOP OF LAYER  9            0.000

  MAXIMUM HEAD ON TOP OF LAYER  9            0.000

  LOCATION OF MAXIMUM HEAD IN LAYER  8
        (DISTANCE FROM DRAIN)                0.0 FEET

  SNOW WATER                                 0.02           73.7433


  MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.4300

  MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.2210

   ***  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.

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


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

             FINAL WATER STORAGE AT END OF YEAR   30
  -----------------------------------------------------------------------
              LAYER        (INCHES)       (VOL/VOL)
              -----        --------       ---------
                1           6.7714         0.2821
```

CASE730Y.OUT

2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	518.5920	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
SNOW WATER	0.000	

****
****

APPENDIX B.10

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 8-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE830Y.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                 USAE WATERWAYS EXPERIMENT STATION                        **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE8.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE830Y.OUT


TIME:   8:39     DATE:   3/14/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 8 (LOCATION 4)

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


     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  13
           THICKNESS                  =    24.00   INCHES
           POROSITY                   =     0.4300 VOL/VOL
           FIELD CAPACITY             =     0.3210 VOL/VOL
           WILTING POINT              =     0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.2733 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-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  20
           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   =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  10.0000000000     CM/SEC
SLOPE                        =     2.00   PERCENT
DRAINAGE LENGTH              =   500.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                    =     0.04   INCHES
POROSITY                     =     0.0000 VOL/VOL
FIELD CAPACITY               =     0.0000 VOL/VOL
WILTING POINT                =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    = 0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY        = 3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                    =     0.24   INCHES
POROSITY                     =     0.7500 VOL/VOL
FIELD CAPACITY               =     0.7470 VOL/VOL
WILTING POINT                =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    = 0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                    =    12.00   INCHES
POROSITY                     =     0.4300 VOL/VOL
FIELD CAPACITY               =     0.3210 VOL/VOL
WILTING POINT                =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    = 0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                    =  1944.00   INCHES
POROSITY                     =     0.6710 VOL/VOL
FIELD CAPACITY               =     0.2920 VOL/VOL
```

CASE830Y.OUT

```
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                        LAYER  8
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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 =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   10.0000000000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    500.0    FEET


                        LAYER  9
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                        LAYER 10
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.24   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
WILTING POINT              =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
```

CASE830Y.OUT

```
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

```
NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
       SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
       GOOD STAND OF GRASS, A SURFACE SLOPE OF  4.%
       AND A SLOPE LENGTH OF  600. FEET.

SCS RUNOFF CURVE NUMBER              =    83.40
FRACTION OF AREA ALLOWING RUNOFF     =   100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =     1.000  ACRES
EVAPORATIVE ZONE DEPTH               =    12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =     2.708  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =     5.160  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =     2.652  INCHES
INITIAL SNOW WATER                   =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =   586.128  INCHES
TOTAL INITIAL WATER                  =   586.128  INCHES
TOTAL SUBSURFACE INFLOW              =     0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       CORPUS CHRISTI        TEXAS

     STATION LATITUDE                        =  27.77 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   3.50
     START OF GROWING SEASON (JULIAN DATE)   =     0
     END OF GROWING SEASON (JULIAN DATE)     =   367
     EVAPORATIVE ZONE DEPTH                  =  12.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =  12.00 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  76.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  78.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  76.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  76.00 %

NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    KINGSVILLE      TEXAS
```

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

CASE830Y.OUT

56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37	1.81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2.99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.003	0.011	0.003	0.043	0.154	0.117
	0.320	0.167	0.536	0.138	0.039	0.002
STD. DEVIATIONS	0.012	0.024	0.015	0.167	0.494	0.168
	0.765	0.317	0.853	0.285	0.166	0.012
EVAPOTRANSPIRATION						
TOTALS	1.075	1.755	1.316	1.246	1.943	2.036
	1.740	2.149	3.445	2.375	1.304	1.111
STD. DEVIATIONS	0.680	0.890	0.616	0.799	1.174	1.212
	1.225	1.476	1.225	1.098	0.904	0.695
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0871	0.2477	0.1143	0.0601	0.2280	0.4259
	0.3740	0.4325	0.9802	0.8286	0.2979	0.0849
STD. DEVIATIONS	0.1585	0.3090	0.1186	0.1609	0.3250	0.5887
	0.6004	0.6575	0.9888	0.8731	0.4168	0.1196
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 8						
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

CASE830Y.OUT

```
                        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 PERCOLATION/LEAKAGE THROUGH LAYER 10
 ------------------------------------
   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


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  3
 -------------------------------------
   AVERAGES             0.0012   0.0039   0.0016   0.0009   0.0104   0.0748
                        0.0679   0.0824   0.3707   0.2120   0.0248   0.0012

   STD. DEVIATIONS      0.0023   0.0048   0.0017   0.0024   0.0323   0.2328
                        0.2719   0.2347   0.7766   0.4906   0.1168   0.0017

 DAILY AVERAGE HEAD ON TOP OF LAYER  9
 -------------------------------------
   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

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


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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                   INCHES            CU. FEET       PERCENT
                             -------------------  -------------   ---------
 PRECIPITATION                27.20    (  5.704)     98722.7      100.00

 RUNOFF                        1.533   ( 1.1930)      5565.96       5.638

 EVAPOTRANSPIRATION           21.495   ( 3.7381)     78026.06      79.036

 LATERAL DRAINAGE COLLECTED    4.16123 ( 2.10988)    15105.281    15.30072
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH   0.00002 ( 0.00003)        0.083     0.00008
   LAYER  4

 AVERAGE HEAD ON TOP           0.071 (   0.104)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED    0.00002 ( 0.00003)        0.079    0.00008
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH   0.00000 ( 0.00000)        0.004     0.00000
   LAYER 10

 AVERAGE HEAD ON TOP           0.000 (   0.000)
   OF LAYER  9

 CHANGE IN WATER STORAGE       0.007   ( 0.4342)        25.30       0.026
```

CASE830Y.OUT

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


↑
*******************************************************************************

          PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
  ------------------------------------------------------------------------
                                             (INCHES)     (CU. FT.)
                                            ----------   -------------
      PRECIPITATION                            5.07        18404.102

      RUNOFF                                   2.585        9382.0947

      DRAINAGE COLLECTED FROM LAYER  2         0.45365      1646.74548

      PERCOLATION/LEAKAGE THROUGH LAYER  4     0.000023        0.08285

      AVERAGE HEAD ON TOP OF LAYER  3         22.774

      MAXIMUM HEAD ON TOP OF LAYER  3         31.078

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)            158.7 FEET

      DRAINAGE COLLECTED FROM LAYER  8         0.00002         0.07933

      PERCOLATION/LEAKAGE THROUGH LAYER 10     0.000000        0.00002

      AVERAGE HEAD ON TOP OF LAYER  9          0.000

      MAXIMUM HEAD ON TOP OF LAYER  9          0.000

      LOCATION OF MAXIMUM HEAD IN LAYER  8
            (DISTANCE FROM DRAIN)              0.0 FEET

      SNOW WATER                               0.02          73.7433


      MAXIMUM VEG. SOIL WATER (VOL/VOL)                0.4300

      MINIMUM VEG. SOIL WATER (VOL/VOL)                0.2210

        ***  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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↑
*******************************************************************************

            FINAL WATER STORAGE AT END OF YEAR   30
  ----------------------------------------------------------------------
               LAYER        (INCHES)       (VOL/VOL)
               -----        --------       ---------
                 1           6.7694          0.2821
```

2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	567.6481	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
SNOW WATER	0.000	

****
****

HELP MODEL ANALYSIS ALTERNATIVE LINER AND OVERLINER

STATE OF TEXAS
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

APPENDIX B.11

HELP MODEL/MULTIMED MODEL-SUMMARY OF CASES 1OL-8OL

STATE OF TEXAS
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91790
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

Project No. 8514-3 Permit Amendment

Description: HELP Model/MULTIMED Model-Summary of Cases 1OL-8OL

Date: 3/07/17

By: JCG

Case1OL-Interim Landfill (Location 1)- An open landfill with 15.5 feet of insitu pre-Subtitle D waste and liner, 30 inches of cover, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 12 feet of waste with 400 foot drain length at 2%, and 6 inches of daily soil cover.

Case2OL-Interim Landfill (Location 2)- An open landfill with 34 feet of insitu pre-Subtitle waste and liner, 30 inches of cover, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 82.5 feet of waste with 400 foot drain length at 2%, and 6 inches of daily soil cover.

Case 3OL-Interim Landfill (Location 3)- An open landfill with 37 feet of insitu pre-Subtitle D waste and liner, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 85.5 feet of waste with 400 foot drain length at 2%, and 6 inches of daily soil cover.

Case4OL-Interim Landfill (Location 4)- An open landfill with 16 feet of insitu pre-Subtitle D waste and liner, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 119.5 feet of waste with 400 foot drain length at 2%, and 6 inches of daily soil cover.

Case5OL-Closed Landfill (Location 1) - A closed landfill with 15.5 feet of insitu pre-Subtitle D waste and liner, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 12 feet of waste with 400 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

Case6OL-Closed Landfill (Location 2)- A closed landfill with 34 feet of insitu pre-Subtitle D waste and liner, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 82.5 feet of waste with 400 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

Case7OL-Closed Landfill (Location 3)- A closed landfill with 37 feet of insitu pre-Subtitle D waste and liner, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 12 inch protective soil layer (Protective Cover), 85.5 feet of waste with 400 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

Case8OL-Closed Landfill (Location 4)- A closed landfill with 16 feet of insitu pre-Subtitle D waste and liner, a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 119.5 feet of waste with 400 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

APPENDIX B.12

HELP MODEL CASE SUMMARY

STATE OF TEXAS
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Jose C. Garza, P.E.

HELP MODEL CASE SUMMARY

Case Alternative Liner/Overliner	Average Precipitation (IN/YR)	Average Runoff (IN/YR)	Average Evapotranspiration (IN/YR)	Average Percolation Through Liner (CF/YR)	Peak Percolation Through Liner (CF/DAY)	*Peak Percolation Through Liner (M/YR)
Interim Landfill HELP Information						
Location 1 (Case 1OL) • 12 feet of waste above liner						
• 15.5 feet of waste below liner						
20 yr	25.74	2.364	21.601	0.004	0.00007	1.79E-07
Location 2 (Case 2OL) • 82.5 feet of waste above liner						
• 34 feet of waste below liner						
20 yr	25.74	2.135	21.716	0.004	0.00006	1.53E-07
Location 3 (Case 3OL) • 85.5 feet of waste above liner						
• 37 feet of waste below liner						
20 yr	25.74	2.043	21.741	0.004	0.00006	1.53E-07
Location 4 (Case 4OL) • 119.5 feet of waste above liner						
• 16 feet of waste below liner						
20 yr	25.74	1.907	21.787	0.004	0.00006	1.53E-07
Closed Landfill HELP Information						
Location 1 (Case 5OL) • 12 feet of waste above liner						
• 15.5 feet of waste below liner						
30 yr	27.20	1.880	21.749	0.001	0.00002	5.11E-08
Location 2 (Case 6OL) • 82.5 feet of waste above liner						
• 34 feet of waste below liner						
30 yr	27.20	1.723	21.785	0.002	0.00002	5.11E-08
Location 3 (Case 7OL) • 85.5 feet of waste above liner						
• 37 feet of waste below liner						
30 yr	27.20	1.657	21.773	0.002	0.00002	5.11E-08
Location 4 (Case 8OL) • 119.5 feet of waste above liner						
• 16 feet of waste below liner						
30 yr	27.20	1.562	21.805	0.002	0.00002	5.11E-08

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00007 FT^3/Day-Acre)x(1 Acre/43,560 FT^2)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= 1.79 x 10^{-7} M/YR

APPENDIX B.13

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1OL-LOCATION 1

STATE OF TEXAS
JOSE C. GARZA
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09/12/18
Jose C. Garza, P.E.

CASE1OL.OUT

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♠
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE1OL.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE1OL.OUT


TIME:  14:36     DATE:   3/ 6/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE1OL (LOCATION 1)

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


     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  13
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2210 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                   LAYER  2
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =    144.00   INCHES
```

CASE1OL.OUT

```
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2837 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3242 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  4
                        --------

             TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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  =      0.0181 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000      CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    400.0    FEET


                        LAYER  5
                        --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
```

```
WILTING POINT              =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.300000003000E-08 CM/SEC


                         LAYER  7
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     30.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-04 CM/SEC


                         LAYER  8
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                  =    186.00   INCHES
POROSITY                   =      0.6710 VOL/VOL
FIELD CAPACITY             =      0.2920 VOL/VOL
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2919 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
          AND A SLOPE LENGTH OF  100. FEET.

SCS RUNOFF CURVE NUMBER            =    89.50
FRACTION OF AREA ALLOWING RUNOFF   =    80.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000   ACRES
EVAPORATIVE ZONE DEPTH             =    12.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     1.886   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     6.606   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     1.788   INCHES
INITIAL SNOW WATER                 =     0.000   INCHES
INITIAL WATER IN LAYER MATERIALS   =   114.065   INCHES
TOTAL INITIAL WATER                =   114.065   INCHES
TOTAL SUBSURFACE INFLOW            =     0.00    INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI        TEXAS
```

CASE10L.OUT

STATION LATITUDE	= 27.77 DEGREES
MAXIMUM LEAF AREA INDEX	= 2.00
START OF GROWING SEASON (JULIAN DATE)	= 0
END OF GROWING SEASON (JULIAN DATE)	= 367
EVAPORATIVE ZONE DEPTH	= 12.0 INCHES
AVERAGE ANNUAL WIND SPEED	= 12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.015	0.067	0.006	0.103	0.278	0.282
	0.377	0.192	0.779	0.173	0.073	0.019
STD. DEVIATIONS	0.042	0.081	0.009	0.233	0.504	0.344

CASE10L.OUT

	0.815	0.200	0.918	0.257	0.214	0.065

EVAPOTRANSPIRATION

TOTALS	0.927	2.081	1.305	1.245	1.981	2.108
	2.038	1.886	3.610	2.255	1.096	1.069
STD. DEVIATIONS	0.558	0.899	0.714	0.924	1.308	1.378
	1.630	1.312	1.219	1.213	0.780	0.585

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	0.0557	0.0293	0.0663	0.0567	0.0409	0.0574
	0.1701	0.1696	0.1118	0.5501	0.3280	0.1472
STD. DEVIATIONS	0.0736	0.0491	0.1278	0.1001	0.0685	0.1269
	0.2914	0.3491	0.2088	0.8668	0.5012	0.2297

PERCOLATION/LEAKAGE THROUGH LAYER 6

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 8

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0006	0.0004	0.0008	0.0007	0.0005	0.0007
	0.0019	0.0019	0.0013	0.0063	0.0039	0.0017
STD. DEVIATIONS	0.0008	0.0006	0.0015	0.0012	0.0008	0.0015
	0.0033	0.0040	0.0025	0.0099	0.0059	0.0026

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.74 (5.706)	93448.9	100.00
RUNOFF	2.364 (1.2831)	8580.98	9.183
EVAPOTRANSPIRATION	21.601 (3.6817)	78409.91	83.907
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.78305 (1.49648)	6472.482	6.92623

```
PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.004      0.00000
  LAYER  6

AVERAGE HEAD ON TOP             0.002 (    0.001)
  OF LAYER  5

PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.000      0.00000
  LAYER  8

CHANGE IN WATER STORAGE        -0.004   (  0.5412)       -14.46     -0.015

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


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

          PEAK DAILY VALUES FOR YEARS    1 THROUGH   20
  ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------    -------------
     PRECIPITATION                              5.07         18404.102

     RUNOFF                                     2.156         7827.0879

     DRAINAGE COLLECTED FROM LAYER  4           0.19851        720.60400

     PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000000         0.00007

     AVERAGE HEAD ON TOP OF LAYER  5            0.070

     MAXIMUM HEAD ON TOP OF LAYER  5            0.139

     LOCATION OF MAXIMUM HEAD IN LAYER  4
           (DISTANCE FROM DRAIN)                4.2 FEET

     PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000         0.00000

     SNOW WATER                                 0.00             0.0000


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3865

     MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1490

      ***  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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            FINAL WATER STORAGE AT END OF YEAR   20
   ----------------------------------------------------------------------
                LAYER        (INCHES)        (VOL/VOL)
                -----        --------        ---------
```

1	1.4228	0.2371
2	40.7579	0.2830
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
7	9.6289	0.3210
8	54.2892	0.2919
SNOW WATER	0.000	

****
****

APPENDIX B.14

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2OL-LOCATION 2

STATE OF TEXAS
JOSE C. GARZA
91790
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE2OL.OUT

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**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE2OL.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE2OL.OUT


TIME:  14:43     DATE:   3/ 6/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE2OL (LOCATION 2)

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


     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  13
          THICKNESS                 =      6.00   INCHES
          POROSITY                  =      0.4300 VOL/VOL
          FIELD CAPACITY            =      0.3210 VOL/VOL
          WILTING POINT             =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.2391 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                 =    990.00   INCHES
```

Page 1

CASE2OL.OUT

```
POROSITY                    =     0.6710 VOL/VOL
FIELD CAPACITY              =     0.2920 VOL/VOL
WILTING POINT               =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.2909 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =    24.00   INCHES
POROSITY                    =     0.4300 VOL/VOL
FIELD CAPACITY              =     0.3210 VOL/VOL
WILTING POINT               =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.3245 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.330000003000E-04 CM/SEC


                        LAYER  4
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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  =     0.0184 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  10.0000000000     CM/SEC
SLOPE                       =     2.00   PERCENT
DRAINAGE LENGTH             =   400.0    FEET


                        LAYER  5
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =     0.06   INCHES
POROSITY                    =     0.0000 VOL/VOL
FIELD CAPACITY              =     0.0000 VOL/VOL
WILTING POINT               =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY       = 3 - GOOD


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =     0.24   INCHES
POROSITY                    =     0.7500 VOL/VOL
FIELD CAPACITY              =     0.7470 VOL/VOL
```

CASE20L.OUT

```
 WILTING POINT              =      0.4000 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
 THICKNESS                  =     30.00   INCHES
 POROSITY                   =      0.4300 VOL/VOL
 FIELD CAPACITY             =      0.3210 VOL/VOL
 WILTING POINT              =      0.2210 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
 THICKNESS                  =    408.00   INCHES
 POROSITY                   =      0.6710 VOL/VOL
 FIELD CAPACITY             =      0.2920 VOL/VOL
 WILTING POINT              =      0.0770 VOL/VOL
 INITIAL SOIL WATER CONTENT =      0.2919 VOL/VOL
 EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.%
          AND A SLOPE LENGTH OF  356. FEET.

 SCS RUNOFF CURVE NUMBER            =     88.80
 FRACTION OF AREA ALLOWING RUNOFF   =     80.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH             =     12.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE  =      2.124  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE =      6.606  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE =      1.788  INCHES
 INITIAL SNOW WATER                 =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS   =    426.166  INCHES
 TOTAL INITIAL WATER                =    426.166  INCHES
 TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR


          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI        TEXAS
```

CASE20L.OUT

```
STATION LATITUDE                           =  27.77 DEGREES
MAXIMUM LEAF AREA INDEX                    =   2.00
START OF GROWING SEASON (JULIAN DATE)      =      0
END OF GROWING SEASON (JULIAN DATE)        =    367
EVAPORATIVE ZONE DEPTH                     =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED                  =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY      =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.012	0.055	0.003	0.092	0.254	0.252
	0.350	0.170	0.716	0.149	0.066	0.016
STD. DEVIATIONS	0.037	0.071	0.006	0.216	0.479	0.315

CASE20L.OUT

```
                       0.770   0.181   0.864   0.234   0.199   0.057

EVAPOTRANSPIRATION
------------------
  TOTALS               0.932   2.093   1.304   1.251   1.993   2.128
                       2.048   1.899   3.628   2.264   1.098   1.076

  STD. DEVIATIONS      0.540   0.899   0.714   0.930   1.317   1.382
                       1.634   1.319   1.222   1.208   0.786   0.592

LATERAL DRAINAGE COLLECTED FROM LAYER  4
----------------------------------------
  TOTALS               0.0702  0.0321  0.0735  0.0597  0.0436  0.0677
                       0.1643  0.1983  0.1143  0.4356  0.4270  0.2210

  STD. DEVIATIONS      0.0901  0.0515  0.1376  0.1032  0.0709  0.1448
                       0.3053  0.4238  0.2389  0.6078  0.7392  0.3968

PERCOLATION/LEAKAGE THROUGH LAYER  6
------------------------------------
  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  8
------------------------------------
  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


-------------------------------------------------------------------------------
            AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  5
-------------------------------------
  AVERAGES             0.0008  0.0004  0.0008  0.0007  0.0005  0.0008
                       0.0019  0.0023  0.0013  0.0050  0.0050  0.0025

  STD. DEVIATIONS      0.0010  0.0006  0.0016  0.0012  0.0008  0.0017
                       0.0035  0.0048  0.0028  0.0069  0.0087  0.0045

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


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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   20
-------------------------------------------------------------------------------
                                  INCHES            CU. FEET       PERCENT
                            -------------------  -------------   ---------
PRECIPITATION                 25.74    (  5.706)     93448.9      100.00

RUNOFF                         2.135   (  1.1936)     7751.57       8.295

EVAPOTRANSPIRATION            21.716   (  3.6903)    78829.24      84.355

LATERAL DRAINAGE COLLECTED     1.90747 (  1.55045)    6924.125      7.40953
  FROM LAYER  4
```

CASE2OL.OUT

PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0.001)		
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000 (0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.015 (0.5500)	-56.04	-0.060

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.088	7578.4883
DRAINAGE COLLECTED FROM LAYER 4	0.16451	597.18555
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.058	
MAXIMUM HEAD ON TOP OF LAYER 5	0.116	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	1.8 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00000
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3901	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1490	

*** 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.

****

****

FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)

1	1.4393	0.2399
2	287.7899	0.2907
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
7	9.6295	0.3210
8	119.1126	0.2919
SNOW WATER	0.000	

****
****

APPENDIX B.15

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3OL-LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE3OL.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE3OL.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE3OL.OUT


TIME:  14:51     DATE:   3/ 6/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE3OL (LOCATION 3)

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


     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  13
           THICKNESS                   =      6.00   INCHES
           POROSITY                    =      0.4300 VOL/VOL
           FIELD CAPACITY              =      0.3210 VOL/VOL
           WILTING POINT               =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.2210 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER  18
           THICKNESS                   =   1026.00   INCHES
```

Page 1

CASE3OL.OUT

```
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2909 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  3
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3246 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  4
                        --------

               TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER  20
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  =      0.0184 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    400.0    FEET


                        LAYER  5
                        --------

               TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  6
                        --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
```

CASE3OL.OUT

```
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


                         LAYER  7
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  13
THICKNESS                    =     30.00   INCHES
POROSITY                     =      0.4300 VOL/VOL
FIELD CAPACITY               =      0.3210 VOL/VOL
WILTING POINT                =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                         LAYER  8
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  18
THICKNESS                    =    444.00   INCHES
POROSITY                     =      0.6710 VOL/VOL
FIELD CAPACITY               =      0.2920 VOL/VOL
WILTING POINT                =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2919 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF  3.%
          AND A SLOPE LENGTH OF  220. FEET.

SCS RUNOFF CURVE NUMBER            =     88.50
FRACTION OF AREA ALLOWING RUNOFF   =     80.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000   ACRES
EVAPORATIVE ZONE DEPTH             =     12.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      1.920   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      6.606   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      1.788   INCHES
INITIAL SNOW WATER                 =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS   =    446.987   INCHES
TOTAL INITIAL WATER                =    446.987   INCHES
TOTAL SUBSURFACE INFLOW            =      0.00    INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI        TEXAS
```

CASE3OL.OUT

STATION LATITUDE	= 27.77 DEGREES
MAXIMUM LEAF AREA INDEX	= 2.00
START OF GROWING SEASON (JULIAN DATE)	= 0
END OF GROWING SEASON (JULIAN DATE)	= 367
EVAPORATIVE ZONE DEPTH	= 12.0 INCHES
AVERAGE ANNUAL WIND SPEED	= 12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.011	0.050	0.003	0.087	0.244	0.240
	0.339	0.160	0.690	0.141	0.062	0.015
STD. DEVIATIONS	0.035	0.066	0.005	0.209	0.469	0.303

CASE3OL.OUT

	0.752	0.173	0.842	0.224	0.191	0.052

EVAPOTRANSPIRATION

TOTALS	0.923	2.100	1.303	1.256	1.998	2.129
	2.050	1.905	3.640	2.259	1.105	1.073
STD. DEVIATIONS	0.556	0.908	0.712	0.934	1.314	1.388
	1.630	1.324	1.226	1.208	0.790	0.591

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	0.0699	0.0385	0.0689	0.0590	0.0458	0.0682
	0.1735	0.2086	0.1176	0.4423	0.4385	0.2333
STD. DEVIATIONS	0.0925	0.0574	0.1339	0.1045	0.0746	0.1486
	0.3121	0.4439	0.2479	0.6142	0.7449	0.4210

PERCOLATION/LEAKAGE THROUGH LAYER 6

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 8

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0008	0.0005	0.0008	0.0007	0.0005	0.0008
	0.0020	0.0024	0.0014	0.0050	0.0052	0.0027
STD. DEVIATIONS	0.0011	0.0007	0.0015	0.0012	0.0008	0.0017
	0.0036	0.0051	0.0029	0.0070	0.0088	0.0048

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.74 (5.706)	93448.9	100.00
RUNOFF	2.043 (1.1566)	7417.81	7.938
EVAPOTRANSPIRATION	21.741 (3.6990)	78919.84	84.452
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.96422 (1.58077)	7130.124	7.62997

CASE3OL.OUT

PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (	0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (	0.002)		
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000 (	0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.005 (	0.5491)	-18.84	-0.020

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.060	7476.7285
DRAINAGE COLLECTED FROM LAYER 4	0.16176	587.17737
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.057	
MAXIMUM HEAD ON TOP OF LAYER 5	0.113	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.4 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00000
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3913
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1490

*** 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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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)

Page 6

CASE3OL.OUT

1	1.4410	0.2402
2	298.3019	0.2907
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
7	9.6295	0.3210
8	129.6245	0.2919
SNOW WATER	0.000	

****
****

APPENDIX B.16

HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 4OL-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

```
*******************************************************************************
*******************************************************************************
**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
**                                                                           **
*******************************************************************************
*******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\MDATA\KGVSO20Y.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\MDATA\CASE4OL.D10
OUTPUT DATA FILE:           C:\HELP3\MDATA\CASE4OL.OUT


TIME:  14:29     DATE:   3/ 6/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE4OL (LOCATION 4)

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


     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  13
           THICKNESS                  =      6.00   INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2210 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                 LAYER  2
                                 --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =   1434.00   INCHES
```

```
POROSITY                   =      0.6710 VOL/VOL
FIELD CAPACITY             =      0.2920 VOL/VOL
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2912 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4300 VOL/VOL
FIELD CAPACITY             =      0.3210 VOL/VOL
WILTING POINT              =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3246 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                    LAYER  4
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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 =      0.0185 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   10.0000000000     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    400.0    FEET


                    LAYER  5
                    --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                    LAYER  6
                    --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.24   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
```

CASE4OL.OUT

```
  WILTING POINT              =      0.4000 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC


                         LAYER  7
                         --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  13
  THICKNESS                  =     30.00   INCHES
  POROSITY                   =      0.4300 VOL/VOL
  FIELD CAPACITY             =      0.3210 VOL/VOL
  WILTING POINT              =      0.2210 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.3210 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-04 CM/SEC


                         LAYER  8
                         --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  18
  THICKNESS                  =    192.00   INCHES
  POROSITY                   =      0.6710 VOL/VOL
  FIELD CAPACITY             =      0.2920 VOL/VOL
  WILTING POINT              =      0.0770 VOL/VOL
  INITIAL SOIL WATER CONTENT =      0.2919 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF  3.%
          AND A SLOPE LENGTH OF  500. FEET.

 SCS RUNOFF CURVE NUMBER             =     88.00
 FRACTION OF AREA ALLOWING RUNOFF    =     80.0    PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE  =      1.000  ACRES
 EVAPORATIVE ZONE DEPTH              =     12.0    INCHES
 INITIAL WATER IN EVAPORATIVE ZONE   =      1.920  INCHES
 UPPER LIMIT OF EVAPORATIVE STORAGE  =      6.606  INCHES
 LOWER LIMIT OF EVAPORATIVE STORAGE  =      1.788  INCHES
 INITIAL SNOW WATER                  =      0.000  INCHES
 INITIAL WATER IN LAYER MATERIALS    =    492.539  INCHES
 TOTAL INITIAL WATER                 =    492.539  INCHES
 TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


            EVAPOTRANSPIRATION AND WEATHER DATA
            -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI        TEXAS
```

CASE4OL.OUT

```
STATION LATITUDE                          =  27.77 DEGREES
MAXIMUM LEAF AREA INDEX                   =   2.00
START OF GROWING SEASON (JULIAN DATE)     =      0
END OF GROWING SEASON (JULIAN DATE)       =    367
EVAPORATIVE ZONE DEPTH                    =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS
AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.010	0.044	0.002	0.080	0.229	0.222
	0.322	0.145	0.650	0.131	0.058	0.013
STD. DEVIATIONS	0.032	0.059	0.004	0.198	0.452	0.284

CASE4OL.OUT

```
                         0.721    0.160    0.809    0.208    0.182    0.047

 EVAPOTRANSPIRATION
 ------------------
   TOTALS                0.926    2.091    1.307    1.259    2.002    2.140
                         2.063    1.908    3.649    2.262    1.101    1.080

   STD. DEVIATIONS       0.553    0.908    0.722    0.938    1.315    1.392
                         1.651    1.324    1.215    1.209    0.795    0.582

 LATERAL DRAINAGE COLLECTED FROM LAYER  4
 ----------------------------------------
   TOTALS                0.0720   0.0389   0.0796   0.0588   0.0484   0.0755
                         0.1785   0.2158   0.1255   0.4555   0.4591   0.2478

   STD. DEVIATIONS       0.0945   0.0552   0.1549   0.1061   0.0808   0.1552
                         0.3193   0.4566   0.2773   0.6167   0.7573   0.4462

 PERCOLATION/LEAKAGE THROUGH LAYER  6
 ------------------------------------
   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  8
 ------------------------------------
   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


-------------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  5
 -------------------------------------
   AVERAGES              0.0008   0.0005   0.0009   0.0007   0.0006   0.0009
                         0.0020   0.0025   0.0015   0.0052   0.0054   0.0028

   STD. DEVIATIONS       0.0011   0.0007   0.0018   0.0012   0.0009   0.0018
                         0.0036   0.0052   0.0033   0.0070   0.0089   0.0051

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


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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                   INCHES             CU. FEET      PERCENT
                             -------------------   -------------   ---------
PRECIPITATION                  25.74   (   5.706)      93448.9     100.00

RUNOFF                          1.907  (  1.1083)       6921.00      7.406

EVAPOTRANSPIRATION             21.787  (  3.6980)      79085.98     84.630

LATERAL DRAINAGE COLLECTED      2.05532 (  1.61590)      7460.818    7.98385
  FROM LAYER  4
```

```
PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.004      0.00000
  LAYER  6

AVERAGE HEAD ON TOP             0.002 (    0.002)
  OF LAYER  5

PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.000      0.00000
  LAYER  8

CHANGE IN WATER STORAGE        -0.005   (  0.5751)       -18.88     -0.020

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


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

           PEAK DAILY VALUES FOR YEARS     1 THROUGH   20
  ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                              ----------   -------------
     PRECIPITATION                              5.07         18404.102

     RUNOFF                                     2.016         7318.0361

     DRAINAGE COLLECTED FROM LAYER  4           0.16526        599.88171

     PERCOLATION/LEAKAGE THROUGH LAYER  6       0.000000         0.00006

     AVERAGE HEAD ON TOP OF LAYER  5            0.058

     MAXIMUM HEAD ON TOP OF LAYER  5            0.115

     LOCATION OF MAXIMUM HEAD IN LAYER  4
           (DISTANCE FROM DRAIN)                4.6 FEET

     PERCOLATION/LEAKAGE THROUGH LAYER  8       0.000000         0.00000

     SNOW WATER                                 0.00             0.0000


     MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.3947

     MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1490

      ***  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.

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


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

             FINAL WATER STORAGE AT END OF YEAR   20
  ----------------------------------------------------------------------
              LAYER        (INCHES)        (VOL/VOL)
              -----        --------        ---------
```

CASE4OL.OUT

1	1.4410	0.2402
2	417.4379	0.2911
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
7	9.6289	0.3210
8	56.0412	0.2919
SNOW WATER	0.000	

****
****

APPENDIX B.17

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5OL-LOCATION 1

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE5OL.OUT

```
*
********************************************************************************
********************************************************************************
**                                                                            **
**                                                                            **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                 **
**               HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                   USAE WATERWAYS EXPERIMENT STATION                        **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                            **
**                                                                            **
********************************************************************************
********************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE5OL.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE5OL.OUT


TIME:  16: 7     DATE:   3/ 6/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE5OL (LOCATION 1)

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


     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  13
           THICKNESS                  =     24.00   INCHES
           POROSITY                   =      0.4300 VOL/VOL
           FIELD CAPACITY             =      0.3210 VOL/VOL
           WILTING POINT              =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2719 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-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  20
           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  =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  10.0000000000     CM/SEC
SLOPE                       =     2.00   PERCENT
DRAINAGE LENGTH             =   250.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                   =     0.04   INCHES
POROSITY                    =     0.0000 VOL/VOL
FIELD CAPACITY              =     0.0000 VOL/VOL
WILTING POINT               =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY       = 3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =     0.24   INCHES
POROSITY                    =     0.7500 VOL/VOL
FIELD CAPACITY              =     0.7470 VOL/VOL
WILTING POINT               =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =    12.00   INCHES
POROSITY                    =     0.4300 VOL/VOL
FIELD CAPACITY              =     0.3210 VOL/VOL
WILTING POINT               =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   144.00   INCHES
POROSITY                    =     0.6710 VOL/VOL
FIELD CAPACITY              =     0.2920 VOL/VOL
```

CASE5OL.OUT

```
WILTING POINT              =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


                         LAYER  7
                         --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  13
THICKNESS                  =    24.00   INCHES
POROSITY                   =     0.4300 VOL/VOL
FIELD CAPACITY             =     0.3210 VOL/VOL
WILTING POINT              =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-04 CM/SEC


                         LAYER  8
                         --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER  20
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 =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  10.0000000000     CM/SEC
SLOPE                      =     2.00   PERCENT
DRAINAGE LENGTH            =   250.0    FEET


                         LAYER  9
                         --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
THICKNESS                  =     0.06   INCHES
POROSITY                   =     0.0000 VOL/VOL
FIELD CAPACITY             =     0.0000 VOL/VOL
WILTING POINT              =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY      = 3 - GOOD


                         LAYER 10
                         --------

                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  17
THICKNESS                  =     0.24   INCHES
POROSITY                   =     0.7500 VOL/VOL
FIELD CAPACITY             =     0.7470 VOL/VOL
WILTING POINT              =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
```

CASE5OL.OUT

```
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER 11
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     30.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER 12
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  18
THICKNESS                   =    186.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2919 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
          GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.%
          AND A SLOPE LENGTH OF  100. FEET.

SCS RUNOFF CURVE NUMBER             =    85.60
FRACTION OF AREA ALLOWING RUNOFF    =   100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
EVAPORATIVE ZONE DEPTH              =    12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =     2.674  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     5.160  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =     2.652  INCHES
INITIAL SNOW WATER                  =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =   124.412  INCHES
TOTAL INITIAL WATER                 =   124.412  INCHES
TOTAL SUBSURFACE INFLOW             =     0.00   INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI        TEXAS

   STATION LATITUDE                       =  27.77 DEGREES
   MAXIMUM LEAF AREA INDEX                =   3.50
```

CASE5OL.OUT

```
START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED              =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37	1.81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2.99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.007	0.022	0.005	0.051	0.188	0.174
	0.342	0.218	0.608	0.191	0.067	0.007
STD. DEVIATIONS	0.022	0.041	0.026	0.171	0.500	0.243
	0.789	0.366	0.822	0.318	0.265	0.028

CASE5OL.OUT

```
EVAPOTRANSPIRATION
------------------
  TOTALS              1.093    1.768    1.331    1.252    1.966    2.071
                      1.754    2.186    3.474    2.435    1.312    1.107

  STD. DEVIATIONS     0.665    0.864    0.621    0.803    1.191    1.228
                      1.256    1.504    1.237    1.136    0.899    0.681

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS              0.0698   0.2237   0.1155   0.0457   0.1805   0.3327
                      0.3318   0.3490   0.8839   0.7081   0.2403   0.0780

  STD. DEVIATIONS     0.1315   0.2604   0.1270   0.1234   0.2785   0.4691
                      0.5455   0.5857   0.9977   0.7204   0.3203   0.1153

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  8
----------------------------------------
  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 10
------------------------------------
  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 12
------------------------------------
  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


-------------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
  AVERAGES            0.0005   0.0017   0.0008   0.0003   0.0013   0.0139
                      0.0206   0.0177   0.1061   0.0240   0.0018   0.0006

  STD. DEVIATIONS     0.0009   0.0020   0.0009   0.0009   0.0020   0.0415
                      0.1028   0.0537   0.2641   0.0529   0.0024   0.0008

DAILY AVERAGE HEAD ON TOP OF LAYER  9
-------------------------------------
  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

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


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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                     INCHES           CU. FEET       PERCENT
                               -------------------  -------------  ---------
PRECIPITATION                   27.20   (   5.704)     98722.7      100.00

RUNOFF                           1.880  (  1.2157)      6825.49       6.914

EVAPOTRANSPIRATION              21.749  (  3.7373)     78947.65      79.969

LATERAL DRAINAGE COLLECTED       3.55912 (  1.91851)    12919.604    13.08676
  FROM LAYER  2

PERCOLATION/LEAKAGE THROUGH      0.00001 (  0.00001)        0.023     0.00002
  LAYER  4

AVERAGE HEAD ON TOP              0.016 (    0.026)
  OF LAYER  3

LATERAL DRAINAGE COLLECTED       0.00001 (  0.00001)        0.022    0.00002
  FROM LAYER  8

PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.001     0.00000
  LAYER 10

AVERAGE HEAD ON TOP              0.000 (    0.000)
  OF LAYER  9

PERCOLATION/LEAKAGE THROUGH      0.00000 (  0.00000)        0.000     0.00000
  LAYER 12

CHANGE IN WATER STORAGE          0.008  (  0.4489)        29.91       0.030

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


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

            PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
   ------------------------------------------------------------------------
                                              (INCHES)      (CU. FT.)
                                             ----------   -------------
     PRECIPITATION                               5.07        18404.102

     RUNOFF                                      2.585        9382.1035

     DRAINAGE COLLECTED FROM LAYER  2            0.91251      3312.41650

     PERCOLATION/LEAKAGE THROUGH LAYER  4        0.000012        0.04380

     AVERAGE HEAD ON TOP OF LAYER  3            14.568

     MAXIMUM HEAD ON TOP OF LAYER  3            18.997

     LOCATION OF MAXIMUM HEAD IN LAYER  2
           (DISTANCE FROM DRAIN)                87.9 FEET
```

CASE5OL.OUT

DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03665
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000000	0.00000
SNOW WATER	0.02	73.7433

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4285
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2210

*** 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.

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	6.7730	0.2822
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	42.0480	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
11	9.6289	0.3210
12	54.2892	0.2919
SNOW WATER	0.000	

CASE5OL.OUT

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

APPENDIX B.18

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6OL-LOCATION 2

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE6OL.OUT

```
↑
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                  **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**              USAE WATERWAYS EXPERIMENT STATION                           **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE6OL.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE6OL.OUT


TIME:  16:16     DATE:   3/ 6/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE6OL (LOCATION 2)

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


     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  13
          THICKNESS                  =     24.00   INCHES
          POROSITY                   =      0.4300 VOL/VOL
          FIELD CAPACITY             =      0.3210 VOL/VOL
          WILTING POINT              =      0.2210 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2722 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.330000003000E-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  20
          THICKNESS                  =      0.20   INCHES
```
Page 1

CASE6OL.OUT

```
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. COND.    =   10.0000000000     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =    250.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                    =      0.04   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.4300 VOL/VOL
FIELD CAPACITY               =      0.3210 VOL/VOL
WILTING POINT                =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                    =    990.00   INCHES
POROSITY                     =      0.6710 VOL/VOL
FIELD CAPACITY               =      0.2920 VOL/VOL
```

```
                                 CASE6OL.OUT
WILTING POINT                =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                        LAYER  7
                        --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  13
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.4300 VOL/VOL
FIELD CAPACITY               =      0.3210 VOL/VOL
WILTING POINT                =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                        LAYER  8
                        --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER  20
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   =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =    250.0    FEET


                        LAYER  9
                        --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                        LAYER 10
                        --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
                                  Page 3
```

```
                              CASE60L.OUT
  EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                     LAYER 11
                     --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
  THICKNESS                   =     30.00   INCHES
  POROSITY                    =      0.4300 VOL/VOL
  FIELD CAPACITY              =      0.3210 VOL/VOL
  WILTING POINT               =      0.2210 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                     LAYER 12
                     --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
  THICKNESS                   =    408.00   INCHES
  POROSITY                    =      0.6710 VOL/VOL
  FIELD CAPACITY              =      0.2920 VOL/VOL
  WILTING POINT               =      0.0770 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.2919 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


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

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
          GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.%
          AND A SLOPE LENGTH OF  356. FEET.

SCS RUNOFF CURVE NUMBER            =    84.60
FRACTION OF AREA ALLOWING RUNOFF   =   100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =    12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     2.681  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     5.160  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     2.652  INCHES
INITIAL SNOW WATER                 =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =   436.275  INCHES
TOTAL INITIAL WATER                =   436.275  INCHES
TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR


         EVAPOTRANSPIRATION AND WEATHER DATA
         -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          CORPUS CHRISTI        TEXAS

     STATION LATITUDE                      =  27.77 DEGREES
     MAXIMUM LEAF AREA INDEX               =   3.50
                                         Page 4
```

CASE6OL.OUT

```
START OF GROWING SEASON (JULIAN DATE)  =       0
END OF GROWING SEASON (JULIAN DATE)    =     367
EVAPORATIVE ZONE DEPTH                 =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED              =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37	1.81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2.99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.005	0.016	0.004	0.047	0.171	0.149
	0.327	0.193	0.573	0.168	0.066	0.005
STD. DEVIATIONS	0.018	0.033	0.020	0.170	0.498	0.215
	0.772	0.343	0.823	0.315	0.283	0.021

CASE6OL.OUT

```
EVAPOTRANSPIRATION
------------------
  TOTALS                 1.096    1.761    1.331    1.252    1.971    2.085
                         1.756    2.192    3.492    2.429    1.316    1.104

  STD. DEVIATIONS        0.662    0.861    0.620    0.803    1.183    1.235
                         1.251    1.505    1.239    1.134    0.905    0.683

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS                 0.0775   0.2338   0.1173   0.0485   0.1907   0.3438
                         0.3452   0.3639   0.9017   0.7403   0.2420   0.0762

  STD. DEVIATIONS        0.1419   0.2767   0.1258   0.1298   0.2881   0.4853
                         0.5558   0.6168   1.0007   0.7614   0.3121   0.1053

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  8
----------------------------------------
  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 10
------------------------------------
  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 12
------------------------------------
  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


-------------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
  AVERAGES               0.0006   0.0018   0.0008   0.0004   0.0014   0.0163
                         0.0205   0.0202   0.1047   0.0279   0.0018   0.0005

  STD. DEVIATIONS        0.0010   0.0022   0.0009   0.0010   0.0021   0.0561
                         0.1017   0.0598   0.2561   0.0609   0.0023   0.0007

DAILY AVERAGE HEAD ON TOP OF LAYER  9
-------------------------------------
  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
```

CASE6OL.OUT

```
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

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


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

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
------------------------------------------------------------------------------
                                     INCHES            CU. FEET      PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                27.20    (   5.704)     98722.7      100.00

 RUNOFF                        1.723   (  1.2076)      6253.77       6.335

 EVAPOTRANSPIRATION           21.785   (  3.7320)     79078.27      80.101

 LATERAL DRAINAGE COLLECTED    3.68090 (  1.95906)    13361.677    13.53456
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH   0.00001 (  0.00001)        0.024     0.00002
   LAYER  4

 AVERAGE HEAD ON TOP           0.016 (    0.026)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED    0.00001 (  0.00001)        0.023    0.00002
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH   0.00000 (  0.00000)        0.002     0.00000
   LAYER 10

 AVERAGE HEAD ON TOP           0.000 (    0.000)
   OF LAYER  9

 PERCOLATION/LEAKAGE THROUGH   0.00000 (  0.00000)        0.000     0.00000
   LAYER 12

 CHANGE IN WATER STORAGE       0.008   (  0.4598)        28.94       0.029
******************************************************************************


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

          PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
 ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
    PRECIPITATION                                 5.07        18404.102

    RUNOFF                                        2.585        9382.1035

    DRAINAGE COLLECTED FROM LAYER  2              0.91340      3315.63574

    PERCOLATION/LEAKAGE THROUGH LAYER  4          0.000012        0.04489

    AVERAGE HEAD ON TOP OF LAYER  3              14.828

    MAXIMUM HEAD ON TOP OF LAYER  3              19.279

    LOCATION OF MAXIMUM HEAD IN LAYER  2
          (DISTANCE FROM DRAIN)                  88.6 FEET
```

CASE6OL.OUT

```
DRAINAGE COLLECTED FROM LAYER  8          0.00001          0.03755

PERCOLATION/LEAKAGE THROUGH LAYER 10      0.000000         0.00002

AVERAGE HEAD ON TOP OF LAYER  9           0.000

MAXIMUM HEAD ON TOP OF LAYER  9           0.006

LOCATION OF MAXIMUM HEAD IN LAYER  8
      (DISTANCE FROM DRAIN)               0.0 FEET

PERCOLATION/LEAKAGE THROUGH LAYER 12      0.000000         0.00000

SNOW WATER                                0.02            73.7433


MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4270

MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.2210


 ***  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.

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


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

             FINAL WATER STORAGE AT END OF YEAR   30
------------------------------------------------------------------------
```

LAYER	(INCHES)	(VOL/VOL)
1	6.7725	0.2822
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	289.0800	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
11	9.6295	0.3210
12	119.1125	0.2919
SNOW WATER	0.000	

CASE6OL.OUT

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

APPENDIX B.19

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7OL-LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE7OL.OUT

```
****************************************************************************
****************************************************************************
**                                                                        **
**                                                                        **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                HELP MODEL VERSION 3.07   (1 NOVEMBER 1997)             **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
**                    USAE WATERWAYS EXPERIMENT STATION                   **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                        **
**                                                                        **
****************************************************************************
****************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE7OL.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE7OL.OUT


TIME:  16:25     DATE:   3/ 6/2017


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

     TITLE:  CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE7OL (LOCATION 3)

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


     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  13
           THICKNESS                     =     24.00    INCHES
           POROSITY                      =      0.4300 VOL/VOL
           FIELD CAPACITY                =      0.3210 VOL/VOL
           WILTING POINT                 =      0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.2758 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.330000003000E-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  20
           THICKNESS                     =      0.20    INCHES
```

Page 1

```
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. COND.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    250.0    FEET


                        LAYER  3
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1026.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
```

CASE7OL.OUT

```
WILTING POINT              =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


                    LAYER  7
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                  =    24.00   INCHES
POROSITY                   =     0.4300 VOL/VOL
FIELD CAPACITY             =     0.3210 VOL/VOL
WILTING POINT              =     0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.330000003000E-04 CM/SEC


                    LAYER  8
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
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 =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  10.0000000000     CM/SEC
SLOPE                      =     2.00   PERCENT
DRAINAGE LENGTH            =   250.0    FEET


                    LAYER  9
                    --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =     0.06   INCHES
POROSITY                   =     0.0000 VOL/VOL
FIELD CAPACITY             =     0.0000 VOL/VOL
WILTING POINT              =     0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =     1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =     2.00   HOLES/ACRE
FML PLACEMENT QUALITY      = 3 - GOOD


                    LAYER 10
                    --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                  =     0.24   INCHES
POROSITY                   =     0.7500 VOL/VOL
FIELD CAPACITY             =     0.7470 VOL/VOL
WILTING POINT              =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
```

```
                         CASE7OL.OUT
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                  LAYER 11
                  --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     30.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                  LAYER 12
                  --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER  18
THICKNESS                   =    444.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2919 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
         GOOD STAND OF GRASS, A SURFACE SLOPE OF  3.%
         AND A SLOPE LENGTH OF  220. FEET.

SCS RUNOFF CURVE NUMBER             =    84.10
FRACTION OF AREA ALLOWING RUNOFF    =   100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
EVAPORATIVE ZONE DEPTH              =    12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =     2.768  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     5.160  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =     2.652  INCHES
INITIAL SNOW WATER                  =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =   457.386  INCHES
TOTAL INITIAL WATER                 =   457.386  INCHES
TOTAL SUBSURFACE INFLOW             =     0.00   INCHES/YEAR


          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         CORPUS CHRISTI        TEXAS

     STATION LATITUDE                       =  27.77 DEGREES
     MAXIMUM LEAF AREA INDEX                =   3.50
                                     Page 4
```

CASE7OL.OUT

```
START OF GROWING SEASON (JULIAN DATE)  =      0
END OF GROWING SEASON (JULIAN DATE)    =    367
EVAPORATIVE ZONE DEPTH                 =  12.0  INCHES
AVERAGE ANNUAL WIND SPEED              =  12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37	1.81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2.99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.004	0.013	0.003	0.044	0.164	0.137
	0.325	0.178	0.562	0.159	0.064	0.004
STD. DEVIATIONS	0.016	0.029	0.018	0.166	0.498	0.200
	0.770	0.331	0.824	0.315	0.281	0.018

CASE7OL.OUT

```
EVAPOTRANSPIRATION
------------------
  TOTALS                 1.095    1.769    1.332    1.252    1.978    2.082
                         1.754    2.181    3.481    2.435    1.313    1.102

  STD. DEVIATIONS        0.663    0.860    0.624    0.803    1.187    1.231
                         1.244    1.501    1.235    1.138    0.902    0.681

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS                 0.0767   0.2331   0.1179   0.0493   0.1925   0.3537
                         0.3548   0.3828   0.9254   0.7490   0.2449   0.0806

  STD. DEVIATIONS        0.1439   0.2713   0.1269   0.1333   0.2928   0.4967
                         0.5774   0.6301   1.0117   0.7734   0.3251   0.1272

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  8
----------------------------------------
  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 10
------------------------------------
  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 12
------------------------------------
  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


-------------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
  AVERAGES               0.0005   0.0018   0.0008   0.0004   0.0014   0.0186
                         0.0223   0.0241   0.1085   0.0318   0.0018   0.0006

  STD. DEVIATIONS        0.0010   0.0021   0.0009   0.0010   0.0021   0.0627
                         0.1021   0.0699   0.2572   0.0681   0.0024   0.0009

DAILY AVERAGE HEAD ON TOP OF LAYER  9
-------------------------------------
  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
```

CASE7OL.OUT

```
  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

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


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                      INCHES          CU. FEET      PERCENT
                                -------------------  -------------  ---------
 PRECIPITATION                  27.20   (   5.704)     98722.7      100.00

 RUNOFF                          1.657  (  1.2106)      6015.83      6.094

 EVAPOTRANSPIRATION             21.773  (  3.7354)     79036.62     80.059

 LATERAL DRAINAGE COLLECTED      3.76085 (  1.98336)    13651.874   13.82851
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH     0.00001 (  0.00001)        0.025    0.00003
   LAYER  4

 AVERAGE HEAD ON TOP             0.018 (    0.026)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED      0.00001 (  0.00001)        0.024   0.00002
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.002    0.00000
   LAYER 10

 AVERAGE HEAD ON TOP             0.000 (    0.000)
   OF LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.000    0.00000
   LAYER 12

 CHANGE IN WATER STORAGE         0.005   (  0.4439)       18.34      0.019
*******************************************************************************


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

             PEAK DAILY VALUES FOR YEARS    1 THROUGH   30
   ------------------------------------------------------------------------
                                               (INCHES)      (CU. FT.)
                                              ----------   -------------
       PRECIPITATION                             5.07        18404.102

       RUNOFF                                    2.585        9382.1035

       DRAINAGE COLLECTED FROM LAYER  2          0.91351      3316.05835

       PERCOLATION/LEAKAGE THROUGH LAYER  4      0.000012        0.04505

       AVERAGE HEAD ON TOP OF LAYER  3          14.866

       MAXIMUM HEAD ON TOP OF LAYER  3          19.319

       LOCATION OF MAXIMUM HEAD IN LAYER  2
             (DISTANCE FROM DRAIN)              88.7 FEET
```

CASE7OL.OUT

DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03769
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.006	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000000	0.00000
SNOW WATER	0.02	73.7433

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4264
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2210

*** 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.

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	6.7715	0.2821
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	299.5920	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
11	9.6295	0.3210
12	129.6245	0.2919
SNOW WATER	0.000	

CASE7OL.OUT

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

APPENDIX B.20

HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 8OL-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE8OL.OUT

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE:       C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MDATA\KGVSO30Y.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MDATA\CASE8OL.D10
OUTPUT DATA FILE:            C:\HELP3\MDATA\CASE8OL.OUT


TIME:  16:36     DATE:   3/ 6/2017


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

     TITLE:  ITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE8OL (LOCATION 4)

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


     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  13
           THICKNESS                    =    24.00   INCHES
           POROSITY                     =     0.4300 VOL/VOL
           FIELD CAPACITY               =     0.3210 VOL/VOL
           WILTING POINT                =     0.2210 VOL/VOL
           INITIAL SOIL WATER CONTENT   =     0.2757 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-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  20
           THICKNESS                    =     0.20   INCHES
```

CASE8OL.OUT

```
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. COND.   =   10.0000000000     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    250.0    FEET


                        LAYER  3
                        --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  36
THICKNESS                   =      0.04   INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  4
                        --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER  5
                        --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER  6
                        --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1434.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
```

CASE8OL.OUT

```
WILTING POINT                =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                      LAYER  7
                      --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  13
THICKNESS                    =     24.00   INCHES
POROSITY                     =      0.4300 VOL/VOL
FIELD CAPACITY               =      0.3210 VOL/VOL
WILTING POINT                =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.330000003000E-04 CM/SEC


                      LAYER  8
                      --------

              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER  20
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   =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   10.0000000000     CM/SEC
SLOPE                        =      2.00   PERCENT
DRAINAGE LENGTH              =    250.0    FEET


                      LAYER  9
                      --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                      LAYER 10
                      --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.24   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
```

```
                              CASE8OL.OUT
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC


                        LAYER 11
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  13
THICKNESS                   =     30.00   INCHES
POROSITY                    =      0.4300 VOL/VOL
FIELD CAPACITY              =      0.3210 VOL/VOL
WILTING POINT               =      0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.330000003000E-04 CM/SEC


                        LAYER 12
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =    192.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2919 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
         GOOD STAND OF GRASS, A SURFACE SLOPE OF  3.%
         AND A SLOPE LENGTH OF  500. FEET.

SCS RUNOFF CURVE NUMBER            =    83.40
FRACTION OF AREA ALLOWING RUNOFF   =   100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =    12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =     2.765  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     5.160  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =     2.652  INCHES
INITIAL SNOW WATER                 =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =   502.935  INCHES
TOTAL INITIAL WATER                =   502.935  INCHES
TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR


          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         CORPUS CHRISTI       TEXAS

     STATION LATITUDE                    =  27.77 DEGREES
     MAXIMUM LEAF AREA INDEX             =   3.50
                                          Page 4
```

```
                                   CASE8OL.OUT
       START OF GROWING SEASON (JULIAN DATE)  =      0
       END OF GROWING SEASON (JULIAN DATE)    =    367
       EVAPORATIVE ZONE DEPTH                 =  12.0  INCHES
       AVERAGE ANNUAL WIND SPEED              =  12.00 MPH
       AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  76.00 %
       AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  78.00 %
       AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  76.00 %
       AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  76.00 %


     NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS

              NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
    1.63        1.69        1.20        1.57        3.29        3.12
    2.26        2.78        5.31        2.92        1.61        1.17


     NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS

       NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
   56.30       59.30       65.90       73.00       78.10       82.70
   84.90       85.00       81.50       74.00       65.00       59.10


     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
              COEFFICIENTS FOR    CORPUS CHRISTI      TEXAS
                AND STATION LATITUDE  =   27.77 DEGREES


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

     AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------

                        JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                        -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                 1.37     1.81     1.19     1.40     2.51     2.59
                          2.36     2.86     5.39     2.99     1.49     1.25

   STD. DEVIATIONS        0.81     1.21     0.57     1.05     1.80     1.82
                          2.23     2.36     2.96     1.90     1.16     0.84

 RUNOFF
 ------
   TOTALS                0.003    0.010    0.003    0.042    0.156    0.122
                         0.316    0.163    0.535    0.147    0.061    0.003

   STD. DEVIATIONS       0.013    0.024    0.015    0.164    0.497    0.184
                         0.758    0.318    0.809    0.320    0.279    0.014

                                   Page 5
```

CASE8OL.OUT

EVAPOTRANSPIRATION

TOTALS	1.098	1.771	1.335	1.250	1.982	2.083
	1.756	2.189	3.487	2.438	1.317	1.099
STD. DEVIATIONS	0.661	0.863	0.626	0.802	1.189	1.239
	1.255	1.518	1.230	1.138	0.905	0.685

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.0759	0.2321	0.1168	0.0532	0.1955	0.3680
	0.3641	0.3858	0.9507	0.7510	0.2525	0.0787
STD. DEVIATIONS	0.1410	0.2677	0.1258	0.1423	0.2933	0.5138
	0.5970	0.6265	1.0470	0.7857	0.3241	0.1151

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 8

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 10

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 12

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

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0005	0.0018	0.0008	0.0004	0.0014	0.0187
	0.0273	0.0201	0.1213	0.0321	0.0019	0.0006
STD. DEVIATIONS	0.0010	0.0021	0.0009	0.0010	0.0021	0.0583
	0.1291	0.0571	0.2670	0.0798	0.0024	0.0008

DAILY AVERAGE HEAD ON TOP OF LAYER 9

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

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


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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------
                                     INCHES              CU. FEET       PERCENT
                               -------------------    -------------   ---------
 PRECIPITATION                 27.20    (   5.704)       98722.7       100.00

 RUNOFF                          1.562  (  1.2013)        5669.92        5.743

 EVAPOTRANSPIRATION             21.805  (  3.7516)       79151.28       80.175

 LATERAL DRAINAGE COLLECTED      3.82437 (  2.05115)      13882.466     14.06208
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH     0.00001 (  0.00001)          0.027      0.00003
   LAYER  4

 AVERAGE HEAD ON TOP             0.019 (    0.029)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED      0.00001 (  0.00001)          0.025     0.00003
   FROM LAYER  8

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)          0.002      0.00000
   LAYER 10

 AVERAGE HEAD ON TOP             0.000 (    0.000)
   OF LAYER  9

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)          0.000      0.00000
   LAYER 12

 CHANGE IN WATER STORAGE         0.005  (  0.4494)          19.00        0.019
*******************************************************************************


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

          PEAK DAILY VALUES FOR YEARS     1 THROUGH   30
   ------------------------------------------------------------------------
                                                (INCHES)      (CU. FT.)
                                               ----------   -------------
      PRECIPITATION                               5.07         18404.102

      RUNOFF                                      2.585         9382.1035

      DRAINAGE COLLECTED FROM LAYER  2            0.91331       3315.29883

      PERCOLATION/LEAKAGE THROUGH LAYER  4        0.000012         0.04488

      AVERAGE HEAD ON TOP OF LAYER  3            14.828

      MAXIMUM HEAD ON TOP OF LAYER  3            19.277

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)                88.6 FEET
```

CASE8OL.OUT

DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03850
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.006	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000000	0.00000
SNOW WATER	0.02	73.7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4265	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2210	

*** 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.

****

****

FINAL WATER STORAGE AT END OF YEAR 30

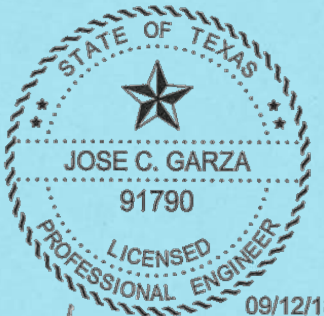
LAYER	(INCHES)	(VOL/VOL)
1	6.7738	0.2822
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	418.7280	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
11	9.6289	0.3210
12	56.0412	0.2919
SNOW WATER	0.000	

CASE8OL.OUT

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

APPENDIX C

MULTIMED MODEL ANALYSIS



09/12/18
Jose C. Garza, P.E.

APPENDIX C.1

CONTENTS

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CONTENTS

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APPENDIX C.2

MULTIMED CHEMICAL-SPECIFIC DATA

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MULTIMED CHEMICAL - SPECIFIC DATA

Variable Name	Units	Value	Comments
Solid phase decay coefficient	1/yr	0	decay not used
Dissolved phase decay coefficient	1/yr	0	decay not used
Chemical decay coefficient	1/yr	0	decay not used
Acid catalyst hydrolysis constant	1/m-yr	0	hydrolysis not used
Neutral hydrolysis rate constant	1/yr	0	hydrolysis not used
Base catalyst hydrolysis constant	1/m-yr	0	hydrolysis not used
Reference temperature	degrees C	20	not used in model since decay not used
Normalized distribution coefficient	ml/g	0	0 because simulation is steady state, with no chemical decay
Distribution coefficient	ml/g		derived by MULTIMED from normalized distribution coefficient
Biodegradation coefficient	1/yr	0	biodegradation not allowed by TCEQ

APPENDIX C.3

MULTIMED SOURCE-SPECIFIC DATA

STATE OF TEXAS
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MULTIMED SOURCE - SPECIFIC DATA

Variable Name	Units	Value	Comments
Infiltration rate	m/yr	varies	See table below.
Area of waste disposal unit	m^2	485,623	120 acres
Spread of contaminant source	m	0	Derived by MULTIMED
Recharge rate	m/yr	0.0368	Five percent of average annual precipitation (1.45 inches/yr)
Initial concentration at landfill (C_0)	mg/L	1.0	Set at 1.0 to find DAF
Length scale of facility	m		Derived by MULTIMED
Width scale of facility	m		Derived by MULTIMED

Case	Infiltration Rate (m/yr)	Comments
Interim cases with Alternative Liner		
• 57.5 feet of waste (Case 1) 20 yr	*1.28×10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2
• 140 feet of waste (Case 2) 20 yr	1.79×10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2
• 148 feet of waste (Case 3) 20 yr	1.79×10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2
• 162 feet of waste (Case 4) 20 yr	1.79×10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2
Closed cases with Alternative Liner		
• 57.5 feet of waste (Case 5) 30 yr	5.11×10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2
• 140 feet of waste (Case 6) 30 yr	5.11×10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2
• 148 feet of waste (Case 7) 30 yr	5.11×10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2
• 162 feet of waste (Case 8) 30 yr	5.11×10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.2

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)
Example: ((.00005 FT^3/Day-Acre)x(1 Acre/43,560 FT^2)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= 1.28×10^{-7} M/YR

APPENDIX C.4

MULTIMED SOURCE-SPECIFIC DATA-OVERLINER DEMONSTRATION

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MULTIMED SOURCE - SPECIFIC DATA

Overliner Demonstration

Variable Name	Units	Value	Comments
Infiltration rate	m/yr	varies	See table below.
Area of waste disposal unit	m^2	485,623	120 acres
Spread of contaminant source	m	0	Derived by MULTIMED
Recharge rate	m/yr	0.0368	Five percent of average annual precipitation (1.45 inches/yr)
Initial concentration at landfill (C_0)	mg/L	1.0	Set at 1.0 to find DAF
Length scale of facility	m		Derived by MULTIMED
Width scale of facility	m		Derived by MULTIMED

Case	Infiltration Rate (m/yr)	Comments
Interim Cases with Overliner		
Location 1 (Case 1OL) • 12 feet of waste above liner • 15.5 feet of waste below liner 20 yr	*1.79 x 10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12
Location 2 (Case 2OL) • 82.5 feet of waste above liner • 34 feet of waste below liner 20 yr	1.53 x 10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12
Location 3 (Case 3OL) • 85.5 feet of waste above liner • 37 feet of waste above liner 20 yr	1.53 x 10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12
Location 4 (Case 4OL) • 119.5 feet of waste above liner • 16 feet of waste above liner 20 yr	1.53 x 10^{-7}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12
Closed cases with Overliner		
Location 1 (Case 5OL) • 12 feet of waste above liner • 15.5 feet of waste below liner 30 yr	5.11 x 10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12
Location 2 (Case 6OL) • 82.5 feet of waste above liner • 34 feet of waste below liner 30 yr	5.11 x 10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12
Location 3 (Case 7OL) • 85.5 feet of waste above liner • 37 feet of waste below liner 30 yr	5.11 x 10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12
Location 4 (Case 8OL) • 119.5 feet of waste above liner • 16 feet of waste below liner 30 yr	5.11 x 10^{-8}	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12

* Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR)

Example: ((.00007 FT^3/Day-Acre)x(1 Acre/43,560 FT^2)/(1 Meter/3.28 FT)) x (365 Days/1 YR)= 1.79 x 10^{-7} M/YR

APPENDIX C.5

UNSATURATED ZONE DATA

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MULTIMED UNSATURATED ZONE DATA

Note that the unsaturated zone was not modeled as part of this point of compliance demonstration. The attenuating effects of the unsaturated zone were conservativeley disregarded.

APPENDIX C.6

MULTIMED AQUIFER-SPECIFIC DATA

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MULTIMED AQUIFER - SPECIFIC DATA

Variable Name	Units	Value	Comments
Particle Diameter*	cm	0.0381	From Permit 235-B Amendment Volume II of V Pages 36-39 (PDF)-1998 Material ranges from fine to coarse. Use an average for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm
Aquifer porosity*	unitless	0.43	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998
Bulk density	g/cc	1.65	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998
Aquifer thickness	m	10	From Permit 235-B Amendment Volume V of V Pgs. 467-473 (PDF)-1998 Avg depth of uppermost aquifer
Mixing zone depth	m		Derived by MULTIMED
Hydraulic conductivity	m/yr	130	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Average hydraulic conductivity of 4.12×10^{-4} cm/sec
Hydraulic gradient	unitless	0.0031	From Groundwater Contour Map (January 2016)
Groundwater seepage velocity	m/yr		Derived by MULTIMED
Retardation coefficient	unitless		Derived by MULTIMED
Longitudinal dispersivity	m		Derived by MULTIMED
Transveral dispersivity	m		Derived by MULTIMED
Vertical dispersivity	m		Derived by MULTIMED
Organic carbon content	%	0.003	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998
Receptor distance from well	m	Varies	Distance from analysis location to point of compliance.
Z-distance from water table	m	0	Assume water table is at bottom of liner.

Note: According to Amendment Application (1998) the Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay.
(assume medium sand (0.015 in) particle diamter or (0.0381 cm)
*** If Aquifer porosity is known MULTIMED will not use particle diameter.**

APPENDIX C.7

MULTIMED AQUIFER-SPECIFIC DATA-OVERLINER DEMONSTRATION

STATE OF TEXAS
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MULTIMED AQUIFER - SPECIFIC DATA

Overliner Demonstration

Variable Name	Units	Value	Comments
Particle Diameter*	cm	0.0381	From Permit 235-B Amendment Volume II of V Pages 36-39 (PDF)-1998 Material ranges from fine to coarse. Use an average for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm
Aquifer porosity*	unitless	0.43	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998
Bulk density	g/cc	1.65	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998
Aquifer thickness	m	10	From Permit 235-B Amendment Volume V of V Pgs. 467-473 (PDF)-1998 Avg depth of uppermost aquifer
Mixing zone depth	m		Derived by MULTIMED
Hydraulic conductivity	m/yr	130	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998 Average hydraulic conductivity of 4.12 x 10^{-4} cm/sec
Hydraulic gradient	unitless	0.002	From Groundwater Contour Map (January 2016)
Groundwater seepage velocity	m/yr		Derived by MULTIMED
Retardation coefficient	unitless		Derived by MULTIMED
Longitudinal dispersivity	m		Derived by MULTIMED
Transveral dispersivity	m		Derived by MULTIMED
Vertical dispersivity	m		Derived by MULTIMED
Organic carbon content	%	0.003	From Permit 235-B Amendment Volume V of V Pages 467-473 (PDF)-1998
Receptor distance from well	m	Varies	Distance from analysis location to point of compliance.
Z-distance from water table	m	0	Assume water table is at bottom of liner.

Note: According to Amendment Application (1998) the Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay.
(assume medium sand (0.015 in) particle diamter or (0.0381 cm)
*** If Aquifer porosity is known MULTIMED will not use particle diameter.**

APPENDIX C.7.1

'APPENDIX E ALTERNATE LINER DESIGN REPORT-CITY OF KINGSVILLE MUNICIPAL SOLID WASTE DISPOSAL FACILITY PERMIT AMENDMENT APPLICATION MSW 235-B', PAGES 467-473 FROM PERMIT 235-B AMENDMENT VOLUME V OF V

STATE OF TEXAS
JOSE C. GARZA
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

APPENDIX E

ALTERNATE LINER DESIGN REPORT

City of Kingsville
Municipal Solid Waste Disposal Facility
Permit Amendment Application MSW 235-B

STATE OF TEXAS
RAY N. FINCH
30926
REGISTERED
PROFESSIONAL ENGINEER
11-25-97

THIS CERTIFICATION IS INTENDED FOR PERMITTING PURPOSES ONLY AND INCLUDES PAGES 1 THROUGH 7.

November 1997

Pages 467 from Permit 235-B Amendment Volume V of V

ALTERNATE LINER DESIGN REPORT

The City of Kingsville, Texas is proposing a municipal solid waste landfill facility and wishes to consider an alternate design. The proposed site has an expected life of 29 years, area of approximately 120 acres in size, an excavation depth of 20 feet to the bottom of the liner, and an estimated horizontal projection of the leachate collection layer from the top to the collector of 155 ft. Through an extensive ground-water characterization study, the following information was acquired:

Aquifer Specific Data

Aquifer porosity	0.43 (Silty Clay Loam)
Bulk density	1.65 g/cc = 103 lbm/ft^3
Aquifer thickness	10m = 32.81 ft.
Average hydraulic conductivity	4.12 X 10^{-4} cm/sec
Hydraulic gradient	0.00331 ft/ft = 0.00331 m/m
Seepage velocity	3.3 ft/yr
Aquifer temperature	21°C
pH	7.2
Organic carbon content	0.003

Four scenarios were considered in evaluating this proposed site:

Case 1 - A closed landfill with a synthetic GeoClay barrier liner (3.0 X 10^{-9} cm/sec), a 60 mil HDPE membrane liner (2 x 10^{-12} cm/sec), a Geocomposite drainage layer (10 cm/sec), a 24 inch protective soil layer, 60 feet of waste, an 18 inch soil cover layer, a 60 mil HDPE membrane, a Geocomposite drainage layer, and a 24 inch infiltration and vegetative erosion control layer.

Case 2 - A closed landfill with a standard composite Subtitle "D" Liner with a Geocomposite drainage layer, 60 feet of waste, and a standard Subtitle "D" cover.

Case 3 - An open landfill with a synthetic GeoClay barrier liner (3.0 X 10^{-9} cm/sec), a 60 mil HDPE membrane liner (2 x 10^{-12} cm/sec), a Geocomposite drainage layer (10 cm/sec), a 24 inch protective soil layer, 30 feet of waste (open face 2 acres w/ 320 foot drain length at 4H:1V), and 12 inches of daily soil cover.

Case 4 - An open landfill with a standard composite Subtitle "D" Liner with a Geocomposite drainage layer, 30 feet of waste (open face 2 acres w/ 320 foot drain length at 4H:1V), and 12 inches of daily soil cover.

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Results of HELP Model

	Avg. Impingement on Drainage Layer, inches	Average Annual Head on Barrier Layer, inches	Avg. Percolation Thru Barrier Layer, ft^3/yr
Case 1	0.00002	0.000	0.003
Case 2	0.00002	0.000	0.003
Case 3	1.00798	0.000	0.007
Case 4	0.88389	0.000	0.009

<u>Evaluation of Leakage Through a Composite Liner</u>

To calculate the leakage rate through a composite liner, it is necessary to determine the impingement rate e (volume of leachate reaching the leachate collection system). From the HELP3 model printout for Case 4, the average annual precipitation is 40.590 inches (295,000 cubit feet), the average annual evapotranspiration is 20.510 inches (148,900 cubic feet), and the peak daily impingement onto the drainage layer is 0.07075 inches/day (513.7 ft^3/day).

Maximum thickness of leachate in the leachate collection system T_{max} must be less than the thickness of the leachate collection system, and T_{max} must be less than 30 cm as per 31 TAC 330.203.

Thus:

$e = 0.07075$ inches/day $= 2.1 \times 10^{-8}$ m/s
$k = 1.0 \times 10^{1}$ cm/sec $= 1.0 \times 10^{-1}$ m/s
$\tan \beta = 2.0\%$
$L = 155$ ft $= 47.2$ meters

$$T_{max} = \frac{47.2 * \sqrt{0.0000008.4 + 0.0004} - 0.020}{1.9996}$$

T_{max} = 0.000495 meters = 0.0195 inches

This value compares well with 0.019 inches calculated in Case 4 and is less than the maximum allowed head of 30 cm (12 inches).

However, when evaluating leakage through a liner to use in a fate and transport model (i.e., Multimed), a more conservative value is recommended. One reasonably conservative estimate would be to assume the sand drainage layer is saturated, or h = 12 inches.

Leakage through a composite liner:

$a = 0.16$ sq. in. $= 0.0001\ m^2$
$h_{tb} = 12.0$ in. $= 0.305$ m.
$k_{st} = 1.0 \times 10^{-7}$ cm/sec $= 1.0 \text{ X } 10^{-9}$ m/s

For good contact:

$$Q_{tb} = 0.21*(1.0 \text{ X } 10^{-4} m^2)^{0.1} * (0.305m)^{0.9} * (1.0 \text{ X } 10^{-9} m/sec)^{0.74}$$
$$Q_{tb} = 0.63 \text{ X } 10^{-8}\ m^3/sec/hole = 0.1438\ gal/day/hole$$

For poor contact:

$$Q_{tb} = (1.15/0.21)*0.1438 = 0.7875\ gal/hole/day$$

Assuming 7 holes per acre, the estimated leakage through a composite liner with poor contact would be:

$$Q = (7\ holes/acre)*(2acres)*(0.7875\ gal/day/hole)$$
$$Q = 11.0\ gal/day = \text{INFiltration Rate} = 0.00188m/yr$$

Evaluation of Leakage Through a GeoClay Synthetic Liner

To calculate the leakage rate through a synthetic GeoClay liner, it is necessary to determine the impingement rate e (volume of leachate reaching the leachate collection system). From the HELP3 model printout for Case 2, the average annual precipitation is 40.590 inches (295,000 cubit feet), the average annual evapotranspiration is 20.882 inches (151,600 cubic feet), and the peak daily impingement onto the drainage layer is 0.07850 inches/day (570.0 ft^3/day).

Maximum thickness of leachate in the leachate collection system T_{max} must be less than the thickness of the leachate collection system, and T_{max} must be less than 30 cm as per 31 TAC 330.203.

Thus:

$e = 0.0785$ inches/day $= 2.3 \text{ X } 10^{-8}$ m/s
$k = 1.0 \text{ X } 10^{-1}$ cm/sec $= 1.0 \text{ X } 10^{-1}$ m/s
$\tan\beta = 2.0\%$
$L = 155$ ft $= 47.2$ meters

$$T_{max} = \frac{47.2 * \sqrt{0.00000092 + 0.0004} - 0.020}{1.9996}$$

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T_{max} = 0.0005426 meters = 0.0214 inches

This value compares well with 0.022 inches calculated in Case 3 and is less than the maximum allowed head of 30 cm (12 inches).

However, when evaluating leakage through a liner to use in a fate and transport model (i.e., Multimed), a more conservative value is recommended. One reasonably conservative estimate would be to assume the sand drainage layer is saturated, or h = 12 inches.

Leakage through a composite liner:

a = 0.16 sq. in. = 0.0001 m^2
h_{tb} = 12.0 in. = 0.305 m.
k_{st} = 3.0 x 10^{-9} cm/sec = 3.0 X 10^{-11} m/s

For good contact:

Q_{tb} = 0.21*(1.0 X 10^{-4} m^2)$^{0.1}$*(0.305m)$^{0.9}$*(3.0 X $10^{-11 m/sec}$)$^{0.74}$
Q_{tb} = 4.677 X 10^{-10} m^3/sec/hole = 0.01068 gal/day/hole

For poor contact:

Q_{tb} = (1.15/0.21)*0.01068 = 0.05847 gal/hole/day

Assuming 7 holes per acre, the estimated leakage through a composite liner with poor contact would be:

Q = (7 holes/acre)*(2 acres)*(0.05847gal/day/hole)
Q = 0.8185 gal/day = INFiltration Rate = 0.000140m/yr

Analysis of the 30 cm (12 inches) head on High Drainage Layers:

The 12 inch head on these synthetic liners with Geocomposite drainage layers seems unreasonable. Therefore, let's answer some questions prior to proceding to input the MultiMed Model.

First, What flow would be required to create a 12" head on the drainage layer?

Solving the Head Equation in reverse for impingement rate:

T_{max} = 12" = 0.3048 meters

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$$\therefore\ 0.3048m = \frac{47.2 * (\sqrt{4 * (\frac{e}{0.1}) + 0.0004} - 0.020)}{1.9996}$$

e = 0.00001708 m/sec = 58.10 inches/day!!!!!!

This impingement rate is **more than the max annual rainfall** coming in one day;
more than a 25 year, 24 hour storm;
more than a 100 year, 24 hour storm; and
equals 3,155,530 gallons/day impingement
just to create 12 inches of head on the drainage layer! Nevertheless, the two compartive cases (cases 11&12) have been run. They illustrate that the Subtitle D Liner will not pass the criteria under 12" head, but that the alternateve GeoClay liner will.

A better conservative estimate for this type of system would be an assumption of a 25 year, 24 hour storm (9 inches/day) hitting the landfill, and using the HELP3 model to estimate the drainage layer impingement in each case. The peak daily precipitation rate for the HELP3 model cases was 7.92 inches. Therefore, we shall increase the impingement on the lower synthetic liner by the ratio of (9.00"/7.92") This generates the following impingement rates on the liners for cases 1 through 4:

Case No.	25 yr, 24 hr Storm HELP Perc'n thru Barrier Layer, ft3/day	25 yr, 24 hr Storm HELP Perc'n thru Barrier Layer, inch/day	25 yr, 24 hr Storm HELP Perc'n thru Barrier Layer, meter/year
1 - COK Alt. Liner Closed	0.0000114	0.000000571	0.0000053
2 - STD Liner Closed	0.0000114	0.000000571	0.0000053
3 - COK Alt. Liner Open	0.0000682	0.00000343	0.0000318
4 - STD Liner Open	0.00025	0.0000126	0.000117

These infiltration rates were used as input to the MultiMed Model and produced the following results:

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Evaluation of leachate concentration at Point of Compliance

Based on the above calculations, the infiltration rate to be input into the Mulitmed models are:

For GeoClay Barrier Liner(Closed): Infiltration = 0.031 gal/day = 0.0000053 m/yr
For Std Subtitle "D" Liner(Open): Infiltration = 0.031 gal/day = 0.0000053 m/yr
For GeoClay Barrier Liner(Open): Infiltration = 0.1862 gal/day = 0.0000318 m/yr
For Std Subtitle "D" Liner(Open): Infiltration = 0.6826 gal/day = 0.000117 m/yr

The first Mulitmed model was run for Case 1 (Closed landfill, alternate design, steady state). The second model run for Case 2 (Closed landfill, Subtitle "D", steady state). The third model run for Case 3 (Open landfill, alternate design, steady state). The fourth model run for Case 4 (Open landfill, Subtitle "D", steady state). Results of these models are tabulated below:

Results of Multimed Models

	Concentration at POC	Dilution Attenuation Factor
Case 1 (steady state)	0.0002089	4,787
Case 2 (steady state)	0.0002089	4,787
Case 3 (steady state)	0.001253	798
Case 4 (steady-state)	0.0004606	217

Conclusions

As can be seen by comparing the Dilution Attenuation Factors (DAF's) for the alternate design scenarios, Case 1 and Case 3 (4,787 and 798, respectively) with the minimum required DAF's listed in Table 2, is has been demonstrated through the use of the HELP and Multimed models that the alternate design is sufficient for all constituents.

APPENDIX C.7.2

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B ATTACHMENT 4-GEOLOGY REPORT, 4.0 REGIONAL AQUIFERS', PAGES 36-39 FROM 235-B AMENDMENT VOLUME II OF V

STATE OF TEXAS
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4.0 Regional Aquifers

The Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. Only in South Texas the base of the Evangeline coincides with the base of the Goliad. The upper boundary of the Evangeline probably follows closely the top of the Goliad Sand where present, but this relationship is somewhat speculative (Muller, 1979). (See Figure 4.11) Ground water flow direction in the Evangeline is in a Northerly direction based on a water level map of the Goliad sand. There are two very significant cones of depression in the Evangeline (Goliad) aquifer located to the northwest of the City of Kingsville MSWLF site. These depressions are primarily due to large groundwater production rates by the City of Kingsville and the Exxon King Ranch Gas Plant. The extent of salt water intrusion from the Gulf of Mexico into the Evangeline (Goliad) aquifer is shown on Figure 4.16.

The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay. Recharge within the site area occurs along the outcrop which is located in western Hidalgo, central-eastern Starr, central Jim Hogg, Duval, southeastern Webb, northeastern Brooks, northern Jim Wells, and extreme northeast Zapata counties, as well as other counties to the north. The maximum width of the outcrop is west of Falfurrias where the Goliad Sand extends for nearly 50 miles at the surface and completely overlaps the underlying Lagarto Clay and Oakville Sandstone and nearly overlaps the Catahoula Tuff (Shafer, 1973). (See Figure 4.12)

The water of the Goliad is under artesian pressure and is yielded to flowing and nonflowing wells. The average coefficient of transmissibility determined during drawdown of the fresh to slightly saline water section of the Goliad Sand in southwestern Kleberg County measured in well no. RR-83-41-803, was about 34,400 gpd per foot. The specific capacity of the well was 17.8 gpm per foot. This was derived from a screened interval of 126 feet near the north boundary of Kenedy and south boundary of Kleberg Counties.

Fresh water of domestic use quality in the Evangeline is found in well developed sands at depths of 500 feet and greater in the MSWLF area. From surface to the fresh water sands in the Evangeline the lithology is predominately a clay described as silty, calcareous, firm to hard with occasionally silty sands.

The regional Chicot aquifer lies approximately 220 feet below ground surface in the vicinity of the MSWLF according to two deep well logs obtained from a local mineral company. (See Section 4.2) The Light Olive Green Clay layer serves as aquiclude between the uppermost aquifer below the landfill site and the Chicot aquifer. In Kleberg County, and specifically the MSWLF, the waters from the Chicot aquifer are generally slightly-saline to saline and yield only marginal quantities of water.

The local unconfined water table aquifer tends to flow in all directions away from the landfill site. The only exception is that for a period of time after excessive rainfall events, ground water in this local uppermost aquifer tends to flow toward the site from the northwest. This determination is based on water levels recorded in wells completed for use in the current expansion phase. However, the largest gradients for ground water flow are in the northeast and southwest directions. The flow toward the southwest is along a caliche channel which slopes to the southwest toward some lower elevation caliche pits. The flow toward the northeast is toward the Santa Gertrudis creek. However, the ground water tends to flow through some fairly tight clay in that direction. The high point of ground water at the MSWLF site is at least partially a following of the surface topography and influenced by direct recharge from any ponding which is not promptly removed. Attachment 5, Appendix E gives a more thorough analysis of ground water direction and rate of ground water flow.

The initial interpretation, based on available data and monitor well density and location, indicated a predominate flow to the north or west. Completion of monitor and observation wells in the current expansion program indicate a northeast flow direction. Later analysis shows that ground water flows slowly away from MSWLF in all directions. This is based on measurements of the top of the saturated zone as evidence by water levels in wells. The initial flow direction determined by REI when the landfill was started was toward the northeast.

4.1 Water Quality

The water quality of the Goliad is highly variable. Chloride contents in the wells sampled ranged from 94 to 9,100 mg/l, exceeding 250 mg/l in 60% of the samples. Sulfate content ranged from 26 to 4,630 mg/l. In Kleberg County, 33% of the samples exceeded 250 mg/l sulfate. Dissolved-solids content ranged from 601 to 49,900 mg/l. Over 75% exceeded 1,000 mg/l dissolved-solids. In summary, ground water that meets most of the quality standards of the U.S. Public Health Service is available from wells less than 1,000 feet deep in the Goliad Sand, Principally in southern Jim Wells County, the western one-half of Kleberg County, and in a few other relatively small areas throughout the report area. Shallow, moderately saline to very saline water overlies the fresh to slightly saline water at most places (Shafer, 1973). (See Figure 4.13)

The Beaumont Clay and Lissie Formation, undifferentiated, (Chicot Aquifer) yields small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. Test wells drilled near Riviera, 15 miles south of Kingsville, in southern Kleberg County show that in this area the shallow sands of the Beaumont and Lissie (Chicot) usually contain very saline water. This group is not considered a supply of useable water because of the highly mineralized water associated with formations in most places. The casings of many wells are cemented through these formations. (Shafer, 1973)

Water held in the Beaumont Clay and Lissie Formation, undifferentiated, (Chicot) is under water-table (unconfined) conditions. There were no recoverable aquifer tests from reference material on this formation as it occurs in the area of the site. This formation is not recognized as a useable source of ground water.

Historical ground water monitoring from in-place monitor wells indicates that the sulfates range approximately from 45 to 500 mg/l, chlorides from approximately 50 to 500 mg/l, and dissolved-solids from approximately 500 to 6,000 mg/l. Values of pH have consistently ranged between 7.00 and 8.00. More detailed analytical data from the ground water monitor wells at the site is given in Table 5.1 in Attachment 5.

4.2 Hydraulic Connection

No hydraulic connection was found between the uppermost fluvial-deltaic beds which will host the MSWLF and the deeper Chicot and Evangeline (Goliad) aquifers.

Deep elevations prepared from water well data located in the vicinity show that the Chicot aquifer is located approximately 200 feet below ground surface in the MSWLF vicinity. This data is confirmed by electric logs from two (2) deep uranium tests located on the southeast side and adjacent to the MSWLF acreage block (URI, Inc. well nos. 2001 & 2016). These wells exhibit the top of the main Chicot sand body at depths of 220 & 225' of measured depth, respectively. The top of the deeper Evangeline (Goliad) sands are found at approximately 500' MD. A confining clay, at the base of the fluvial–deltaic section which will host the MSWLF, is indicated in both URI wells to depths of 120' and 130' respectively. In addition, four deep borings (wells 21,23,24,25) at the MSWLF confirm that the "light olive green clay" is ubiquitous under the site with a minimum proven thickness of 38'.

TABLE 4.2.1

WELL #	ELEVATION (feet)	TOTAL DEPTH (feet)	TOP LT OLIVE GRN CLAY (ft.,+M.S.L.)	FOOTAGE OF CLAY
21	52.4	84	+6.4	38
23	49.5	86	+13.5	38
24	47.4	72	+15.4	40
25	61.1	88	+11.1	38

The "light olive green clay" is the aquiclude for the MSWLF facility.

4.3 Recharge

Recharge within a 5 mile radius is from downward percolation of surface water, infiltration from streams, impoundments and water retained in abandoned caliche pits. (Figure 4.14) Flow through the soils is very slow.

4.4 Water Use

A survey of, and for, water wells within a 1 mile radius of the MSWLF site was prepared by Agency Information Consultants (AIC). All known water wells within the survey area produce water for domestic use from the Evangeline Aquifer (Goliad Sand). Thirty one wells were identified in the survey area. (See Figure 4.15) Depth to the top of the perforated or screened interval varies from 524 feet to 726 feet, with an average depth of 621 feet. (See Figures 4.12 & 4.13) There are no known water wells completed in the Chicot aquifer for potable water. There are a few stock wells. The water from the Chicot is mostly very saline. This salinity causes casing corrosion problems with the good fresh water wells in the Goliad aquifer unless they are cemented properly through the Chicot.

APPENDIX C.7.3

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'FIGURE 5.16 BORING PLOT PLAN', PAGE 197 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

STATE OF TEXAS
JOSE C. GARZA
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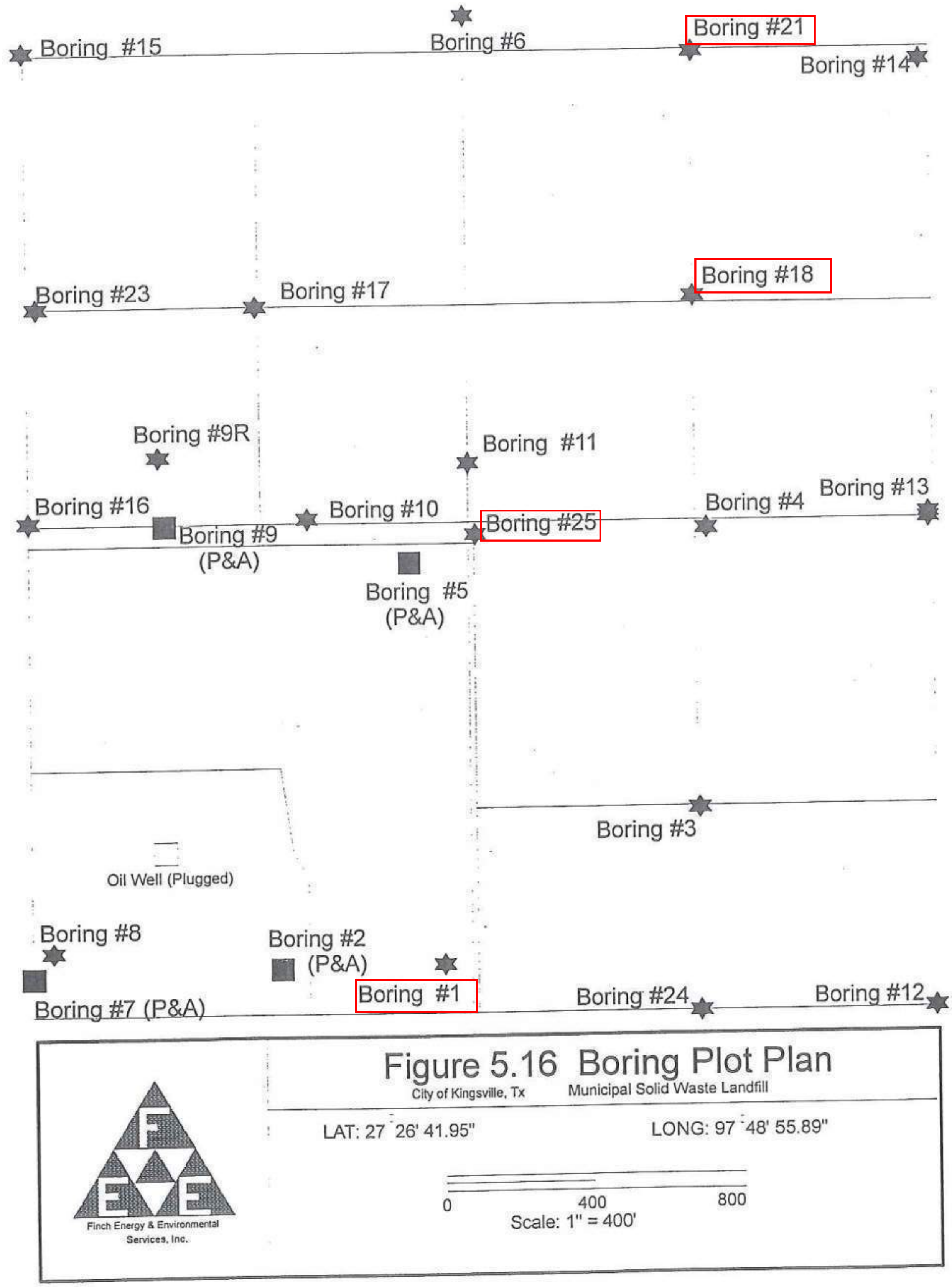

Figure 5.16 Boring Plot Plan
City of Kingsville, Tx
Municipal Solid Waste Landfill

APPENDIX C.7.4

‘CITY OF KINGSVILLE MSWLF-PERMIT 235-B ‘SUBSURFACE EXPLORATION RECORD B/W NO. 21’, PAGE 371 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

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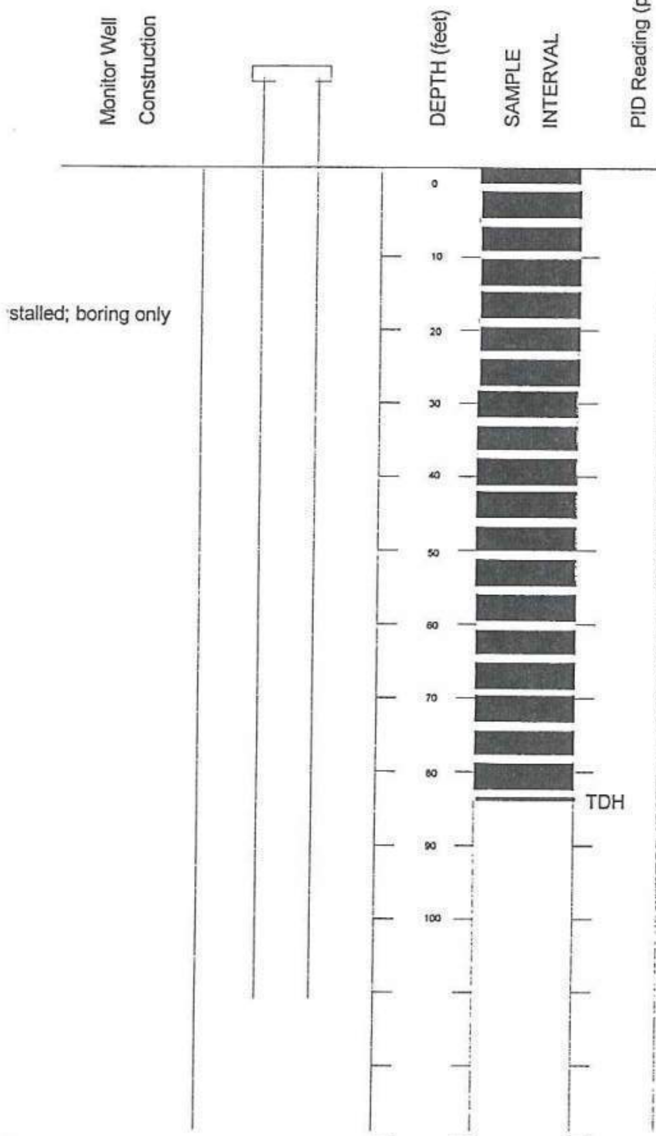
PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville	Boring/Well No.:	21
Project Name:	Kingsville Landfill	Date Drilled:	April 27, 1998
Project Location:	5 mi SE of City	Boring Method:	HOLLOW STEM AUGER
LAT: 27° 26' 09"	LONG: 97° 48' 47.6"	Sample Method:	Shelby Tube
MSWLF ID:	Permit #235-B	Surface Elevation:	52.41' MSL
		Depth to Water:	17.8' BGS
		Total Depth:	84' BGS
		Casing:	
		Screen:	
		Borehole Dia.:	6 inch
		Driller ID:	PSI - Craig Schena



SOIL CLASSIFICATION

Dark Brown Sand Clay - Topsoil
Caliche Bearing Channel (I)
Sand Filled Channel (II)
Sandy Clay
Clayey Sand (Clay Dune)
LT OLIVE GREEN CLAY

Water depth on Drilling = 25.0 ft. BGS

TOTAL DEPTH = 84 feet

APPENDIX C.7.5

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'SUBSURFACE EXPLORATION RECORD B/W NO. 18', PAGE 369 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

STATE OF TEXAS
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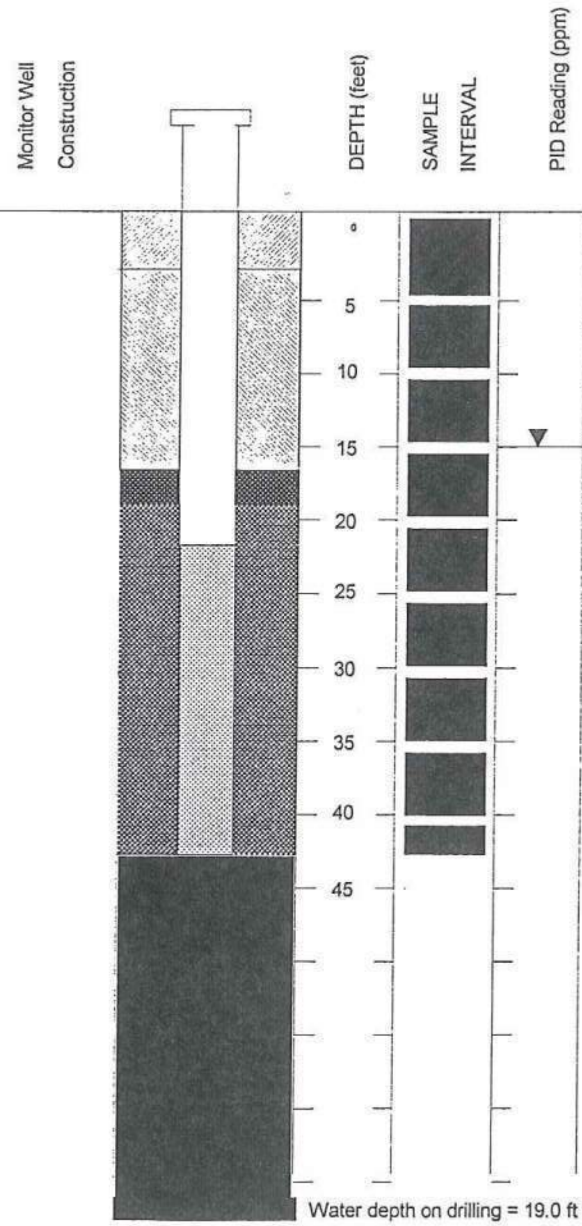
PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville	Boring/Well No.: 18
Project Name: Kingsville Landfill	Date Drilled: July 9, 1997
Project Location: 5 mi. SE of City	Boring Method: Hollow Stem Auger
LAT: 27° 27' 01.4" LONG: 97° 49' 04 "	Sample Method: 5 foot core barrel
MSWLF ID: Permit #235-B	Surface Elevation: 50.04' MSL
	Depth to Water: 15' BGS
	Total Depth: 42' BGS
	Casing: 2" S-40 PVC - 0-22' BGS
	Screen: 20' of 2" S-40 PVC - 22' BGS
	Borehole Dia.: 6 inches
	Driller: PSI - Craig Schena



SOIL CLASSIFICATION

DARK BROWN SANDY CLAY TOPSOIL

SAND FILLED CHANNEL (II)

SANDY CLAY
SILTY CLAY

Water depth on drilling = 19.0 ft BGS

TOTAL DEPTH = 42 ft.

APPENDIX C.7.6

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'SUBSURFACE EXPLORATION RECORD B/W NO. 25', PAGE 374 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

STATE OF TEXAS
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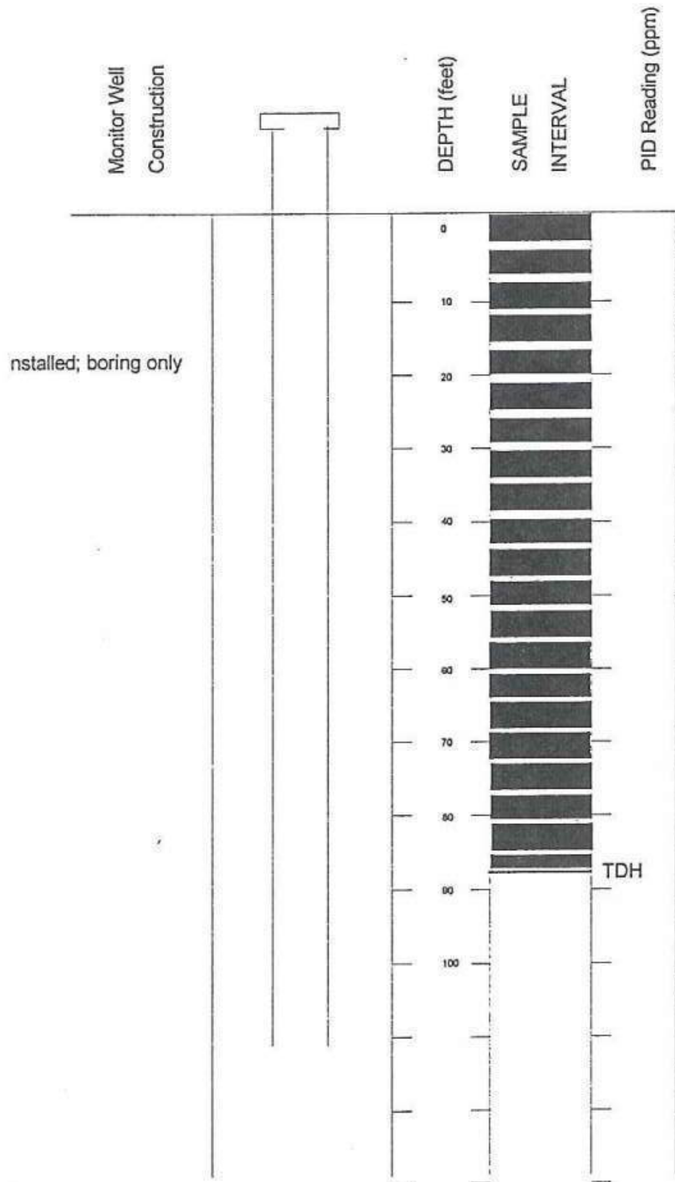
PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville	Boring/Well No.:	25
Project Name:	Kingsville Landfill	Date Drilled:	April 29, 1998
Project Location:	5 mi SE of City	Boring Method:	HOLLOW STEM AUGER
LAT: 27• 26' 55.2"	LONG: 97• 48' 41.8"	Sample Method:	SPLIT SPOON
MSWLF ID:	Permit #235-B	Surface Elevation:	61.12' MSL
		Depth to Water:	21.1' BGS
		Total Depth:	88' BGS
		Casing:	
		Screen:	
		Borehole Dia.:	6 inch
		Driller ID:	PSI - Craig Schena



SOIL CLASSIFICATION

TOP SOIL & DARK BROWN CLAY

CALICHE BEARING CHANNEL (I)

SAND FILLED CHANNEL (II)

SANDY CLAY

LT OLIVE GREEN CLAY

Water depth on Drilling = 31.0 ft. BGS

TOTAL DEPTH = 88 feet

APPENDIX C.7.7

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'SUBSURFACE EXPLORATION RECORD B/W NO. 1', PAGE 351 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

STATE OF TEXAS
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

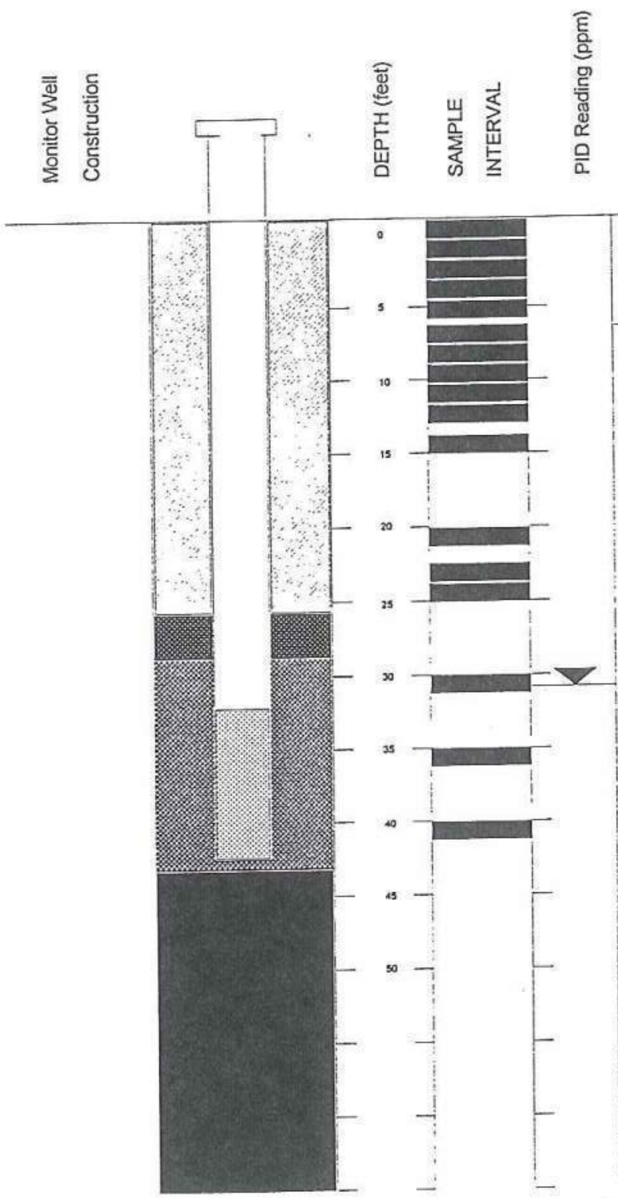
PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 26' 42.2" LONG: 97° 49' 10.6"
MSWLF ID: Permit #235-B

Boring/Well No.: 1
Date Drilled: June 19, 1984
Boring Method: Hollow Stem Auger
Sample Method: SHELBY TUBE & SPLIT SPOON
Surface Elevation: 59.25' MSL
Depth to Water: 31.0' BGS
Total Depth: 42' BGS
Casing: 2" S-40 PVC - 0-32' BGS
Screen: 10'of 2" S-40 PVC - 32' BGS
Borehole Dia.: 6 inch
Driller ID: TETCO



SOIL CLASSIFICATION

TOP SOIL & DARK BROWN CLAY

CALICHE, CLAY & SAND (I)

SILTY CLAY

Water depth on Drilling = 30.19ft. BGS

TOTAL DEPTH = 42 feet

APPENDIX C.7.8

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'X-SECTION LOCATION MAP', PAGE 68 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

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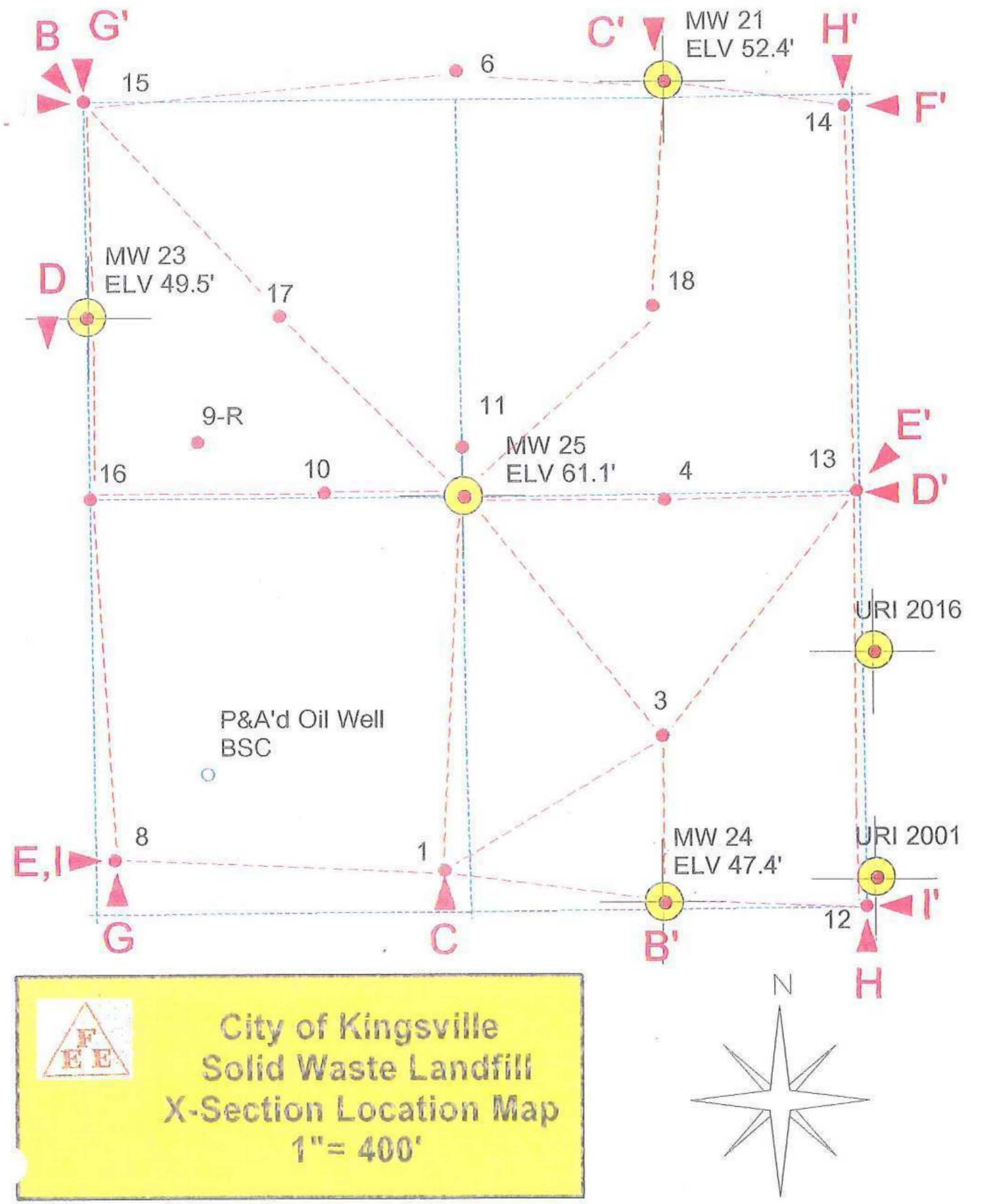

Page 68 from Permit 235-B Amendment Volume II of V

REVISION 1

APPENDIX C.7.9

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'X-SECTION C-C", PAGE 71 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

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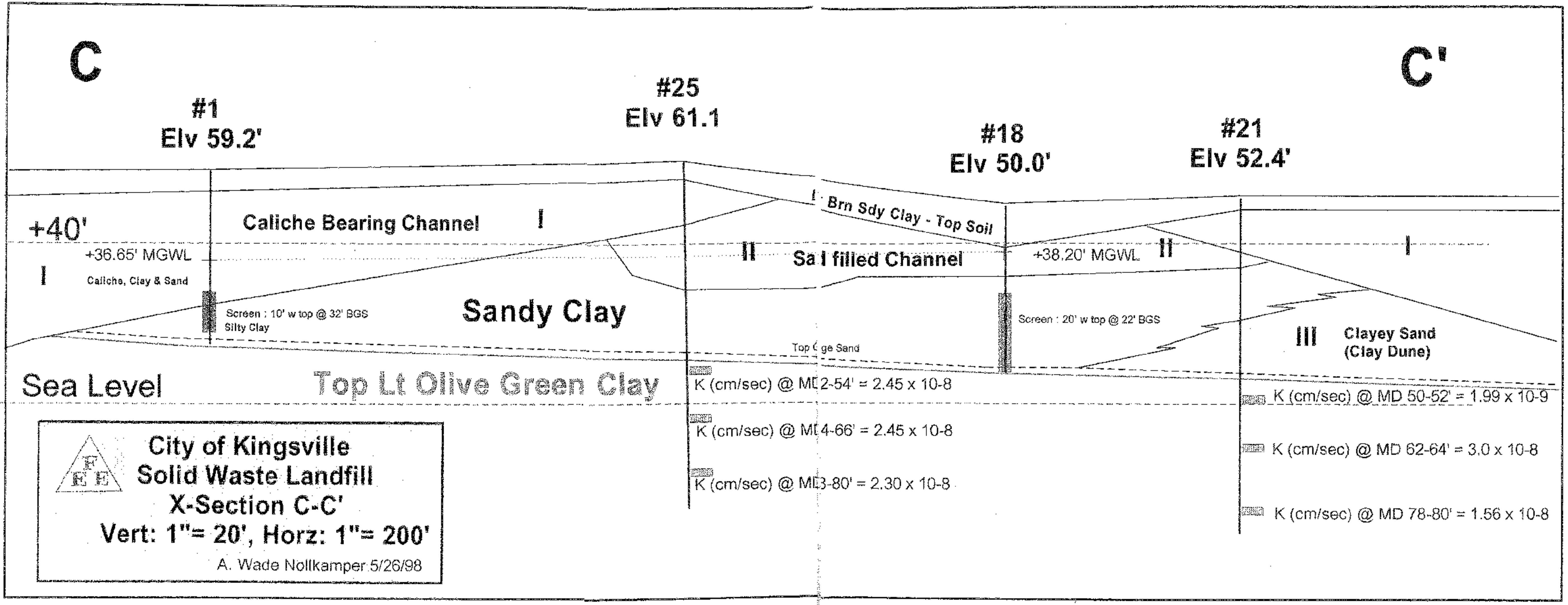

Page 71 from Permit 235-B Amendment Volume II of V

APPENDIX C.7.10

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'CORRELATION OF GEOLOGIC UNITS ALONG A-A KLEBERG AND SOUTHERN JIM WELLS COUNTIES'', PAGE 45 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

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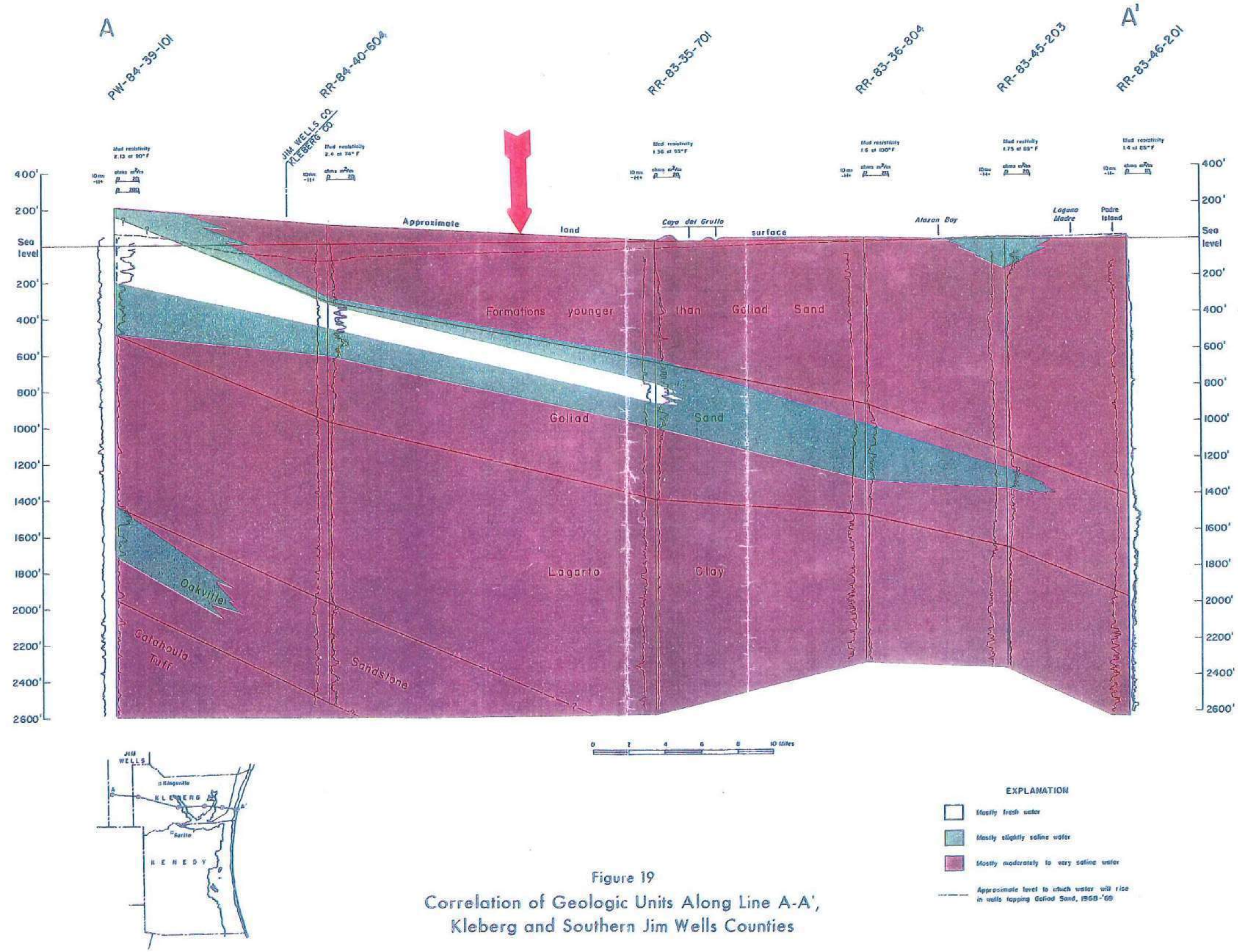

Figure 19
Correlation of Geologic Units Along Line A-A',
Kleberg and Southern Jim Wells Counties

Page 45 from Permit 235-B Amendment Volume II of V

APPENDIX C.7.11

'CITY OF KINGSVILLE MSWLF-PERMIT 235-B 'STRATIGRAPHIC AND HYDROGEOLOGIC SECTION I-I'', PAGE 43 FROM PERMIT 235-B AMENDMENT VOLUME II OF V

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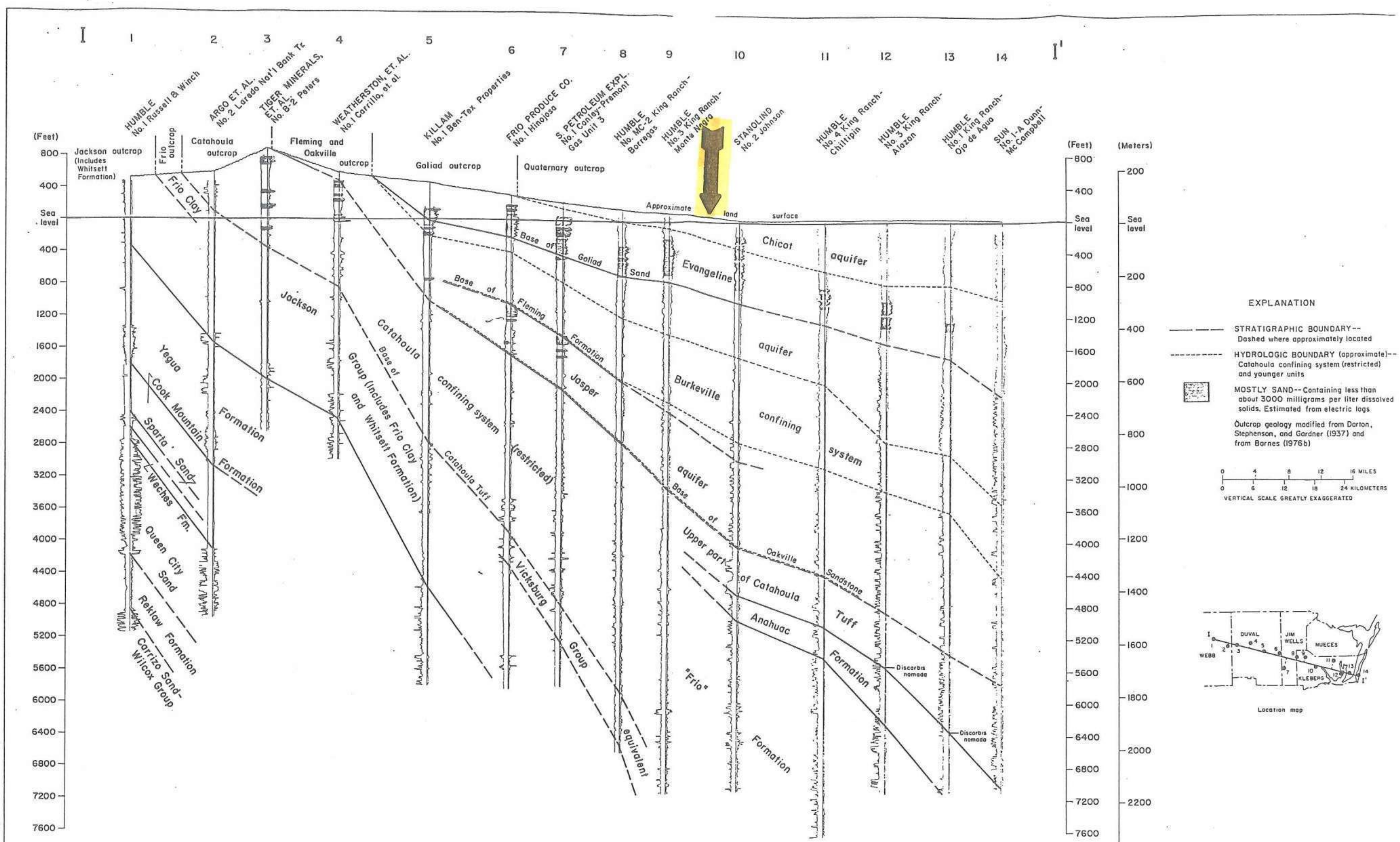

Figure 10
Stratigraphic and Hydrogeologic Section I-I'

Page 43 from Permit 235-B Amendment Volume II of V

APPENDIX D

CALCULATIONS OF THE DILUTION ATTENUATION FACTOR (DAF)

STATE OF TEXAS
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CALCULATIONS OF THE DILUTION ATTENUATION FACTOR

Example Calculation for the Interim Case with Alternative Liner

Result from MULTIMED model:

Chemical concentration at the point of compliance = 0.2943×10^{-4} mg/l
(see MULTIMED model output)

To find the resulting DAF, take the recipricol:

DAF= $1/0.2943 \times 10^{-4}$ mg/1
DAF= 33,979

Table 1

Location	Interim Case DAF	Closed Case DAF
Alternative Liner Location 1	33,979	85,106
Alternative Liner Location 2	57,471	201,288
Alternative Liner Location 3	80,645	282,566
Alternative Liner Location 4	286,533	1,003,814

Location	Interim Case DAF	Closed Case DAF
Overliner Location 1	18,797	65,833
Overliner Location 2	77,640	232,450
Overliner Location 3	158,253	473,934
Overliner Location 4	615,385	1,842,639

APPENDIX D.1

TYPICAL PROFILE-ALTERNATIVE LINER INTERIM LANDFILL DAF

STATE OF TEXAS
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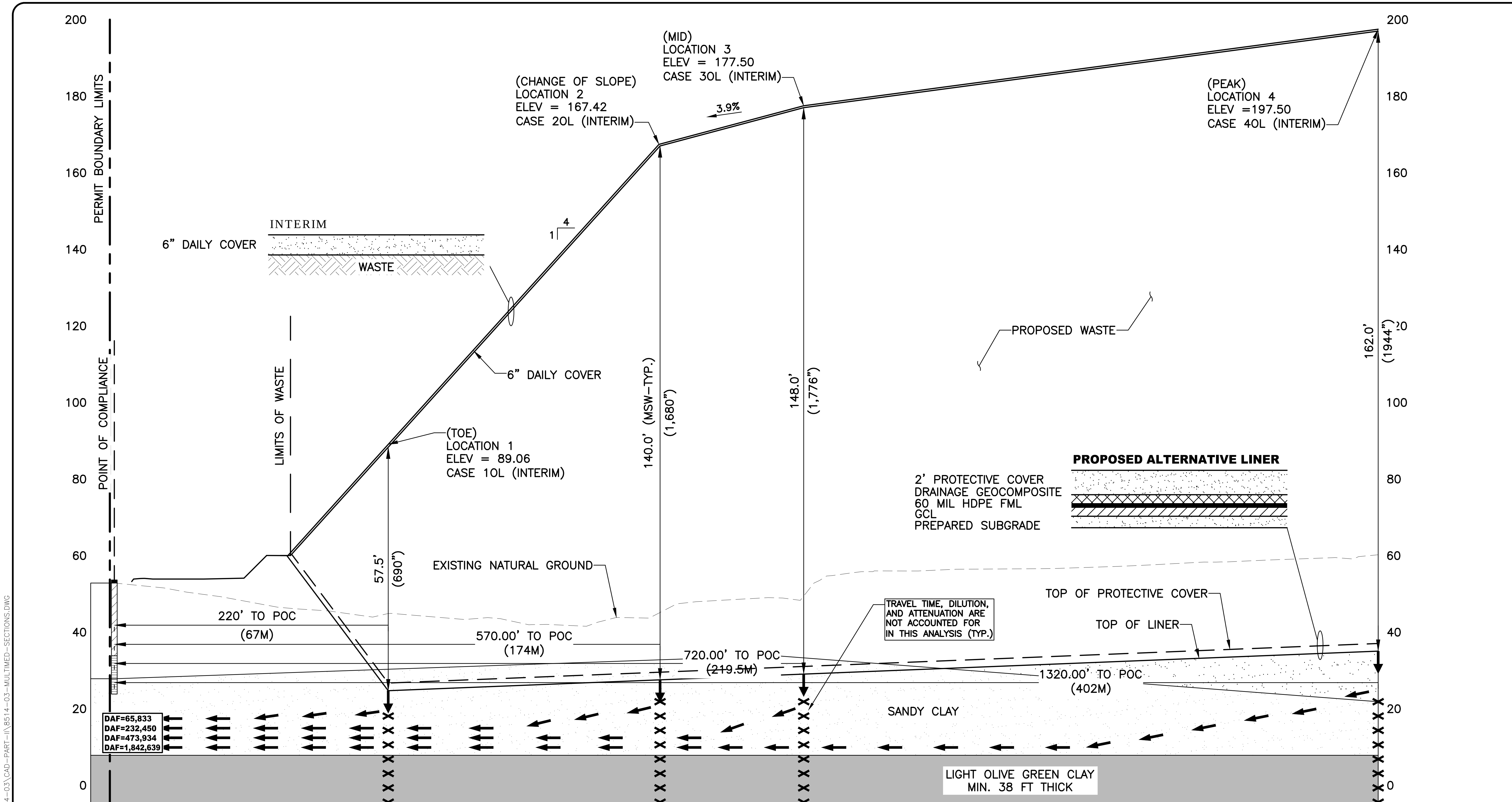

ALTERNATIVE LINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12×10^{-4} CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

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09/12/18
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER
INTERIM LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.1

APPENDIX D.2

TYPICAL PROFILE-ALTERNATIVE LINER CLOSED LANDFILL DAF

STATE OF TEXAS
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PROFESSIONAL ENGINEER
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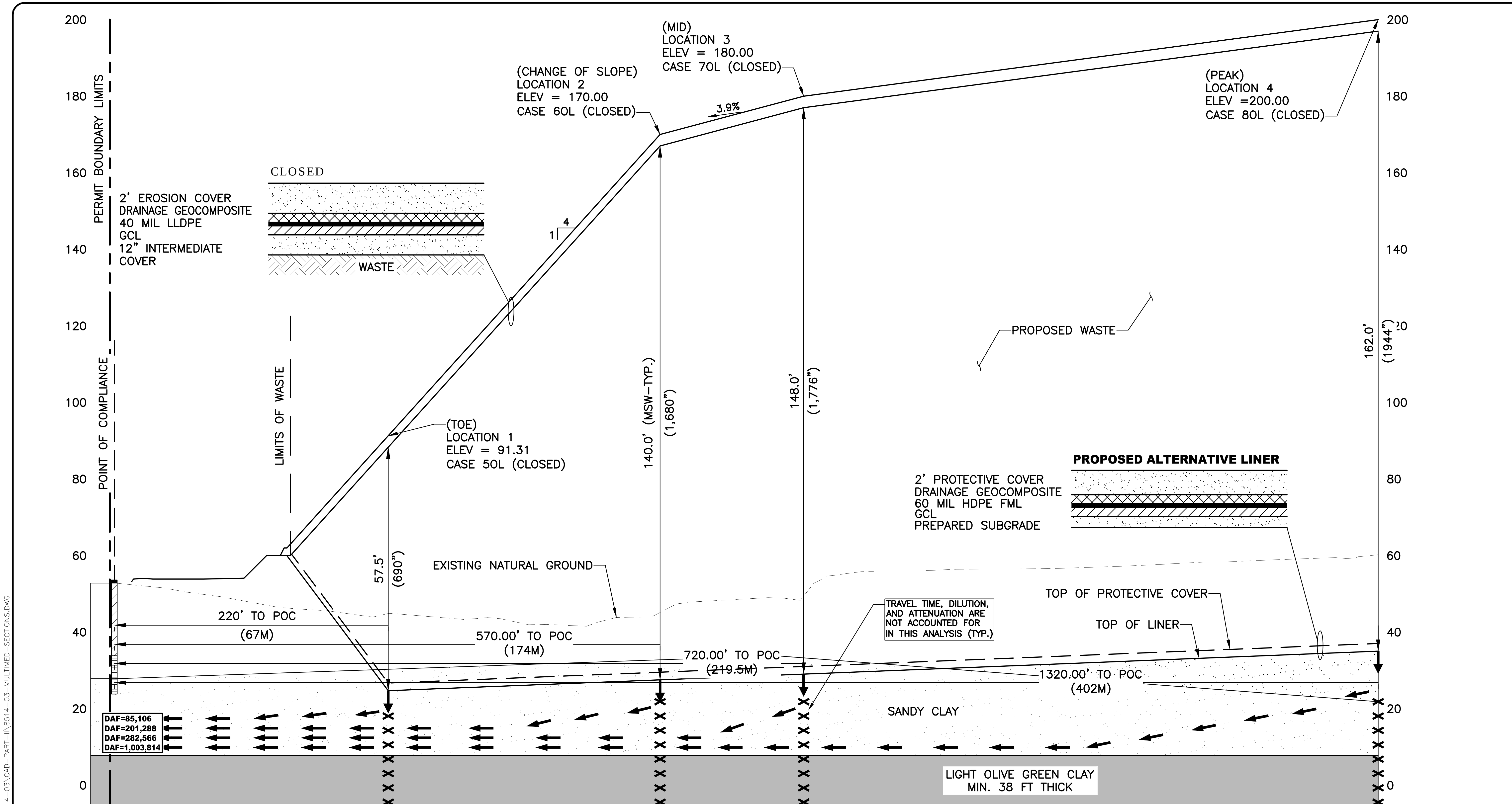

ALTERNATIVE LINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE ALTERNATIVE LINER.
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12×10^{-4} CM/SEC OR 130 M/YR
HYDRAULIC GRADIENT = i = 0.003125

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

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PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER
CLOSED LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.2

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APPENDIX D.3

TYPICAL PROFILE-ALTERNATIVE LINER AND OVERLINER INTERIM LANDFILL DAF

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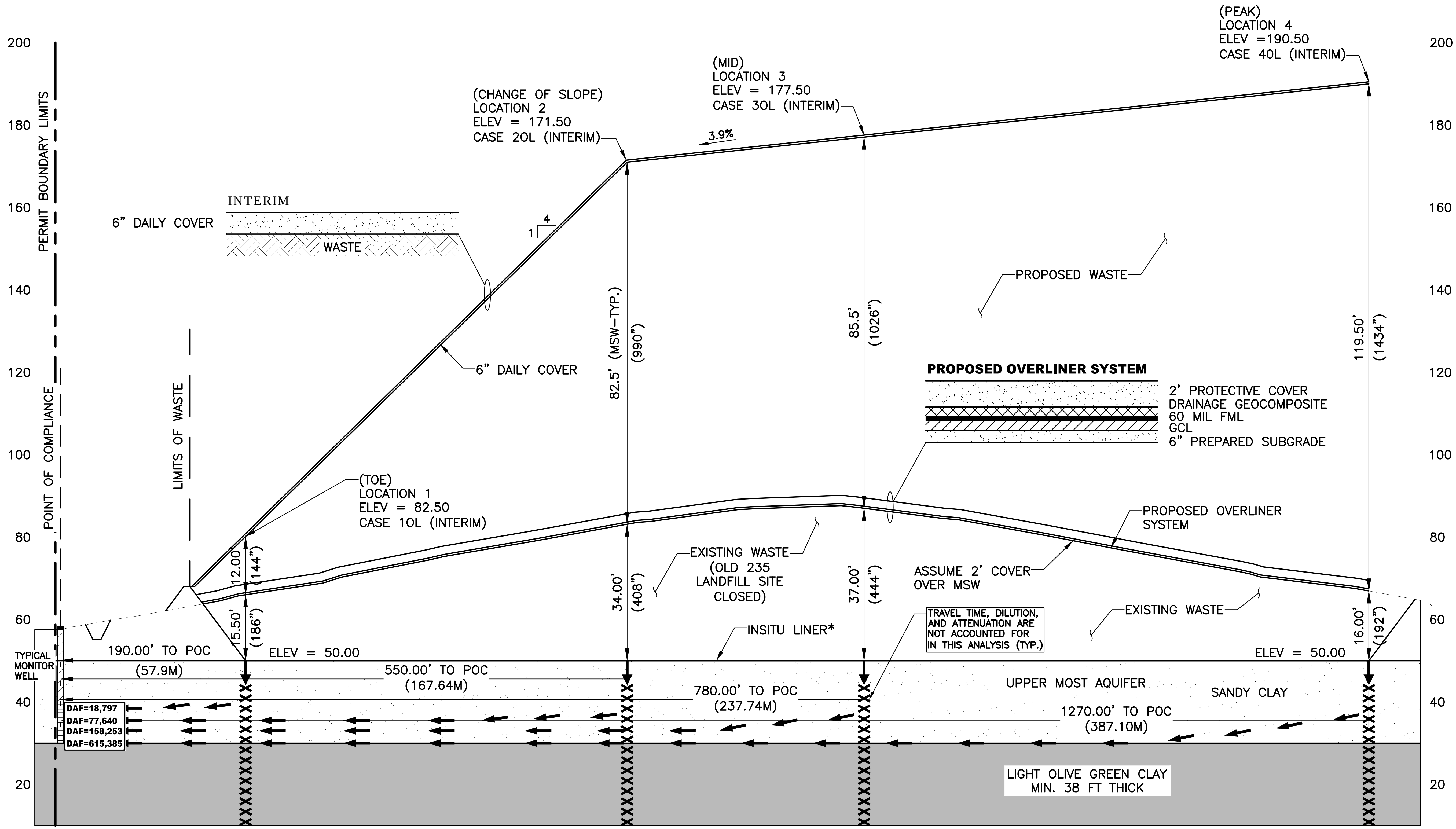
Jose C. Garza, P.E.



*OVERLINER DEMONSTRATION – INTERIM LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE INSITU LINER (ASSUMED EQUAL TO PERCOLATION THROUGH OVERLINER).
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12×10^{-4} CM/SEC
HYDRAULIC GRADIENT = i = 0.002

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

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09/12/18
Jose C. Garza, P.E.

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PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER AND OVERLINER INTERIM LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.3

APPENDIX D.4

TYPICAL PROFILE-ALTERNATIVE LINER AND OVERLINER CLOSED LANDFILL DAF

STATE OF TEXAS
JOSE C. GARZA
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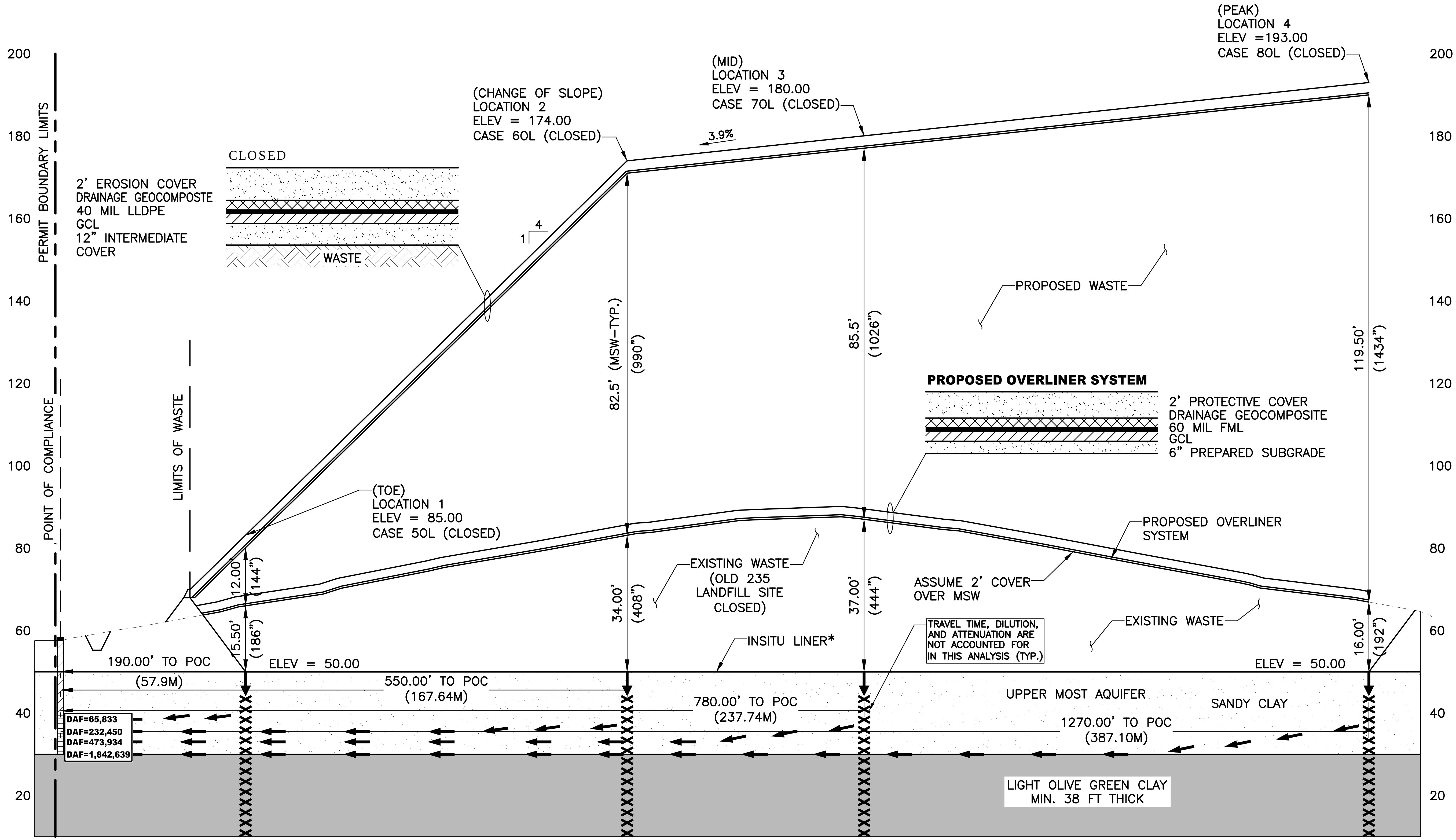

*OVERLINER DEMONSTRATION – CLOSED LANDFILL CONDITION

1. USE HELP TO MODEL PERCOLATION THROUGH THE INSITU LINER (ASSUMED EQUAL TO PERCOLATION THROUGH OVERLINER).
2. USE MULTIMED TO CALCULATE THE DILUTION ATTENUATION FACTOR (DAF).

MULTIMED INFORMATION

AVERAGE AQUIFER THICKNESS = 32.81FT (10M)
HYDRAULIC CONDUCTIVITY = 4.12×10^{-4} CM/SEC
HYDRAULIC GRADIENT = i = 0.002

NOTES:

1. EVANGELINE AQUIFER (500 FT BELOW GROUND SURFACE) (FRESH)
2. CHICOT AQUIFER (220 FT BELOW GROUND SURFACE)

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JOSE C. GARZA
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LICENSED PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 09/12/2018

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PART III, ATTACHMENT 5, APPENDIX D
TYPICAL PROFILE-ALTERNATIVE LINER AND OVERLINER CLOSED LANDFILL DAF
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.5-D.4

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APPENDIX E

LEACHATE DATA

STATE OF TEXAS
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LEACHATE DATA

An initial concentration (C_0) equal to 1.0 mg/L was used for MULTIMED modeling, as detailed in Input Leachate Requirements (page 23) of the TCEQ's *Alternate Liner Design Handbook (1993)* .

APPENDIX F

MULTIMED MODEL OUTPUT

STATE OF TEXAS
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APPENDIX F.1

MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1- LOCATION 1

STATE OF TEXAS
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Jose C. Garza, P.E.

CASE1

1 U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

Case 1

Location 1
Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

1

			CASE1				
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00	

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Infiltration rate	m/yr	CONSTANT	0.128E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	67.0	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2943E-04

APPENDIX F.2

MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2

STATE OF TEXAS
JOSE C. GARZA
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09/12/18
Jose C. Garza, P.E.

```
                                                              CASE2
1                    U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                                E X P O S U R E   A S S E S S M E N T

                                   M U L T I M E D I A   M O D E L

                                  MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 Case 2

 Location 2
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                      Saturated zone model
 Run was                            DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
                                        CHEMICAL SPECIFIC VARIABLES
```

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

CASE2

Not currently used	CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.179E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	174.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1740E-04

APPENDIX F.3

MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3-LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE3

1 U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

Case 3

Location 3
Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

CASE3

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.179E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	219.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1240E-04

APPENDIX F.4

MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 4-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE4

1 U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1
Run options
--- -------

Case 4

Location 4
Chemical simulated is DEFAULT CHEMICAL

Option Chosen Saturated zone model
Run was DETERMIN
Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

CASE4

Not currently used	CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.179E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	402.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.3490E-05

APPENDIX F.5

MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1

STATE OF TEXAS
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09/12/18
Jose C. Garza, P.E.

CASE5

1 U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

Case 5

Location 1

Chemical simulated is DEFAULT CHEMICAL

Option Chosen	Saturated zone model
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

CASE5

Not currently used	CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	67.0	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1175E-04

APPENDIX F.6

MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2

STATE OF TEXAS
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09/12/18
Jose C. Garza, P.E.

CASE6

1 U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

Case 6

Location 2
Chemical simulated is DEFAULT CHEMICAL

Option Chosen	Saturated zone model
Run was	DETERMIN
Infiltration input by user	
Run was steady-state	
Reject runs if Y coordinate outside plume	
Reject runs if Z coordinate outside plume	
Gaussian source used in saturated zone model	

1
1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

CASE6

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	174.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.4968E-05

APPENDIX F.7

MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7-LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE7

```
1                    U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                              E X P O S U R E   A S S E S S M E N T

                                  M U L T I M E D I A   M O D E L

                                  MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 Case 7

 Location 3
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                      Saturated zone model
 Run was                            DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

		CASE7				
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	219.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.3539E-05

APPENDIX F.8

MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 8-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE8

1 U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.01, June 1991)

1
Run options
--- -------

Case 8

Location 4
Chemical simulated is DEFAULT CHEMICAL

Option Chosen	Saturated zone model
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

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                                        CASE8
Not currently used                    CONSTANT       -999.     -999.      0.000E+00   1.00
1
                               SOURCE SPECIFIC VARIABLES
```

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.310E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	402.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.9962E-06

APPENDIX F.9

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER INTERIM CASE 1OL-LOCATION 1

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

```
                                                          CASE1OL
1                         U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                                       E X P O S U R E   A S S E S S M E N T

                                         M U L T I M E D I A   M O D E L

                                       MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 CASE1OL

 Location 1
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                     Saturated zone model
 Run was                           DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

CASE1OL

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.179E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	58.0	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5320E-04

APPENDIX F.10

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER INTERIM CASE 2OL-LOCATION 2

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE2OL

1 U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options
--- -------

CASE2OL

Location 2
Chemical simulated is DEFAULT CHEMICAL

Option Chosen	Saturated zone model
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1
1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

CASE2OL

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.153E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	168.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1288E-04

APPENDIX F.11

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER INTERIM CASE 3OL-LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE3OL

```
1                U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                              E X P O S U R E   A S S E S S M E N T

                                 M U L T I M E D I A   M O D E L

                                MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 CASE3OL

 Location 3
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                     Saturated zone model
 Run was                           DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

CASE3OL

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.153E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	238.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.6319E-05

APPENDIX F.12

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER INTERIM CASE 4OL-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
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LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

```
                                          CASE4OL
1                   U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                              E X P O S U R E   A S S E S S M E N T

                                 M U L T I M E D I A   M O D E L

                               MULTIMED  (Version 1.01, June 1991)
1
 Run options
 --- -------

 CASE4OL

 Location 4
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                     Saturated zone model
 Run was                           DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

CASE4OL

Not currently used	CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.153E-06	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	387.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1625E-05

APPENDIX F.13

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER CLOSED CASE 5OL-LOCATION 1

STATE OF TEXAS
JOSE C. GARZA
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LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE5OL

1 U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

1

Run options

--- -------

CASE5OL

Location 1

Chemical simulated is DEFAULT CHEMICAL

Option Chosen	Saturated zone model
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1

1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

CASE50L

Not currently used	CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	58.0	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1519E-04

APPENDIX F.14

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER CLOSED CASE 6OL-LOCATION 2

STATE OF TEXAS
JOSE C. GARZA
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LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE6OL

1 U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.01, June 1991)

1
Run options
--- -------

CASE6OL

Location 2
Chemical simulated is DEFAULT CHEMICAL

Option Chosen	Saturated zone model
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

CASE60L

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	168.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.4302E-05

APPENDIX F.15

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER CLOSED CASE 7OL-LOCATION 3

STATE OF TEXAS
JOSE C. GARZA
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

CASE7OL

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1                    U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                                  E X P O S U R E   A S S E S S M E N T

                                      M U L T I M E D I A   M O D E L

                                   MULTIMED  (Version 1.01, June 1991)
1
 Run options
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 CASE7OL

 Location 3
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                       Saturated zone model
 Run was                             DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

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CASE70L

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	STD DEV	LIMITS MIN	MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	238.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2110E-05

APPENDIX F.16

MULTIMED OUTPUT FOR ALTERNATIVE LINER/OVERLINER CLOSED CASE 8OL-LOCATION 4

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

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                                                                  CASE8OL
1                              U. S.   E N V I R O N M E N T A L   P R O T E C T I O N   A G E N C Y

                                              E X P O S U R E   A S S E S S M E N T

                                                 M U L T I M E D I A   M O D E L

                                              MULTIMED  (Version 1.01, June 1991)
1
 Run options
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 CASE8OL

 Location 4
 Chemical simulated is DEFAULT CHEMICAL


 Option Chosen                         Saturated zone model
 Run was                               DETERMIN
 Infiltration input by user
 Run was steady-state
 Reject runs if Y coordinate outside plume
 Reject runs if Z coordinate outside plume
 Gaussian source used in saturated zone model
1
1
```

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	20.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry`s law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

Page 1

CASE8OL

Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

1

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.511E-07	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.486E+06	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.368E-01	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.430	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	10.0	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.200E-02	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	21.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.20	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.300E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	387.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.5427E-06

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 6

FACILITY SURFACE WATER

DRAINAGE REPORT

ATTACHMENT 6

FACILITY SURFACE WATER DRAINAGE REPORT

STATE OF TEXAS
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Jose C. Garza, P.E.

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For Pages i - iii

APPENDIX 6B
SITE POST-DEVELOPMENT CONDITIONS

ATTACHMENT 6

1.0 INTRODUCTION

The City of Kingsville Landfill (Kingsville Landfill) is located in Kleberg County, Texas, at the northeast corner of the intersection of Farm to Market Road 2619 and County Road 2130. The northern boundary of the property is approximately 2,811 feet from FM 1717, while the eastern boundary is approximately 1,300 feet from N. County Road 1070 (See Part I, Attachment 2, Figure I.1 - Site Location Map).

The Kingsville Landfill has been in existence since February 1977 and is intended to provide waste disposal for residences and businesses in Kleberg County and surrounding Texas counties. The nearest community is the City of Kingsville, whose city limits are approximately 1.45 miles from the northeast corner of the landfill boundary. The facility has undergone two permit amendments to date allowing it to extend its initial permit boundaries, and increase the permitted maximum elevation (Refer to Part I, Attachment 1, Section 1.2 – Permit History).

The existing Kingsville Landfill includes a scale house, an office building, a maintenance shop, enclosed within a perimeter fence. These facilities will continue to be operational for the life of the landfill. No new buildings or infrastructure improvements will be constructed as part of the proposed permit amendment.

This Facility Surface Water Drainage Report (FSWDR) for the City of Kingsville Landfill TCEQ Permit MSW 235-C has been designed to collect, route, retain, and detain stormwater runoff from the facility. The Plan for the landfill contains design features that follow best management practices that meet or exceed the regulations applicable to stormwater management outlined in Title 30 of the Texas Administrative Code (30 TAC), Section 330, Municipal Solid Waste as follows;

Rule §330.63 Contents of Part III of the Application

(c) Facility surface water drainage report. The owner or operator of a municipal solid waste (MSW) facility shall include a statement that the facility design complies with the requirements of §330.303 of this title (relating to Surface Water Drainage for Municipal Solid Waste Facilities). Additionally, applications for landfill and compost units shall include a surface water drainage report to satisfy the requirements of Subchapter G of this chapter (relating to Surface Water Drainage)…

Rule §330.303 Surface Water Drainage for Municipal Solid Waste Facilities *(a) A facility must be constructed, maintained, and operated to manage run-on and runoff during the peak discharge of a 25-year rainfall event and must prevent the off-site discharge of waste and feedstock material, including, but not limited to, in-process and/or processed materials.*

(b) Surface water drainage in and around a facility shall be controlled to minimize surface water running onto, into, and off treatment area.

Rule §330.305 Additional Surface Water Drainage Requirements for Landfills

(a) Existing or permitted drainage patterns must not be adversely altered.

(b) The owner or operator shall design, construct, and maintain a run-on control system capable of preventing flow onto the active portion of the landfill during peak discharge from at least a 25-year rainfall event.

(c) The owner or operator shall design, construct, and maintain a runoff management system from the active portion of the landfill to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

(d) The landfill design must provide effective erosional stability on top dome surfaces and external embankment side slopes during all phases of landfill operation, closure, and post-closure care in accordance with the following.

(e) Dikes, embankments, drainage structures, or diversion channels sized and graded to handle the design runoff must be provided. The slopes of the sides and toe will be graded in such a manner as to minimize the potential for erosion. The surface water protection and erosion control practices must maintain low non-erodible velocities, minimize soil erosion losses below permissible levels, and provide long-term, low maintenance geotechnical stability to the final cover.

Rule §330.307 Flood Protection for Landfills

(a) The facility shall be protected from flooding by suitable levees constructed to provide protection from a 100-year frequency flood and in accordance with the rules of the commission relating to levee improvement districts and approval of plans for reclamation projects or the rules of the county or city having jurisdiction under Texas Water Code, §16.236, as implemented by Chapter 301, Subchapter C of this title (relating to Approval of Levees and Other Improvements).

(b) Flood protection levees must be designed and constructed to prevent the washout of solid waste from the facility.

The property boundary is 196.88 acres, the proposed updated Permit boundary is 176.33 acres, and the proposed waste footprint is 121.30 acres.

The pre-development calculations represent conditions at the site prior to any landfill development. The post-developed condition calculations represent conditions at the site after the landfill has been closed, final cover has been placed, and all components of the designed drainage system have been established. The existing City of Kingsville Landfill TCEQ Permit MSW 235-B has been referenced and utilized to evaluate the site pre-development conditions and the site post-development conditions in Appendices 6A and 6B, respectively.

Stormwater modeling has been completed with the software program HydroCAD. HydroCAD is a computer aided design program used to model hydrology and hydraulics of stormwater using either TR-20 or TR-55 procedures developed by the Soil Conservation Service (now the Natural Resource Conservation Service). HydroCAD was selected for the modeling software due to the large number of drainage areas and stormwater control devices at the landfill facility.

2.0 EXISTING SURFACE WATER DRAINAGE

The City of Kingsville Landfill TCEQ Permit MSW 235-C (existing City of Kingsville Landfill TCEQ Permit MSW 235-B) is located on uplands south of Santa Gertrudis Creek. The overall property consists of gently undulating grasslands with limited forest cover. The property generally slopes to the northeast with no major topographic features. The nearest 100-year floodplain is located to the northeast of the site along Santa Gertrudis Creek. The existing Kingsville Landfill is not located within the 100-year floodplain as designated by the Federal Emergency Management Agency (FEMA) Firm Community Panel Numbers 48273C03205E and 48273C0325E included in Appendix 6B.17. Surrounding land use is predominantly agricultural.

3.0 PROPOSED SURFACE WATER MANAGEMENT SYSTEM

The proposed surface water management system will utilize stormwater best management practices (BMPs). The landfill will be developed as an above ground hill and designed to allow stormwater runoff to be collected in diversion berms or swales located near the upper grade break and on the landfill slopes. Stormwater will then be conveyed to let-down structures or chutes down the side slopes to the perimeter channel system and into either a retention pond or detention pond. The perimeter channels will be constructed prior to placing fill above ground in each adjacent landfill sector. The perimeter channels will be vegetated. Erosion protection will be provided at critical discharge locations where velocities are five feet per second (5 ft./sec.) or greater such as chutes or culvert discharges. These areas will be lined with concrete articulated block or flexible revetment system. Energy dissipaters will be required downstream of the chutes within the final cover area where flow enters unlined channels.

During landfilling operations, stormwater controls will be implemented to minimize run-on from flowing into the active portion of the site. Contaminated runoff from the working face will be contained with stormwater controls as well. This is shown in Appendix 6B.15.14 Working Face Containment and Diversion Berms.

The SWPPP has been prepared according to the requirements of the *Texas Commission on Environmental Quality (TCEQ) Permit Number TXR050000 – General Permit to Discharge Under the Texas Pollutant Discharge Elimination System (TPDES) – Multi-Sector General Permit (MSGP),* effective on August 14, 2016. The MSGP classifies industrial activities by Sectors containing various Standard Industrial Classification (SIC) Codes. The City of Kingsville Landfill falls under Sector L: Landfills and Land Application Sites under Activity Code LF – Landfills, Land Application Sites, and Open Dumps that Receive or Have Previously Received Industrial Waste under subtitle C of RCRA and including those that are subject to regulation under subtitle D of RCRA. Stormwater discharges at the facility were previously authorized by the submittal of a Notice of Intent (NOI) filed on November 26, 2001 and renewed on October 10, 2006 and November 3, 2011. Currently, discharges are authorized by an NOI submitted in November 2016. A copy of the current NOI and the MSGP are included in Appendix A. Discharges from the facility are not received by a Municipal Separate Storm Sewer System (MS4). Eventually stormwater discharges from outfalls on the west side of the facility flow into Santa Gertrudis Creek, then San Fernando Creek (TCEQ Classified Segment 2492A), and then Baffin Bay/Alazan Bay/Cayo del Grulla/Laguna Salada (TCEQ Classified Segment 2492A). Eventually stormwater discharges from outfalls on the south side of the facility flow into Baffin Bay/Alazan Bay/Cayo del Grulla/Laguna Salada (TCEQ Classified Segment 2492A).

The facility has been designed to prevent discharge of pollutants into the waters of the State or waters of the United States, as defined by the Texas Water Code and the Federal Clean Water Act.

All onsite surface drainage features are designed to collect and route stormwater through diversion berms, chutes, perimeter channels, and into three storage ponds. The three storage ponds are Pond A, Pond B, and Pond C. Pond A and Pond C are retention ponds and Pond B is a detention pond. The only stormwater discharge from the site will be at

Pond B via two drainage culverts. This is further discussed in Section 5.0 Site Post-Development Conditions.

4.0 SITE PRE-DEVELOPMENT CONDITIONS

The pre-development drainage characteristics of the landfill site are described in Appendix 6A-Site Pre-Development conditions. A summary of the pre-development conditions is summarized in Appendix 6A.1, 25 Year Pre-Development Conditions Summary Table. Pre-development drainage information from the City of Kingsville Landfill Permit Amendment 235-B, Attachment 6, Appendix 6A Pre-Development Conditions (Table of Contents and Pages 1-32) contained in Appendix 6A.2.1, Pre-Development Drainage Map Solid Waste Landfill Permit 235-B Amendment Figure 1 contained in Appendix 6A.2.2, and Pre-Development Slope Map Solid Waste Landfill Permit 235-B Amendment Figure A-2 contained in Appendix 6A.2.3 were all used to develop the summary table in Appendix 6A.1.

The City of Kingsville Landfill Permit Amendment 235-B illustrates that Watershed A contains drainage areas PA1, PA2, and PA3; Watershed B contains drainage areas PB1, PB2, and PB3; and Watershed C contains areas PC1, PC2, and PC3 for existing permitted conditions. A HydroCad model was developed to simulate the results from the pre-development drainage conditions using the same data. Results using HydroCAD were similar. HydroCAD results are shown in Appendix 6A.2.4 (HydroCAD Model Pre-Development Conditions 25 Year Existing Permitted Conditions). In addition, a separate HydroCAD model was developed to include a proposed updated boundary as shown in Appendix 6A.2.7 (Pre-Development Drainage Map Solid Waste Landfill Permit 235-B Amendment Figure A-1 (Updated Permitted Conditions)). The proposed updated permit boundary introduces drainage area PB4 located near the east boundary of the permit boundary. HydroCAD results are shown in Appendix 6A.2.5 (HydroCAD Model Pre-Development Conditions 25 Year Updated Permitted Conditions).

Results contained in the Appendix 6A.1 summary table illustrate that the combined total for the 25 year pre-development condition at the northwest corner of the landfill site adjacent to F.M. 2619 in the roadside ditch is approximately 49.3 cubic feet per second (cfs) to 51.1 cfs for both the existing permitted conditions and proposed updated conditions. The only stormwater discharge from the permit boundary will be at this northwest location (Pond B) via two (2) 21” x 128’ reinforced concrete pipe (RCP) culverts with a discharge of 33.7 cfs for the 24 hr duration-25 year frequency storm and 42.5 cfs for the 24 hr duration-100 year frequency storm which is less than the combined 25 year pre-development flows as described in this section and in section 5.0 Site Post-Development Conditions.

5.0 SITE POST-DEVELOPMENT CONDITIONS

The post-development surface water management system design will include landfill final cover, a system of diversion berms or swales, let-down structures or chutes, perimeter channels, drainage culverts, two retention ponds and one detention pond. Onsite stormwater surface runoff from final cover will sheet flow to the diversion berms constructed at vertical intervals down the slope of the landfill. The diversion berms will convey runoff into the chutes that will convey the stormwater runoff down the slope of the landfill and into the perimeter channel drainage system. The chutes will be lined with concrete articulated block or flexible revetment system. Channels that exhibit velocities of 5 ft/sec or more will be also be lined with the same system. Collector channels along the landfill perimeter road at the northeast will collect landfill surface stormwater runoff not collected in the chutes. The stormwater will be conveyed to post inlets which will direct it across the road to Pond C via drainage culverts. In other areas to the east and south of the landfill, stormwater runoff not collected by the chutes will sheetflow into the adjacent perimeter channels which will in turn be directed into either Pond A or Pond C. At the north and northwest areas of the landfill, runoff not collected in the chutes will sheetflow into Pond B. The perimeter landfill channel system is divided into four segments; East, South, North, and West. The East channel system flows into Pond C, the South and West flow into Pond A, and the North flows into Pond C. Surface water from outside the boundary of the landfill will continue to be collected or directed as shown in Section 4.0 Site Pre-Development Conditions via existing roadside ditches along FM 2619 and C.R. 2130 that border the property. All surface stormwater runoff will be contained onsite with retention Ponds A and C with the exception of a discharge at Pond B. This discharge is less than the pre-development condition and post-development condition as shown in Appendices 6B.8.1 (Portion of Attachment 6 Groundwater and Surface Water Protection Plan (Pre-Development/Post Development Drainage Conditions and Design [Annotated], 6B.8.2 (Portion of Appendix 6A-Pre-Development Conditions (Figure A-1 Pre-Development Drainage Map) [Annotated]), 6B.8.3 (Portion of Appendix 6B-Final Development Conditions (Figure B-1 Final Development Drainage Map) [Annotated]), and 6B.8.4 (Portion of Appendix 6C Detention Ponds and Discharge Culverts (25-Year Storm Strategy/Comparative Summary of Peak Flow) [Annotated].

5.1 RAINFALL

Appendix 6B.1 USGS Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas-Depth of Precipitation for 25 Yr-24 Hr and 100 Yr-24 Hr [Annotated] was used to determine the rainfall depth at the site location. 8.7 inches and 11.5 inches was selected for the 25 Yr-24 Hr and 100 Yr-24 storms, respectively. These values were used for modeling purposes.

5.2 SOIL GROUPS AND FINAL DRAINAGE AREAS

Appendix 6B.2 contains Table 6B-1 Hydrologic Soils Groups for On-Site Soils (from NRCS, 2015) that was used to determine the hydrologic soil group. This Table indicates that the soil is predominantly a clay loam and sandy loam. It also lists the drainage area designations and areas in acres. The total onsite drainage areas are approximately 164.60 acres.

5.3 Time of Concentration (Tc) Values for Landfill Top/Slope Drainage Areas

Appendix 6B.3 illustrates values for the time of concentration (tc) at the top and slope drainage areas of the landfill. A conservative value of tc=10 min was used at the slopes.

5.4 HYDROCAD MODEL

The computer model HydroCAD was used to develop discharge rates, volumes, and velocities for the 24-hour duration, 25-year and 100-year storm frequencies. All drainage elements were modeled using HydroCAD. The HydroCAD stormwater model used the following analysis methods:

Runoff Calculation Method:	SCS TR-20
Reach Routing Method:	Storage-Indication Routing Method (also known as Modified-Puls Method)
Pond Routing Method:	Storage-Indication Routing Method (also known as Modified-Puls Method)
Storm Distribution:	SCS Type III-24-hour storm
Unit Hydrograph:	SCS

The post-development models are in Appendices 6B.4 (HydroCad Model Post Development-25 Year) and Apppendix 6B.5 (HydroCAD Model Post Development-100 Year). Cross sections are shown in the models for perimeter channels, collector channels, and chutes with average depths at peak storage. Peak elevations and storage are shown for Pond A, Pond B, and Pond C. A summary of the results are described below in sections 5.5 PONDS AND 5.7 PERIMETER CHANNELS, COLLECTOR CHANNELS, AND CHUTES. Typical drainage cross sections are shown in Appendix 6B.18. The analyses meet or exceed state and federal requirements for landfills.

5.5 PONDS

A HydroCAD pond results summary for the post-development 24-hour duration, 25-year & 100-year storm frequencies are in Appendices 6B.6 (HydroCAD Model

Post Development 25 Year Pond Summary) and 6B.7 (HydroCAD Model Post Development 100 Year Pond Summary). The post-development drainage plan for the 25 year and the 100 year are in Appendices 6B.6.1 (Post Development Drainage Plan-25 Year) and 6B.7.1 (Post Development Drainage Plan-100 Year). The landfill surface stormwater runoff will be routed to three ponds, Pond A, Pond B, and Pond C. Pond A is a retention pond (no discharge) located at the southwest corner, Pond B is a detention pond (33.70 cfs/42.46 cfs discharge for 25-Year/100-Year) located at the northwest corner, and Pond C is a retention pond (no discharge) located at the northeast corner of the permit boundary. All ponds will have adequate freeboard.

5.6 CITY OF KINGSVILLE MSW 235-B PERMIT

Information from the Kingsville MSW 235-B Permit is contained in Appendix 6B.8 (Kingsville Landfill Permit Amendment 235-B). It was utilized to make the comparative analysis between pre-development conditions and post-development conditions. Modeling results demonstrate that the peak discharge flow for the 24-hour duration, 25-year frequency is 33.70 cfs via two (2) 21” x 128 ft. RCP culverts at Pond B after detention. The discharge is to an existing roadside ditch along FM 2619. Pre-development flow in this ditch is approximately 50 cfs. The post-development flow in this ditch will be 33.70 cfs for the 25-year storm and 42.46 cfs for the 100-year storm which is lower than the pre-development flows. The velocities will range between 7-9 ft/sec and therefore the receiving ditch will require erosion protection as discussed in previous sections.

5.7 PERIMETER CHANNELS, COLLECTOR CHANNELS, AND CHUTES

A summary of perimeter channels, collector channels, and chutes are located in Appendices 6B.9 (Perimeter Channels, Collector Channels, and Chutes-25 Year Summary Table) and 6B.10 (Perimeter Channels, Collector Channels, and Chutes-100 Year Summary Table). The table illustrates the geometry as well as peak flows, velocities, slopes, hydraulic grade line elevations, and freeboard for all identified channels and chutes.

5.8 SOUTHERN DRAINAGE PLAN

Appendix 6B.11 Figure 1 illustrates the overall southern drainage plan. Appendix 6B.11.1 Figure 2 is the Enlarged Southern Drainage Plan, and Appendix 6B.11.2 Figure 3 is the Cross Sections that illustrates the drainage channels relative to the existing waste locations. As shown the drainage channels will be articulated concrete block or flexible revetment placed over 60 mil HDPE geomembrane on prepared subgrade.

5.9 POST DEVELOPMENT CHUTES-HYDROCAD MODEL

The drainage chutes have been modeled using HydroCAD as shown in Appendices 6B.12 (HydroCAD Model 25 Year Post Development Chutes) and 6B.13 (HydroCAD Model 100 Year Post Development Chutes). Chute cross sections are shown. The chutes will be no more than 2 ft. deep, 5 ft. wide, at 4:1 side slopes. All chutes will accommodate the 24-hour duration 25 year and 100 year storm frequencies with adequate freeboard. Appendix 6B.14 (Engineering Handbook Chute-Spillways-Chute Spillway Design) was used to design the SAF stilling basin criteria at the bottom of the chute. As discussed in previous sections, articulated concrete blocks or flexible revetment will be used for the chutes and high velocity areas. Included is manufacturer data and specifications for the block and geotextile. Chute details are located in Appendices 6B.14.1 and 6B.14.2 (Chute Details).

5.10 DIVERSION BERMS OR SWALES

The diversions berms (swales) have been modeled using HydroCAD as shown in Appendix 6B.15 (HydroCAD Model Post Development Diversion Berms (Swales) NRCS & Rational Methods). The post-development plan for the diversion berms is shown in Appendix 6B.15.1 (Post Development Typical Diversion Berm Drainage Plan). This plan illustrates the proposed layout of the diversion berms. The largest drainage area was used to design a typical diversion berm and flow will be conveyed to a corresponding chute as shown on the drawing. The National Engineering Handbook (NEH) was used to determine the velocity versus slope for shallow concentrated flow using short grass criteria. This is shown in Appendix 6B.15.2 (National Engineering Handbook (NEH) Figure 15-4 Velocity Versus Slope for Shallow Concentrated Flow [Annotated]).

Swales were analyzed with a 0.5% slope and a 1.0% slope. The HydroCAD swales input data for 0.5% diversion berm slope (along the 25% slope of the landfill) is contained in Appendix 6B.15.3 (HydroCAD-Swales Input Data (Swale B1S-0.5% Slope). The HydroCAD swales input data for 1.0% diversion berm slope (along the 25% slope of the landfill) is contained in Appendix 6B.15.4 (HydroCAD-Swales Input Data (Swale B1S-1.0% Slope)). The HydroCAD swales input data for the largest drainage area at the top of the landfill (B1T) is shown in Appendix 6B.15.5 (HydroCAD-Swales Input Data (Swale B1T-0.5% & 1.0% Slope)). The HydroCAD input data for drainage area B1S and B1T is in Appendices 6B.15.6 (HydroCAD-Swales Input Data (Drainage Area B1S) and 6B.15.7 (HydroCAD-Swales Input Data (Drainage Area B1T)), respectively. Both the 0.5% slope and 1.0% diversion berm slopes were modeled with HydroCAD using the NRCS method and the Rational Method. The NRCS method is shown in Appendices 6B.15.8 (HydroCAD-Model 25 Year Post Development Diversion Berms (NRCS

Method) and 6B.15.11 (HydroCAD Model 100 Year Post Development Diversion Berms (NRCS Method). The Rational Method is shown in Appendices 6B.16.9 (HydroCAD-Model 25 Year Post Development Diversion Berms (Rational Method)) and 6B.15.12 (HydroCAD Model 100 Year Post Development Diversion Berms (Rational Method)). A summary of the results is in Appendix 6B.15.10 (Summary of 25 Year Intensity Flow Rates By Rational Method and NRCS Method for Swale Design) and Appendices 6B.15.11 (Summary of 100 Year Intensity Flow Rates by Rational Method and NRCS Method for Swale Design) and 6B.15.13 (Summary of 100 Year Intensity Flow Rates by Rational Method and NRCS Method for Swale Design). Cross sections are shown in the model. The analyses demonstrates that a typical diversion berm (swale) 3 ft. tall with 2:1 side slopes flowing at a 1% slope into the chute will suffice for both the 24-hr duration/25 year storm and 100 year storm frequencies with an acceptable velocity of approximately 3.7 ft./sec. (below 5 ft./sec) to prevent erosion and allowable freeboard of at least one foot (1 ft.).

5.11 SOIL LOSS ESTIMATE FOR FINAL COVER

The Revised Universal Soil Loss Equation (RUSLE) for top of slope (4%) and side slope (25%) interim cover and post closure is in Appendix 6B.16.1. The RUSLE is described as follows:

A= computed soil loss (tons/acre/year)
R= the rainfall and runoff factor (unitless)
K= the soil erodibility factor (unitless)
LS= the topographic factor (unitless)
C= the cover and management factor (unitless)
P= the support practice factor (unitless)

Detailed calculations and assumptions are provided in Appendix 6B.16.1 (Revised Universal Soil Loss Equation (RUSLE) for Top of Slope (4%) and Side Slope (25%) Interim Cover & Post Closure. The RUSLE calculation results show that the soil loss is 0.36 tons/acre/year for final conditions at top of slope and 2.39 tons/acre/year at the side slope and are both below the allowable 3 tons/acre/year. Also, the soil loss is 2.52 tons/acre/year for interim conditions at top of slope and 18.61 tons/acre/year at the side slope and are both below the allowable 50 tons/acre/year.

6.0 CONCLUSION

The following conclusions summarize the results of the Facility Surface Water Drainage Report:

- The surface water management system for the proposed City of Kingsville Landfill TCEQ Permit MSW 235-C meets or exceeds the regulations applicable to stormwater management outlined in Title 30 of the Texas Administrative Code (30 TAC), Section 330, Municipal Solid Waste as outlined in section 1.0 INTRODUCTION.
- The surface water management plan system provides the required conveyance with a minimum of 1 foot of freeboard.
- It is designed to minimize surface water flow into the working face of the landfill and to minimize discharge pollutants.
- Erosion will be reduced using Best Management Practices. Temporary and permanent erosion control measures are provided to prevent and reduce sediment generation at the site.
- Drainage structures (diversion berms (swales), chutes, perimeter channels, and collector channels) are designed as a minimum to convey peak flow rates from the 25-year, 24-hour storm event.
- Site development will not significantly alter regional drainage patterns.
- The proposed development will not restrict the flow of the 100-year flood, reduce the temporary storage capacity of the floodway or result in wash-out of solid waste.
- All areas of solid waste disposal will be adequately protected from the 24 hr duration, 25 year frequency storm event.
- All stormwater will be retained onsite with the exception of the discharge at the northwest corner of the site at detention Pond B. Discharge at this location will be less than pre-development flows as outlined in section 4.0 SITE PRE-DEVELOPMENT CONDTIONS and section 5.0 SITE POST-DEVELOPMENT CONDITIONS.

The designs, drawings, figures, data, and conclusions described herein are based upon current site conditions and existing information available. This Facility Surface Water Drainage Report (FSWDR) has been prepared for permitting purposes only.

APPENDIX 6A

SITE PRE-DEVELOPMENT CONDITIONS

STATE OF TEXAS
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PROFESSIONAL ENGINEER
09/12/18
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APPENDIX 6A.1

25 YEAR PRE-DEVELOPMENT CONDITIONS SUMMARY TABLE

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25 YEAR PRE-DEVELOPMENT CONDITIONS SUMMARY TABLE

*** Existing Permitted Conditions**

Drainage Area	Area Sq. Mi.	Area AC.	Curve No. CN	Time of Concentration Tc-hr	Time of Concentration Tc-min	Rain Distribution Type	Frequency Year	Rainfall (24-hour) Inches	Peak Discharge CFS	
Watershed A										
PA1	0.031	19.84	46	0.4	24.0	III	25	8.7	27.3	Combined Total
PA2	0.05	32	40	0.69	41.4	III	25	8.7	22.0	49.3 cfs
PA3	0.03	19.2	40	0.64	38.4	III	25	8.7	13.7	
Watershed B										
PB1	0.041	26.24	40	0.61	36.6	III	25	8.7	19.0	
PB2	0.006	3.84	42	0.32	19.2	III	25	8.7	4.3	
PB3	0.01	6.4	40	0.44	26.4	III	25	8.7	5.4	
Watershed C										
PC1	0.071	45.44	42	0.6	36.0	III	25	8.7	39.6	
PC2	0.015	9.6	47	0.28	16.8	III	25	8.7	15.7	
PC3	0.005	3.2	41	0.38	22.8	III	25	8.7	3.1	

*** Kingsville Landfill Permit Amendment 235-B Attachment 6**
Appendix 6A Pre-Development Conditions

****Existing Permitted Conditions**

Drainage Area	Area Sq. Mi.	Area AC.	Curve No. CN	Time of Concentration Tc-hr	Time of Concentration Tc-min	Rain Distribution Type	Frequency Year	Rainfall (24-hour) Inches	Peak Discharge CFS	
Watershed A										
PA1	0.031	19.84	46	0.4	24.0	III	25	8.7	28.7	Combined Total
PA2	0.05	32	40	0.69	41.4	III	25	8.7	22.3	51.1 cfs
PA3	0.03	19.2	40	0.64	38.4	III	25	8.7	13.9	
Watershed B										
PB1	0.041	26.24	40	0.61	36.6	III	25	8.7	19.5	
PB2	0.006	3.84	42	0.32	19.2	III	25	8.7	4.5	
PB3	0.01	6.4	40	0.44	26.4	III	25	8.7	5.5	
Watershed C										
PC1	0.071	45.44	42	0.6	36.0	III	25	8.7	40.9	
PC2	0.015	9.6	47	0.28	16.8	III	25	8.7	17.1	
PC3	0.005	3.2	41	0.38	22.8	III	25	8.7	3.2	

**** Duplicated Existing Permitted Conditions from Kingsville Landfill Permit Amendment 235-B Attachment 6**
Appendix 6A Pre-Development Conditions Using HydroCAD-Results Comparable

*****Updated Permitted Conditions**

Drainage Area	Area Sq. Mi.	Area AC.	Curve No. CN	Time of Concentration Tc-hr	Time of Concentration Tc-min	Rain Distribution Type	Frequency Year	Rainfall (24-hour) Inches	Peak Discharge CFS	
Watershed A										
PA1	0.031	19.84	46	0.4	24.0	III	25	8.7	28.7	Combined Total
PA2	0.05	32	40	0.69	41.4	III	25	8.7	22.3	51.1 cfs
PA3	0.03	19.2	40	0.64	38.4	III	25	8.7	13.9	
Watershed B										
PB1	0.041	26.24	40	0.61	36.6	III	25	8.7	19.5	
PB2	0.006	3.84	42	0.32	19.2	III	25	8.7	4.5	
PB3	0.01	6.4	40	0.44	26.4	III	25	8.7	5.5	
***PB4	0.021	13.38	40	0.26	15.6	III	25	8.7	13.9	
Watershed C										
PC1	0.071	45.44	42	0.6	36.0	III	25	8.7	40.9	
PC2	0.015	9.6	47	0.28	16.8	III	25	8.7	17.1	
PC3	0.005	3.2	41	0.38	22.8	III	25	8.7	3.2	

*****Updated Permitted Conditions Includes the Addition of Drainage Area PB4**
Results Using HydroCAD

APPENDIX 6A.2

SITE PRE-DEVELOPMENT CONDITIONS-EXISTING PERMITTED CONDITIONS

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APPENDIX 6A.2.1

KINGSVILLE LANDFILL PERMIT AMENDMENT 235-B ATTACHMENT 6 APPENDIX 6A PRE-DEVELOPMENT CONDITIONS (TABLE OF CONTENTS AND PAGES 1-32)

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APPENDIX 6A

Appendix 6A
Pre-Development Conditions

TABLE OF CONTENTS

STATE OF TEXAS
HOMERO CASTILLO
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May 1998
Revision 1

Pre-Development Conditions
TR-55 Runoff Curve Number

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PA1

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area __ acres _X_ sq.mi. ____ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.01	0.39
Kingsville, A/D	Unimproved Area, 2 - 7% slope	49			0.02	0.98
Kingsville, A/D	Unimproved Area, > 7% slope	59			0.001	0.06
				Totals =	0.031	1.43

1. Use only one CN source per line.

CN (weighted) = total product / total area = 1.43 / 0.031 = 46 **Use CN = 46**

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	2.2		

S = 1000/CN - 10: S = 11.7

$Q = \frac{(P - 0.2s)^2}{(P + 0.8s)}$ Q = 2.23

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Pre-Development Conditions
TR-55 Time of Concentration

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PA1 (Trial)

Sheet Flow (applicable to Tc only)	Segment ID	A-B				
1. Surface description (table 3-1)		grass				
2. Mannings roughness coeff., n (table 3-1)		0.13				
3. Flow length, L (total < 300 ft)	ft.	200				
4. Two -year 24-hr rainfall, P_2	in.	4.5				
5. Land slope, s	ft/ft	0.01				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\,s^{\,0.4}}$ Compute T_t	hr.	0.28	+		=	0.28
Shallow Concentrated Flow	Segment ID	B - C				
7. surface description (paved or unpaved)		grass				
8. Flow length, L	ft	450				
9. Watercourse slope, S	ft/ft	0.06				
10. average velocity, V (figure 3-1)	ft/s	4				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr.	0.03	+		=	0.03
Channel Flow	Segment ID	C - D				***See***
12. Cross sectional flow area, a	ft^2	10				***Page 29***
13. Wetted perimeter, Pw	ft.	20.2				
14. Hydraulic radius, r = a/Pw	ft.	0.50				
15. Channel slope, s	ft./ft.	0.0125				
16. Manning's roughness coefficient, n		0.03				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft./s	3.5				
18. Flow Length, L	ft.	1000				
19. $Tt = \frac{L}{3600\,V}$ Compute T_t	hr	0.08	+		=	0.08
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					hr.	0.39

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Revision 1

Pre-Development Conditions
TR-55 Time of Concentration

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PA1 (Final)

Sheet Flow (applicable to Tc only)	Segment ID	A-B			
1. Surface description (table 3-1)		grass			
2. Mannings roughness coeff., n (table 3-1)		0.13			
3. Flow length, L (total < 300 ft)	ft.	200			
4. Two -year 24-hr rainfall, P_2	in.	4.5			
5. Land slope, s	ft/ft	0.01			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{\ 0.5}\ s^{\ 0.4}}$ Compute T_t	hr.	0.28	+	=	0.28
Shallow Concentrated Flow	Segment ID	B - C			
7. surface description (paved or unpaved)		grass			
8. Flow length, L	ft	450			
9. Watercourse slope, S	ft/ft	0.06			
10. average velocity, V (figure 3-1)	ft/s	4			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr.	0.03	+	=	0.03
Channel Flow	Segment ID	C - D			*See*
12. Cross sectional flow area, a	ft^2	8.36			*Page 30*
13. Wetted perimeter, Pw	ft.	18.46			
14. Hydraulic radius, r = a/Pw	ft.	0.45			
15. Channel slope, s	ft./ft.	0.0125			
16. Manning's roughness coefficient, n		0.03			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft./s	3.3			
18. Flow Length, L	ft.	1000			
19. $Tt = \frac{L}{3600\ V}$ Compute T_t	hr	0.08	+	=	0.08
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)				hr.	0.40

Pre-Development Conditions
TR-55 Graphical Peak Discharge Method

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PA1 (Trial and Final)

1. Data:

Drainage Area	A_m=	0.031	sq.mi.
Runoff Curve number	CN=	46	(from worksheet 2)
Time of concentration	T_c=	0.40	hr (from worksheet 3)
Rainfall distribution type	=	III	(I, IA, II, III)
Pond and swamp areas spread throughtout watershed	=	0	% of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	2.35		
5. Compute I_a/P		0.27		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	400		
7. Runoff, Q (from worksheet 2)	inches	2.2		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	27.3		

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Revision 1

Pre-Development Conditions
TR-55 Runoff Curve Number

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PA2

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area __ acres _X_ sq.mi. ___ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.05	1.95
				Totals =	0.05	1.95

1. Use only one CN source per line.

N (weighted): total product / total area = 1.95 / 0.05 = 39 Use CN : 40

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	1.6		

S = 1000/CN - 10: S = 15

Q = (P - 0.2s)2 / (P + 0.8s) Q = 1.6

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TR-55 Time of Concentration

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Drainage Area PA2

Sheet Flow (applicable to Tc only)	Segment ID	F - G				
1. Surface description (table 3-1)		grass				
2. Mannings roughness coeff., n (table 3-1)		0.13				
3. Flow length, L (total < 300 ft)	ft.	300				
4. Two -year 24-hr rainfall, P_2	in.	4.5				
5. Land slope, s	ft/ft	0.01				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\,s^{\,0.4}}$ Compute T_t	hr.	0.39	+		=	0.39
Shallow Concentrated Flow	Segment ID	G - E				
7. surface description (paved or unpaved)		grass				
8. Flow length, L	ft	1700				
9. Watercourse slope, S	ft/ft	0.01				
10. average velocity, V (figure 3-1)	ft/s	1.6				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr.	0.30	+		=	0.30
Channel Flow	Segment ID					
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, Pw	ft.					
14. Hydraulic radius, r = a/Pw	ft.					
15. Channel slope, s	ft./ft.					
16. Manning's roughness coefficient, n						
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft./s					
18. Flow Length, L	ft.					
19. $Tt = \frac{L}{3600\,V}$ Compute T_t	hr		+		=	0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					hr.	0.69

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TR-55 Graphical Peak Discharge Method

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Drainage Area PA2

1. Data:

Drainage Area A_m= 0.05 sq.mi.

Runoff Curve number CN= 40 (from worksheet 2)

Time of concentration T_c= 0.69 hr (from worksheet 3)

Rainfall distribution type = III (I, IA, II, III)

Pond and swamp areas spread throughtout watershed = 0 % of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	3.00		
5. Compute I_a/P		0.34		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	275		
7. Runoff, Q (from worksheet 2)	inches	1.6		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	22.0		

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Drainage Area PA3

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area __ acres _x_ sq.mi. ____ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.03	1.17
				Totals =	0.03	1.17

1. Use only one CN source per line.

N (weighted)= total product / total area = 1.17 / 0.03 = 39 Use CN = 40

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	1.6		

S = 1000/CN - 10: S = 15

Q = (P - 0.2s)2 / (P + 0.8s) Q = 1.6

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Drainage Area PA3

Sheet Flow (applicable to Tc only)	Segment ID	H - I			
1. Surface description (table 3-1)		grass			
2. Mannings roughness coeff., n (table 3-1)		0.13			
3. Flow length, L (total < 300 ft)	ft.	300			
4. Two -year 24-hr rainfall, P_2	in.	4.5			
5. Land slope, s	ft/ft	0.01			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr.	0.39	+		= 0.39
Shallow Concentrated Flow	Segment ID	I - E			
7. surface description (paved or unpaved)		grass			
8. Flow length, L	ft	1450			
9. Watercourse slope, S	ft/ft	0.01			
10. average velocity, V (figure 3-1)	ft/s	1.6			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr.	0.25	+		= 0.25
Channel Flow	Segment ID				
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, Pw	ft.				
14. Hydraulic radius, r = a/Pw	ft.				
15. Channel slope, s	ft./ft.				
16. Manning's roughness coefficient, n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft./s				
18. Flow Length, L	ft.				
19. $Tt = \frac{L}{3600\ V}$ Compute T_t	hr		+		= 0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					hr. 0.64

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Drainage Area PA3

1. Data:

Drainage Area	A_m=	0.03	sq.mi.
Runoff Curve number	CN=	40	(from worksheet 2)
Time of concentration	T_c=	0.64	hr (from worksheet 3)
Rainfall distribution type	=	III	(I, IA, II, III)
Pond and swamp areas spread throughtout watershed	=	0	% of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	3.00		
5. Compute I_a/P		0.34		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	285		
7. Runoff, Q (from worksheet 2)	inches	1.6		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	13.7		

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Drainage Area PB1

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area ___ acres _x_ sq.mi. ____ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.04	1.56
Kingsville, A/D	Unimproved Area, 3 - 7% slope	49			0.001	0.05
				Totals =	0.041	1.61

1. Use only one CN source per line.

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{1.61}{0.041} = 39 \qquad \text{Use CN} = 40$$

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	1.6		

S = 1000/CN - 10: S = 15

$$Q = \frac{(P - 0.2s)2}{(P + 0.8s)} \qquad Q = 1.6$$

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Drainage Area PB1

Sheet Flow (applicable to Tc only)	Segment ID	j-k				
1. Surface description (table 3-1)		grass				
2. Mannings roughness coeff., n (table 3-1)		0.13				
3. Flow length, L (total < 300 ft)	ft.	300				
4. Two -year 24-hr rainfall, P_2	in.	4.5				
5. Land slope, s	ft/ft	0.01				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\,s^{0.4}}$ Compute T_t	hr.	0.39	+		=	0.39
Shallow Concentrated Flow	Segment ID	k-l				
7. surface description (paved or unpaved)		grass				
8. Flow length, L	ft	1250				
9. Watercourse slope, S	ft/ft	0.01				
10. average velocity, V (figure 3-1)	ft/s	1.6				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr.	0.22	+		=	0.22
Channel Flow	Segment ID					
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, Pw	ft.					
14. Hydraulic radius, r = a/Pw	ft.					
15. Channel slope, s	ft./ft.					
16. Manning's roughness coefficient, n						
17. $V = \frac{1.49\, r^{2/3} s^{1/2}}{n}$ Compute V	ft./s					
18. Flow Length, L	ft.					
19. $Tt = \frac{L}{3600\,V}$ Compute T_t	hr		+		=	0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					hr.	0.61

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Drainage Area PB1

1. Data:

Drainage Area A_m= 0.041 sq.mi.

Runoff Curve number CN= 40 (from worksheet 2)

Time of concentration T_c= 0.61 hr (from worksheet 3)

Rainfall distribution type = III (I, IA, II, III)

Pond and swamp areas spread throughtout watershed = 0 % of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	3.00		
5. Compute I_a/P		0.34		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	290		
7. Runoff, Q (from worksheet 2)	inches	1.6		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	19.0		

Drainage Area PB2

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN			Area __ acres _x_ sq.mi. ____ %	Product of CN x Area
		Table2-2	Fig. 2-3	Fig. 2-4		
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.004	0.16
Kingsville, A/D	Unimproved Area, 3 - 7% slope	49			0.002	0.10
					Totals = 0.006	0.25

1. Use only one CN source per line.

CN (weighted) = total product / total area = $\frac{0.25}{0.006}$ = 42 Use CN = 42

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	1.8		

S = 1000/CN - 10: S = 14

$Q = \frac{(P - 0.2s)2}{(P + 0.8s)}$ Q = 1.8

Drainage Area PB2

Sheet Flow (applicable to Tc only)	Segment ID	m - l			
1. Surface description (table 3-1)		grass			
2. Mannings roughness coeff., n (table 3-1)		0.13			
3. Flow length, L (total < 300 ft)	ft.	300			
4. Two -year 24-hr rainfall, P_2	in.	4.5			
5. Land slope, s	ft/ft	0.016			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{\ 0.5}\ s^{\ 0.4}}$ Compute T_t	hr.	0.32	+	=	0.32
Shallow Concentrated Flow	Segment ID				
7. surface description (paved or unpaved)					
8. Flow length, L	ft				
9. Watercourse slope, S	ft/ft				
10. average velocity, V (figure 3-1)	ft/s				
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr.	0.00	+	=	0.00
Channel Flow	Segment ID				
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, Pw	ft.				
14. Hydraulic radius, r = a/Pw	ft.				
15. Channel slope, s	ft./ft.				
16. Manning's roughness coefficient, n					
17. $V = \frac{1.49\ r^{2/3} s^{1/2}}{n}$ Compute V	ft./s				
18. Flow Length, L	ft.				
19. $Tt = \frac{L}{3600\ V}$ Compute T_t	hr		+	=	0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)				hr.	0.32

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Drainage Area PB2

1. Data:

Drainage Area	A_m=	0.006 sq.mi.
Runoff Curve number	CN=	42 (from worksheet 2)
Time of concentration	T_c=	0.32 hr (from worksheet 3)
Rainfall distribution type	=	III (I, IA, II, III)
Pond and swamp areas spread throughtout watershed	=	0 % of A_m(___ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	2.76		
5. Compute I_a/P		0.32		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	400		
7. Runoff, Q (from worksheet 2)	inches	1.8		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	4.3		

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Drainage Area PB3

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area __ acres _x_ sq.mi. ______ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.01	0.39
				Totals =	0.01	0.39

1. Use only one CN source per line.

N (weighted): total product / total area = 0.39 / 0.01 = 39 Use CN = 40

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	1.6		

S = 1000/CN - 10: S = 15

Q = (P - 0.2s)2 / (P + 0.8s) Q = 1.6

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Drainage Area PB3

Sheet Flow (applicable to Tc only)	Segment ID	n-o				
1. Surface description (table 3-1)		grass				
2. Mannings roughness coeff., n (table 3-1)		0.13				
3. Flow length, L (total < 300 ft)	ft.	300				
4. Two -year 24-hr rainfall, P_2	in.	4.5				
5. Land slope, s	ft/ft	0.01				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr.	0.39	+		=	0.39
Shallow Concentrated Flow	Segment ID	o-m				
7. surface description (paved or unpaved)		grass				
8. Flow length, L	ft	300				
9. Watercourse slope, S	ft/ft	0.01				
10. average velocity, V (figure 3-1)	ft/s	1.6				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr.	0.05	+		=	0.05
Channel Flow	Segment ID					
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, Pw	ft.					
14. Hydraulic radius, r = a/Pw	ft.					
15. Channel slope, s	ft./ft.					
16. Manning's roughness coefficient, n						
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft./s					
18. Flow Length, L	ft.					
19. $Tt = \frac{L}{3600\,V}$ Compute T_t	hr		+		=	0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					hr.	0.44

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Drainage Area PB3

1. Data:

Drainage Area	A_m=	0.01	sq.mi.
Runoff Curve number	CN=	40	(from worksheet 2)
Time of concentration	T_c=	0.44	hr (from worksheet 3)
Rainfall distribution type	=	III	(I, IA, II, III)
Pond and swamp areas spread throughtout watershed	=	0	% of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	3.00		
5. Compute I_a/P		0.34		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	340		
7. Runoff, Q (from worksheet 2)	inches	1.6		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	5.4		

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Drainage Area PC1

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area __ acres _x_ sq.mi. ____ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.05	1.95
Kingsville, A/D	Unimproved Area, 3 - 7% slope	49			0.02	0.98
Kingsville, A/D	Unimproved Area, > 7% slope	59			0.001	0.06
				Totals =	0.071	2.99

1. Use only one CN source per line.

CN (weighted) = total product / total area = 2.99 / 0.071 = 42 Use CN = 42

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	1.8		

S = 1000/CN - 10: S = 13.81

Q = (P - 0.2s)2 / (P + 0.8s) Q = 1.8

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Drainage Area PC1

Sheet Flow (applicable to Tc only)	Segment ID	i-p			
1. Surface description (table 3-1)		grass			
2. Mannings roughness coeff., n (table 3-1)		0.13			
3. Flow length, L (total < 300 ft)	ft.	300			
4. Two -year 24-hr rainfall, P_2	in.	4.5			
5. Land slope, s	ft/ft	0.01			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\, s^{\,0.4}}$ Compute T_t	hr.	0.39	+	=	0.39
Shallow Concentrated Flow	Segment ID	p-q			
7. surface description (paved or unpaved)		grass			
8. Flow length, L	ft	650			
9. Watercourse slope, S	ft/ft	0.025			
10. average velocity, V (figure 3-1)	ft/s	1.6			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr.	0.11	+	=	0.11
Channel Flow	Segment ID	q-r			See
12. Cross sectional flow area, a	ft^2	17.5			*Page 31*
13. Wetted perimeter, Pw	ft.	70.01			
14. Hydraulic radius, r = a/Pw	ft.	0.25			
15. Channel slope, s	ft./ft.	0.018			
16. Manning's roughness coefficient, n		0.03			
17. $V = \frac{1.49\ r^{2/3} s^{1/2}}{n}$ Compute V	ft./s	2.6			
18. Flow Length, L	ft.	950			
19. $Tt = \frac{L}{3600\ V}$ Compute T_t	hr	0.10	+	=	0.10
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)				hr.	0.60

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Drainage Area PC1

1. Data:

Drainage Area	A_m=	0.071 sq.mi.
Runoff Curve number	CN=	42 (from worksheet 2)
Time of concentration	T_c=	0.60 hr (from worksheet 3)
Rainfall distribution type	=	III (I, IA, II, III)
Pond and swamp areas spread throughtout watershed	=	0 % of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	2.76		
5. Compute I_a/P		0.32		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	310		
7. Runoff, Q (from worksheet 2)	inches	1.8		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	39.6		

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Drainage Area PC2

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area __ acres _X_ sq.mi. ____ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.004	0.16
Kingsville, A/D	Unimproved Area, 3 - 7% slope	49			0.01	0.49
Kingsville, A/D	Unimproved Area, > 7% slope	59			0.001	0.06
				Totals =	0.015	0.71

1. Use only one CN source per line.

N (weighted): total product / total area = 0.71 / 0.015 = 47 Use CN : 47

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	2.3		

S = 1000/CN - 10: S = 11

Q = (P - 0.2s)2 / (P + 0.8s) Q = 2.3

Drainage Area PC2

Sheet Flow (applicable to Tc only)	Segment ID	a-l				
1. Surface description (table 3-1)		grass				
2. Mannings roughness coeff., n (table 3-1)		0.13				
3. Flow length, L (total < 300 ft)	ft.	150				
4. Two -year 24-hr rainfall, P_2	in.	4.5				
5. Land slope, s	ft/ft	0.01				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\,s^{\,0.4}}$ Compute T_t	hr.	0.22	+		=	0.22
Shallow Concentrated Flow	Segment ID	u-w				
7. surface description (paved or unpaved)		grass				
8. Flow length, L	ft	180				
9. Watercourse slope, S	ft/ft	0.06				
10. average velocity, V (figure 3-1)	ft/s	4				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr.	0.01	+		=	0.01
Channel Flow	Segment ID	w-x				
12. Cross sectional flow area, a	ft^2	3.54				*See*
13. Wetted perimeter, Pw	ft.	11.72				*Page 32*
14. Hydraulic radius, r = a/Pw	ft.	0.30				
15. Channel slope, s	ft./ft.	0.036				
16. Manning's roughness coefficient, n		0.03				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft./s	4.2				
18. Flow Length, L	ft.	650				
19. $Tt = \frac{L}{3600\,V}$ Compute T_t	hr	0.04	+		=	0.04
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					hr.	0.28

Pre-Development Conditions
TR-55 Graphical Peak Discharge Method

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PC2

1. Data:

Drainage Area A_m= 0.015 sq.mi.

Runoff Curve number CN= 47 (from worksheet 2)

Time of concentration T_c= 0.28 hr (from worksheet 3)

Rainfall distribution type = III (I, IA, II, III)

Pond and swamp areas spread throughtout watershed = 0 % of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	2.26		
5. Compute I_a/P		0.26		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	455		
7. Runoff, Q (from worksheet 2)	inches	2.3		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	15.7		

Pre-Development Conditions
TR-55 Runoff Curve Number

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PC3

1. Runoff Curve Number (CN)

Soil Name and hydrologic group (Appendix A)	Cover Description (cover type, treatment, and hydrologic condition;percent impervious; unconnected/connected imperviousarea ratio)	CN Table2-2	CN Fig. 2-3	CN Fig. 2-4	Area __ acres _X_ sq.mi. ____ %	Product of CN x Area
Kingsville, A/D	Unimproved Area, 0 - 2% slope	39			0.004	0.16
Kingsville, A/D	Unimproved Area, 3 - 7% slope	49			0.001	0.05
				Totals =	0.005	0.21

1. Use only one CN source per line.

N (weighted): $\frac{\text{total product}}{\text{total area}} = \frac{0.21}{0.005} = 41$ Use CN = 41

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr.	25		
Rainfall, P (24-hour)	in.	8.7		
Runoff, Q .... (use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4)	in.	1.7		

S = 1000/CN - 10: S = 14

$Q = \frac{(P - 0.2s)2}{(P + 0.8s)}$ Q = 1.7

Appendix 6A
May 1998
Revision 1

Drainage Area PC3

Sheet Flow (applicable to Tc only)	Segment ID	y-s				
1. Surface description (table 3-1)		grass				
2. Mannings roughness coeff., n (table 3-1)		0.13				
3. Flow length, L (total < 300 ft)	ft.	300				
4. Two -year 24-hr rainfall, P_2	in.	4.5				
5. Land slope, s	ft/ft	0.015				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr.	0.33	+		=	0.33
Shallow Concentrated Flow	Segment ID	s-t				
7. surface description (paved or unpaved)		grass				
8. Flow length, L	ft	300				
9. Watercourse slope, S	ft/ft	0.015				
10. average velocity, V (figure 3-1)	ft/s	1.6				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr.	0.05	+		=	0.05
Channel Flow	Segment ID					
12. Cross sectional flow area, a	ft^2					
13. Wetted perimeter, Pw	ft.					
14. Hydraulic radius, r = a/Pw	ft.					
15. Channel slope, s	ft./ft.					
16. Manning's roughness coefficient, n						
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft./s					
18. Flow Length, L	ft.					
19. $Tt = \frac{L}{3600\,V}$ Compute T_t	hr		+		=	0.00
20. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, and 19)					hr.	0.38

Pre-Development Conditions
TR-55 Graphical Peak Discharge Method

Kingsville Landfill Permit Application 235-B
Attachment 6

Drainage Area PC3

1. Data:

Drainage Area A_m= 0.005 sq.mi.

Runoff Curve number CN= 41 (from worksheet 2)

Time of concentration T_c= 0.38 hr (from worksheet 3)

Rainfall distribution type = III (I, IA, II, III)

Pond and swamp areas spread throughtout watershed = 0 % of A_m(____ acres/mi.^{2} covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	year	25		
3. Rainfall, P (24-hour)	inches	8.7		
4. Initial abstraction, I_a (use CN with table 4-1)	inches	2.88		
5. Compute I_a/P		0.33		
6. Unit peak discharge, q_u (use T_c and I_a/p with exhibit 4 - III)	csm/in	360		
7. Runoff, Q (from worksheet 2)	inches	1.7		
8. Pond & swamp adjustment factor, Fp (use percent pond and swamp area with table 4-2. Factor is 1.0 for zeropercent pond and swamp area.)		1.0		
9. Peak discharge, q_p (where $q_p = q_u A_m Q F_p$)	cfs	3.1		

PreDevelop Channel C-D Trial 1
Worksheet for Triangular Channel

Project Description	
Project File	d:\98 files\kingsville landfill permit 235b\predevel.fm2
Worksheet	Seg CD
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.012500	ft/ft
Depth	1.00	ft
Left Side Slope	17.000000	H : V
Right Side Slope	3.000000	H : V

Results		
Discharge	34.66	cfs
Flow Area	10.00	ft²
Wetted Perimeter	20.19	ft
Top Width	20.00	ft
Critical Depth	0.94	ft
Critical Slope	0.017063	ft/ft
Velocity	3.47	ft/s
Velocity Head	0.19	ft
Specific Energy	1.19	ft
Froude Number	0.86	
Flow is subcritical.		

Pre-Development Channel C-D Final
Worksheet for Triangular Channel

Project Description	
Project File	d:\98 files\kingsville landfill permit 235b\final.fm2
Worksheet	6A C-D final
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.012500	ft/ft
Left Side Slope	17.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	27.30	cfs

Results		
Depth	0.91	ft
Flow Area	8.36	ft²
Wetted Perimeter	18.46	ft
Top Width	18.29	ft
Critical Depth	0.86	ft
Critical Slope	0.017616	ft/ft
Velocity	3.27	ft/s
Velocity Head	0.17	ft
Specific Energy	1.08	ft
Froude Number	0.85	
Flow is subcritical.		

PreDevelopment Segment Q - R
Worksheet for Triangular Channel

Project Description	
Project File	d:\98 files\kingsville landfill permit 235b\predevel.fm2
Worksheet	PreDev Q-R
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.018000	ft/ft
Depth	0.50	ft
Left Side Slope	82.000000	H : V
Right Side Slope	58.000000	H : V

Results		
Discharge	46.15	cfs
Flow Area	17.50	ft²
Wetted Perimeter	70.01	ft
Top Width	70.00	ft
Critical Depth	0.49	ft
Critical Slope	0.021023	ft/ft
Velocity	2.64	ft/s
Velocity Head	0.11	ft
Specific Energy	0.61	ft
Froude Number	0.93	
Flow is subcritical.		

Kingsville Landfill Permit Amendment 235-B
Attachment 6

PreDevelopment Segment W-X
Worksheet for Triangular Channel

Project Description	
Project File	d:\98 files\kingsville landfill permit 235b\predevel.fm2
Worksheet	PreD WX Final
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.036000	ft/ft
Left Side Slope	16.000000	H : V
Right Side Slope	3.000000	H : V
Discharge	15.00	cfs

Results		
Depth	0.61	ft
Flow Area	3.54	ft^2
Wetted Perimeter	11.72	ft
Top Width	11.60	ft
Critical Depth	0.69	ft
Critical Slope	0.018964	ft/ft
Velocity	4.23	ft/s
Velocity Head	0.28	ft
Specific Energy	0.89	ft
Froude Number	1.35	
Flow is supercritical.		

APPENDIX 6A.2.2

PRE-DEVELOPMENT DRAINAGE MAP SOLID WASTE LANDFILL PERMIT 235-B AMENDMENT FIGURE A-1

STATE OF TEXAS
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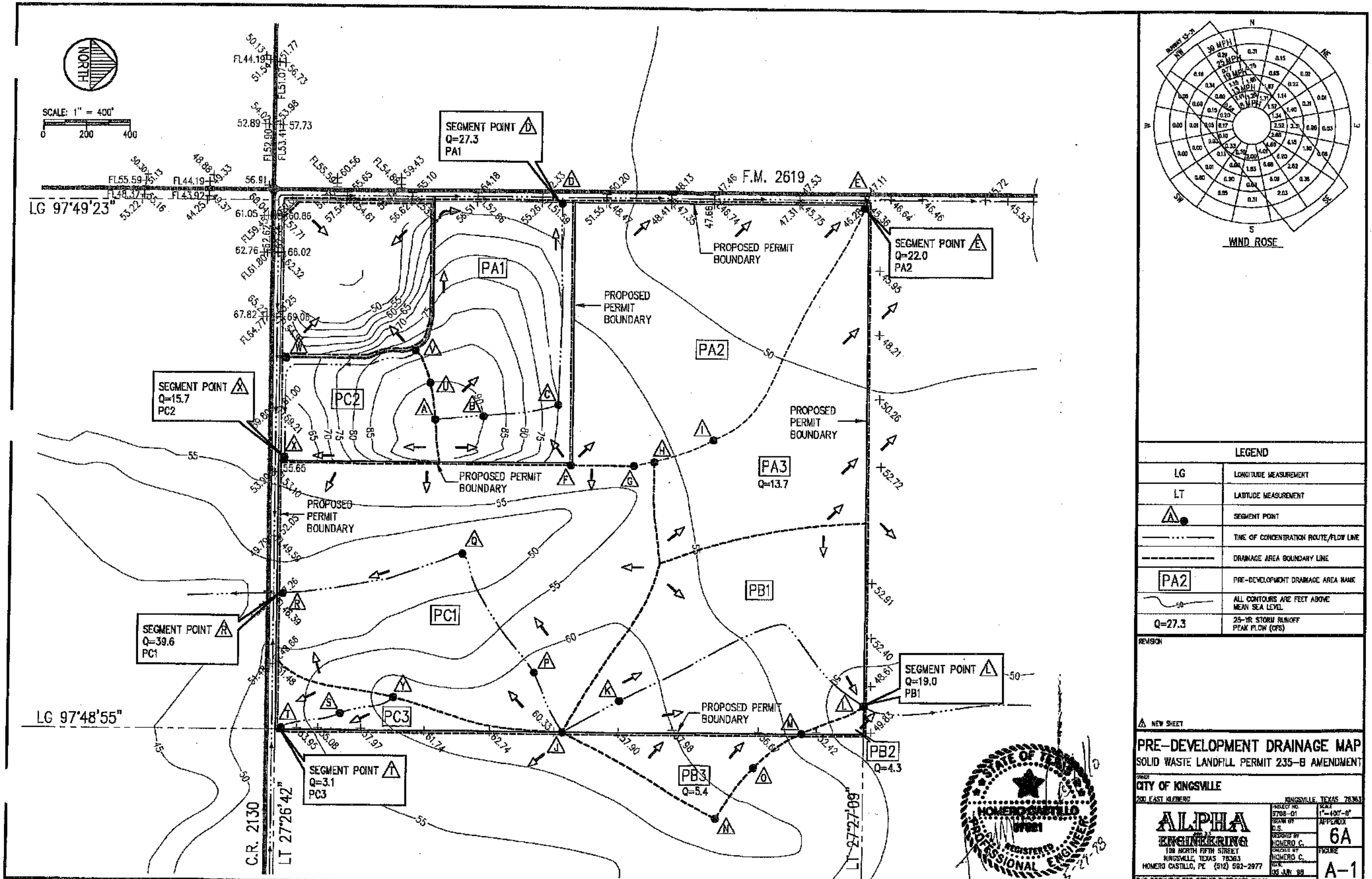
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

FOR PERMIT PURPOSES ONLY



APPENDIX 6A.2.3

PRE-DEVELOPMENT SLOPE MAP SOLID WASTE LANDFILL PERMIT 235-B AMENDMENT FIGURE A-2

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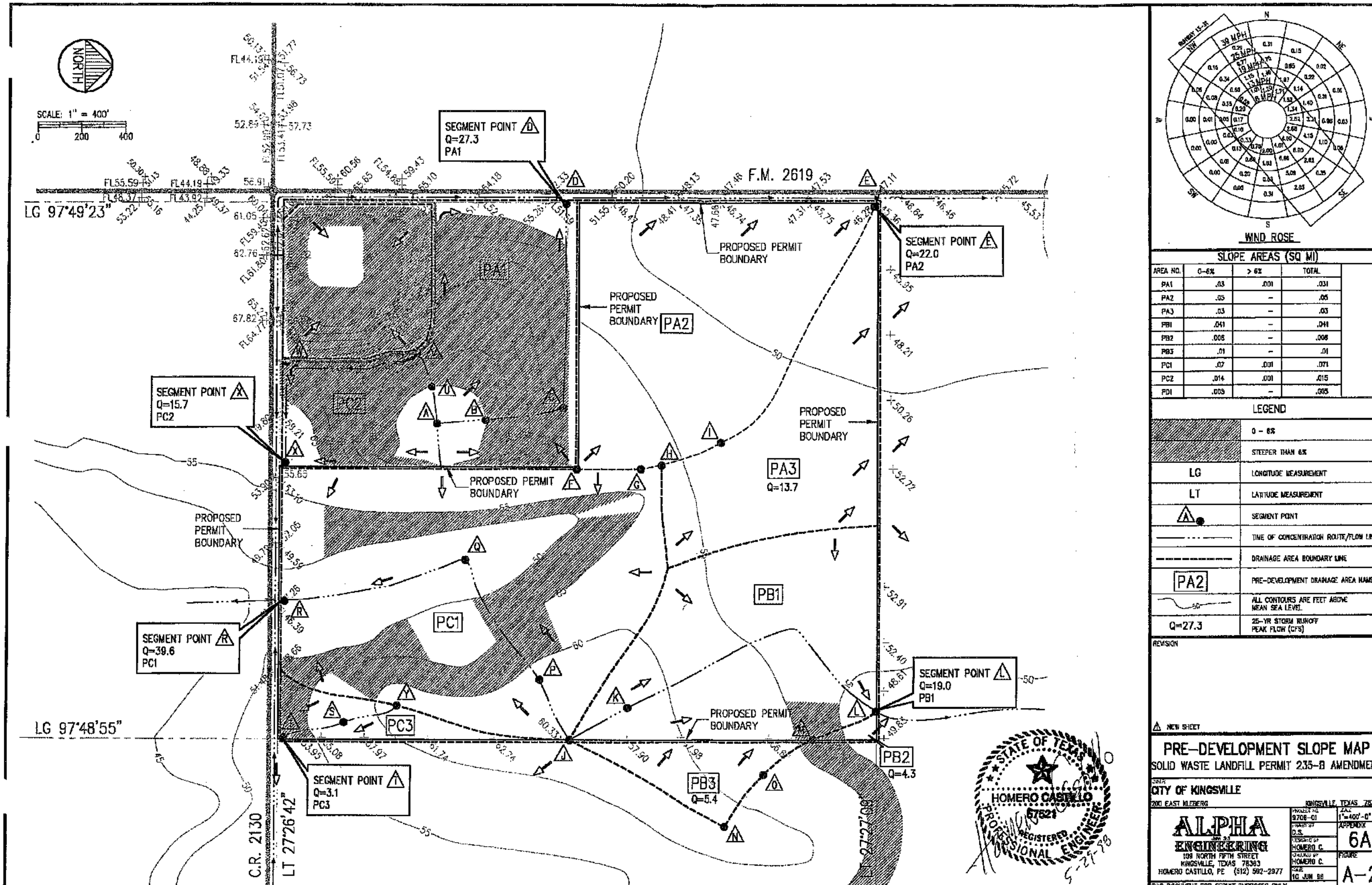

SLOPE AREAS (SQ MI)

AREA NO.	0-6%	> 6%	TOTAL
PA1	.03	.001	.031
PA2	.05	–	.05
PA3	.03	–	.03
PB1	.041	–	.041
PB2	.006	–	.006
PB3	.01	–	.01
PC1	.07	.001	.071
PC2	.014	.001	.015
PD1	.005	–	.005

APPENDIX 6A.2.4

HYDROCAD MODEL PRE-DEVELOPMENT CONDITIONS 25 YEAR EXISTING PERMITTED CONDITIONS

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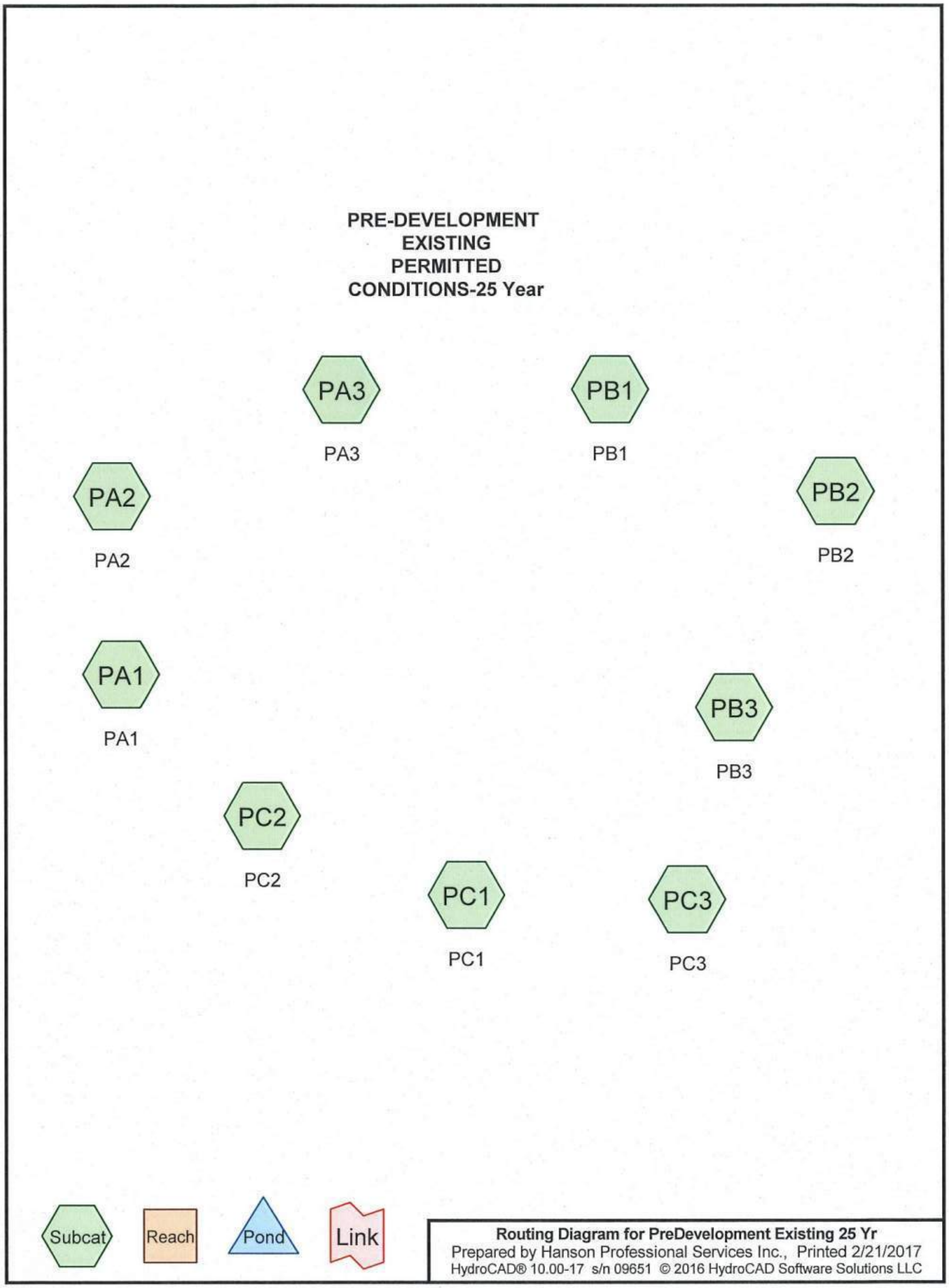
PRE-DEVELOPMENT
EXISTING
PERMITTED
CONDITIONS-25 Year
PA3
PA3
PB1
PB1
PA2
PA2
PB2
PB2
PA1
PA1
PB3
PB3
PC2
PC2
PC1
PC1
PC3
PC3
Subcat
Reach
Pond
Link
Routing Diagram for PreDevelopment Existing 25 Yr
Prepared by Hanson Professional Services Inc., Printed 2/21/2017
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PreDevelopment Existing 25 Yr
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
19.840	46	(PA1)
83.840	40	(PA2, PA3, PB1, PB3)
49.280	42	(PB2, PC1)
9.600	47	(PC2)
3.200	41	(PC3)
165.760	**42**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
165.760	Other	PA1, PA2, PA3, PB1, PB2, PB3, PC1, PC2, PC3
165.760		**TOTAL AREA**

PreDevelopment Existing 25 Yr
Prepared by Hanson Professional Services Inc. Printed 2/21/2017
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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	165.760	165.760		PA1, PA2, PA3, PB1, PB2, PB3, PC1, PC2, PC3
0.000	**0.000**	**0.000**	**0.000**	**165.760**	**165.760**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PA1: PA1 Runoff Area=19.840 ac 0.00% Impervious Runoff Depth=2.23"
Tc=24.0 min CN=46 Runoff=28.74 cfs 3.688 af

Subcatchment PA2: PA2 Runoff Area=32.000 ac 0.00% Impervious Runoff Depth=1.57"
Tc=41.4 min CN=40 Runoff=22.31 cfs 4.186 af

Subcatchment PA3: PA3 Runoff Area=19.200 ac 0.00% Impervious Runoff Depth=1.57"
Tc=38.4 min CN=40 Runoff=13.91 cfs 2.511 af

Subcatchment PB1: PB1 Runoff Area=26.240 ac 0.00% Impervious Runoff Depth=1.57"
Tc=36.6 min CN=40 Runoff=19.49 cfs 3.432 af

Subcatchment PB2: PB2 Runoff Area=3.840 ac 0.00% Impervious Runoff Depth=1.79"
Tc=19.2 min CN=42 Runoff=4.48 cfs 0.571 af

Subcatchment PB3: PB3 Runoff Area=6.400 ac 0.00% Impervious Runoff Depth=1.57"
Tc=26.4 min CN=40 Runoff=5.49 cfs 0.837 af

Subcatchment PC1: PC1 Runoff Area=45.440 ac 0.00% Impervious Runoff Depth=1.79"
Tc=36.0 min CN=42 Runoff=40.94 cfs 6.761 af

Subcatchment PC2: PC2 Runoff Area=9.600 ac 0.00% Impervious Runoff Depth=2.34"
Tc=16.8 min CN=47 Runoff=17.12 cfs 1.875 af

Subcatchment PC3: PC3 Runoff Area=3.200 ac 0.00% Impervious Runoff Depth=1.68"
Tc=22.8 min CN=41 Runoff=3.20 cfs 0.447 af

Total Runoff Area = 165.760 ac Runoff Volume = 24.309 af Average Runoff Depth = 1.76"
100.00% Pervious = 165.760 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment PA1: PA1

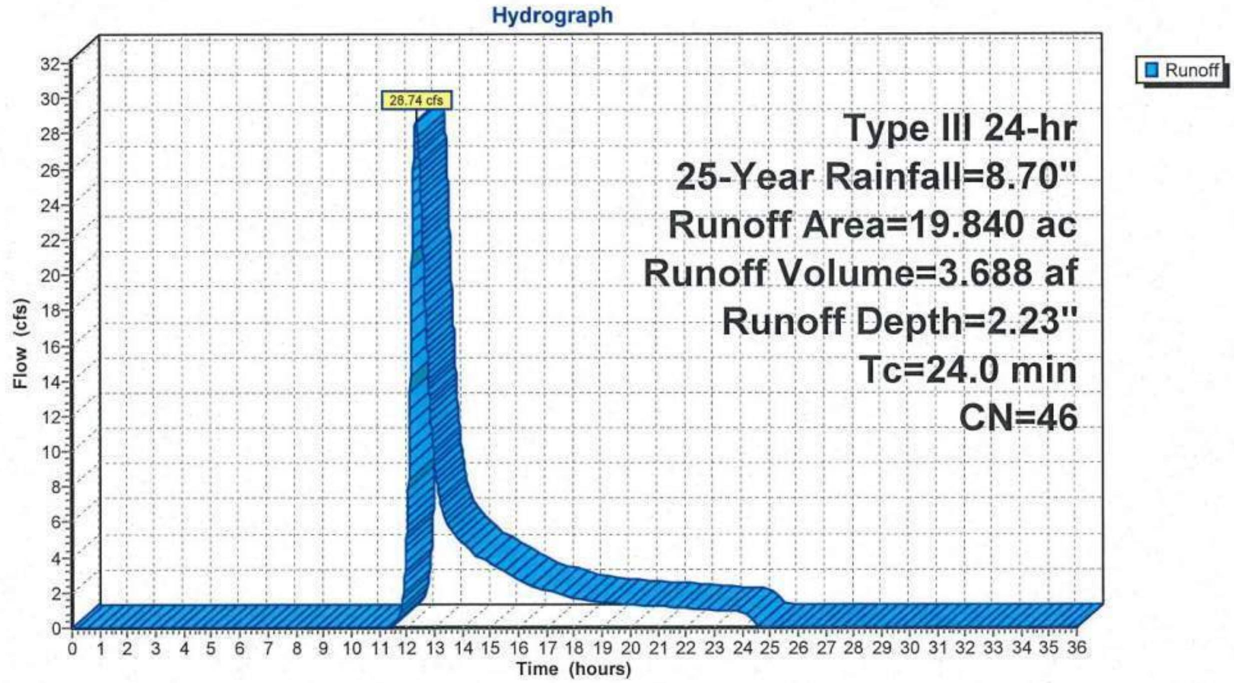
Runoff = 28.74 cfs @ 12.38 hrs, Volume= 3.688 af, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	19.840	46	
	19.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.0					**Direct Entry,**

Subcatchment PA1: PA1



Summary for Subcatchment PA2: PA2

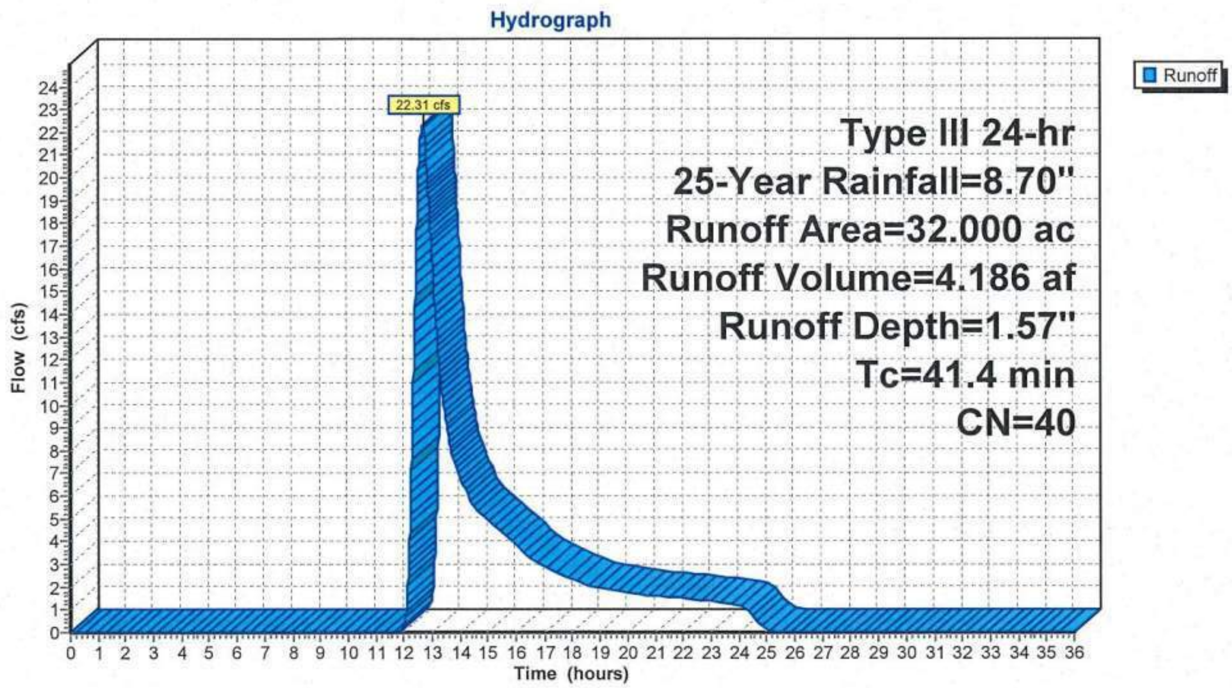
Runoff = 22.31 cfs @ 12.69 hrs, Volume= 4.186 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	32.000	40	
	32.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.4					**Direct Entry,**

Subcatchment PA2: PA2



Summary for Subcatchment PA3: PA3

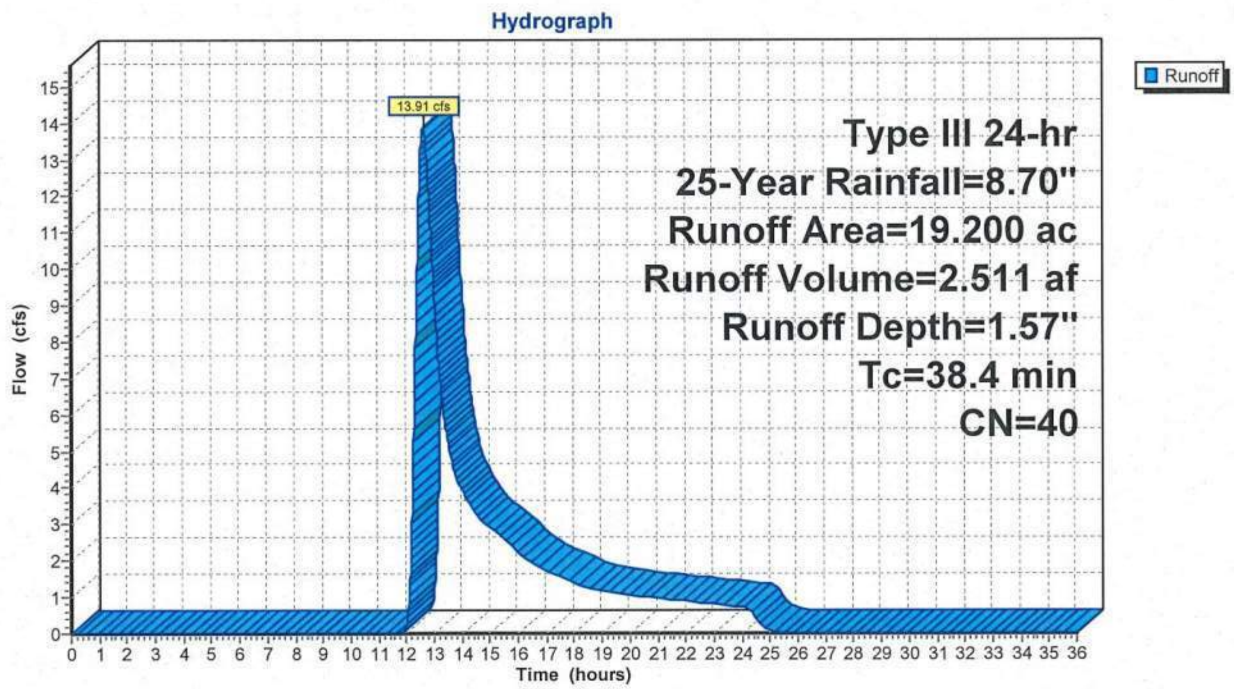
Runoff = 13.91 cfs @ 12.64 hrs, Volume= 2.511 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	19.200	40	
	19.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
38.4					**Direct Entry, Direct Entry**

Subcatchment PA3: PA3



Summary for Subcatchment PB1: PB1

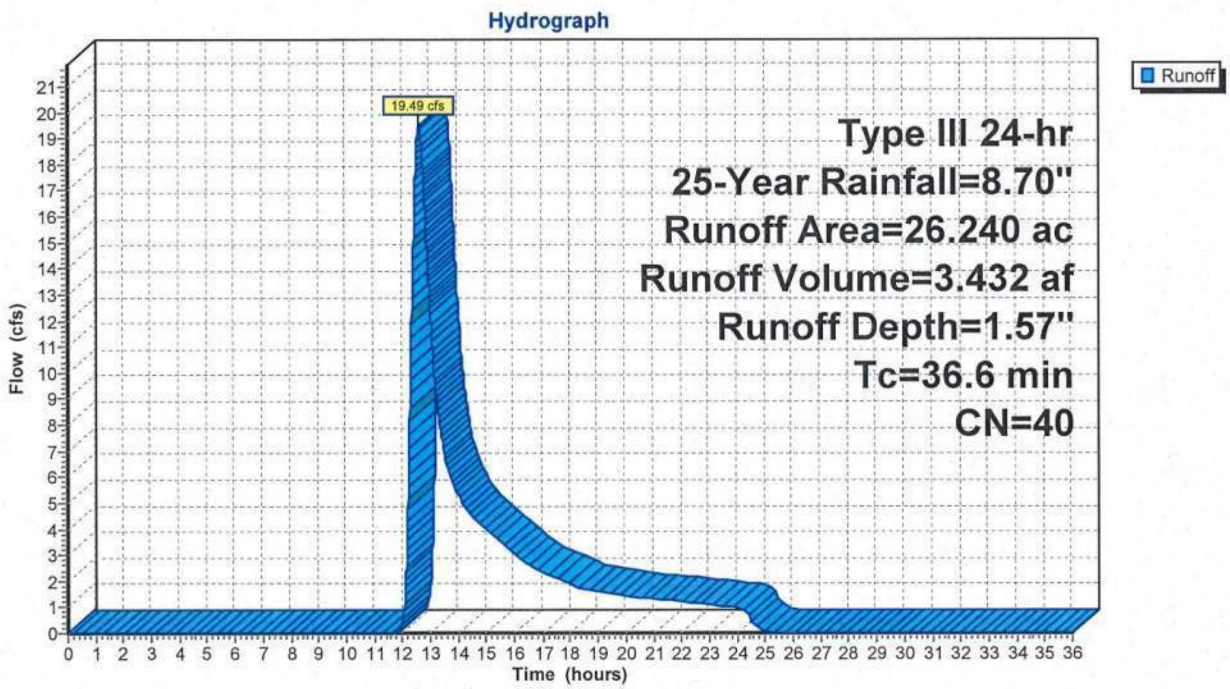
Runoff = 19.49 cfs @ 12.61 hrs, Volume= 3.432 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	26.240	40	
	26.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.6					**Direct Entry,**

Subcatchment PB1: PB1



Summary for Subcatchment PB2: PB2

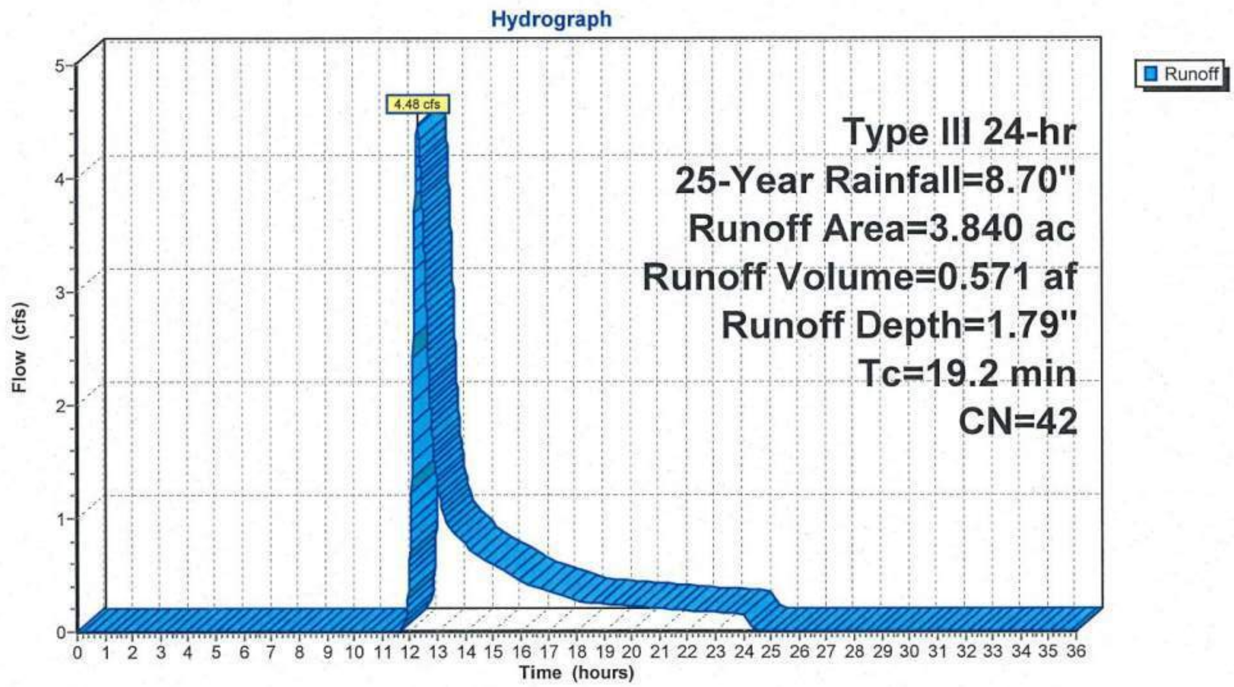
Runoff = 4.48 cfs @ 12.31 hrs, Volume= 0.571 af, Depth= 1.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	3.840	42	
	3.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.2					**Direct Entry,**

Subcatchment PB2: PB2



Summary for Subcatchment PB3: PB3

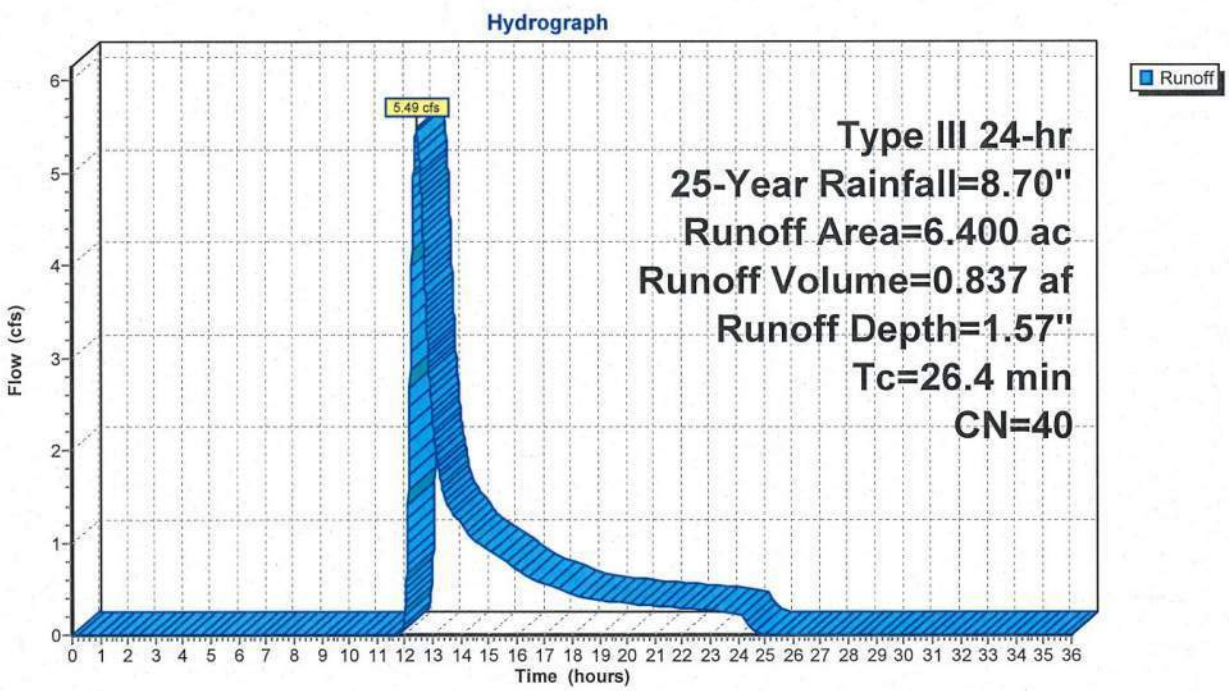
Runoff = 5.49 cfs @ 12.46 hrs, Volume= 0.837 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	6.400	40	
	6.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4					**Direct Entry,**

Subcatchment PB3: PB3



Summary for Subcatchment PC1: PC1

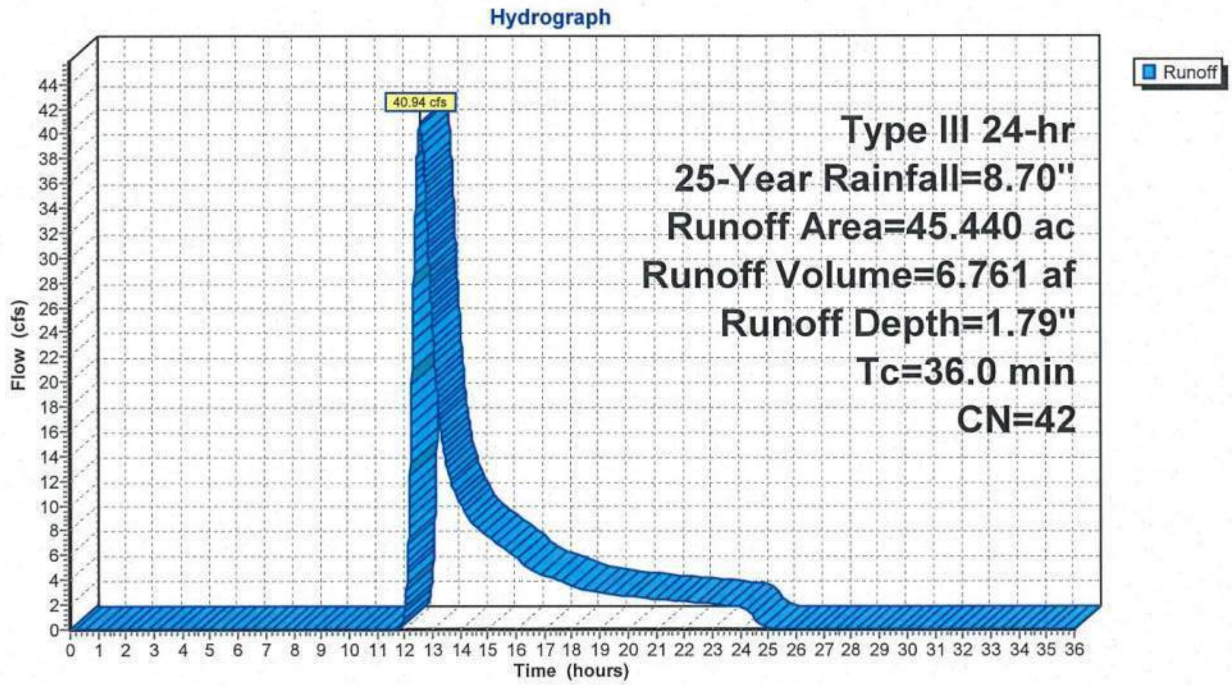
Runoff = 40.94 cfs @ 12.60 hrs, Volume= 6.761 af, Depth= 1.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	45.440	42	
	45.440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.0					**Direct Entry,**

Subcatchment PC1: PC1



Summary for Subcatchment PC2: PC2

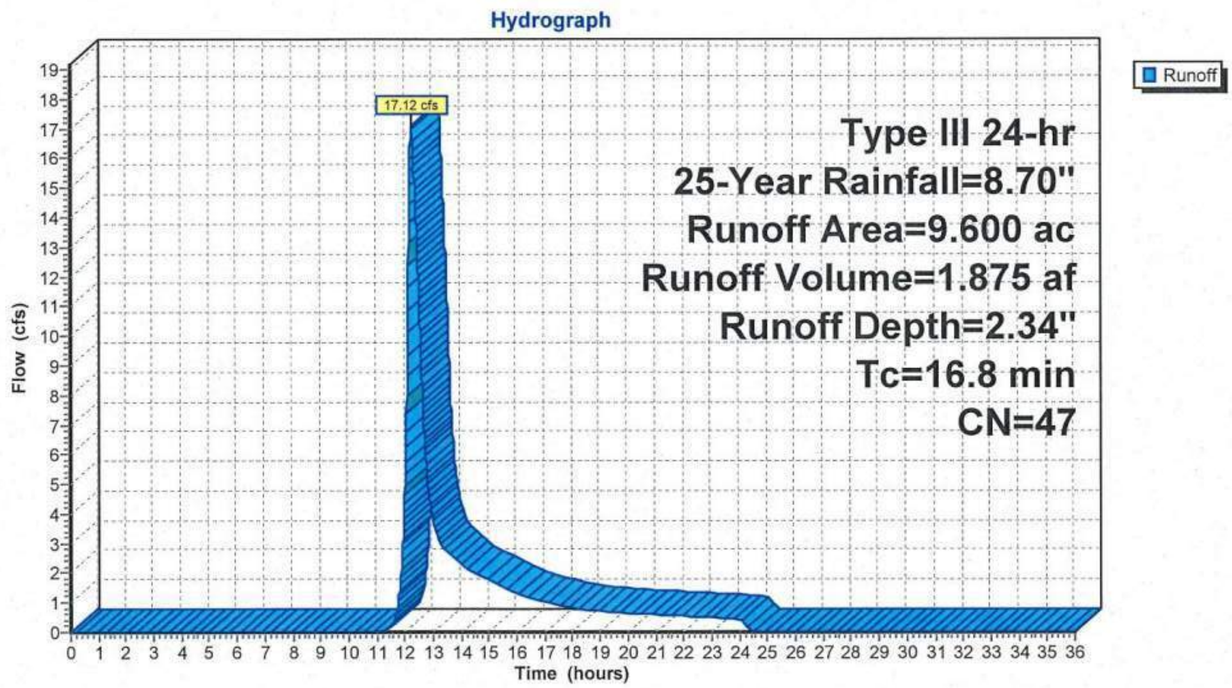
Runoff = 17.12 cfs @ 12.26 hrs, Volume= 1.875 af, Depth= 2.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	9.600	47	
	9.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.8					**Direct Entry,**

Subcatchment PC2: PC2



Summary for Subcatchment PC3: PC3

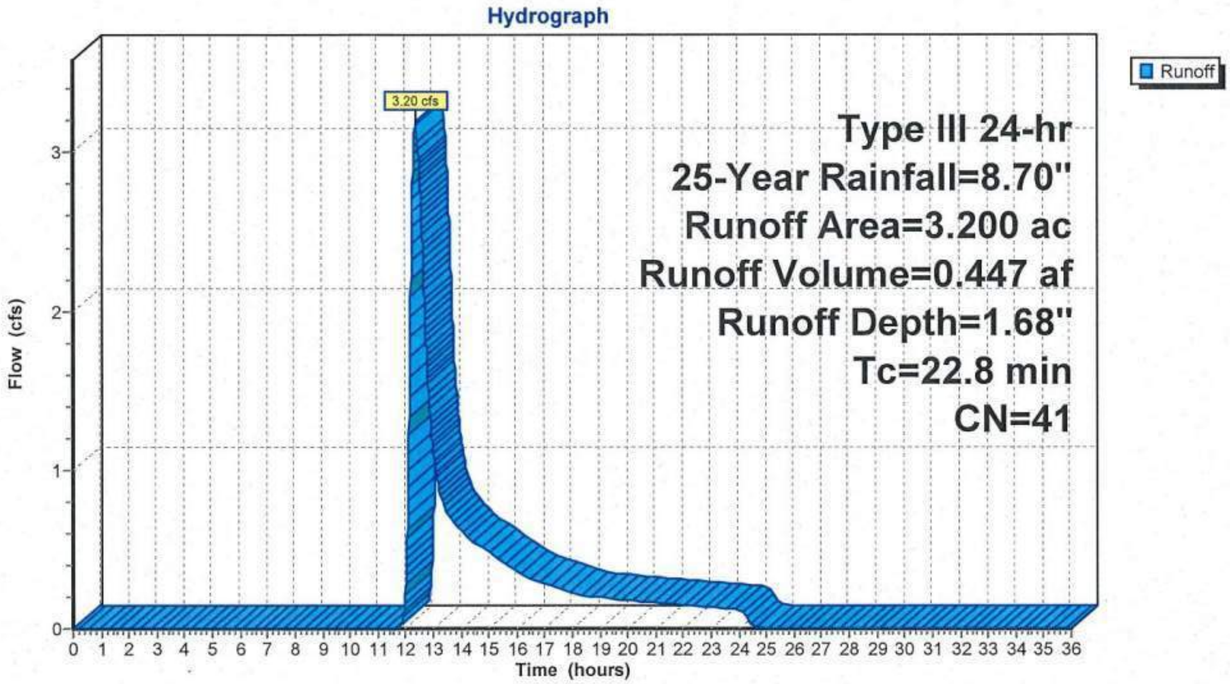
Runoff = 3.20 cfs @ 12.39 hrs, Volume= 0.447 af, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	3.200	41	
	3.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.8					**Direct Entry,**

Subcatchment PC3: PC3



APPENDIX 6A.2.5

HYDROCAD MODEL PRE-DEVELOPMENT CONDITIONS 25 YEAR UPDATED PERMITTED CONDITIONS

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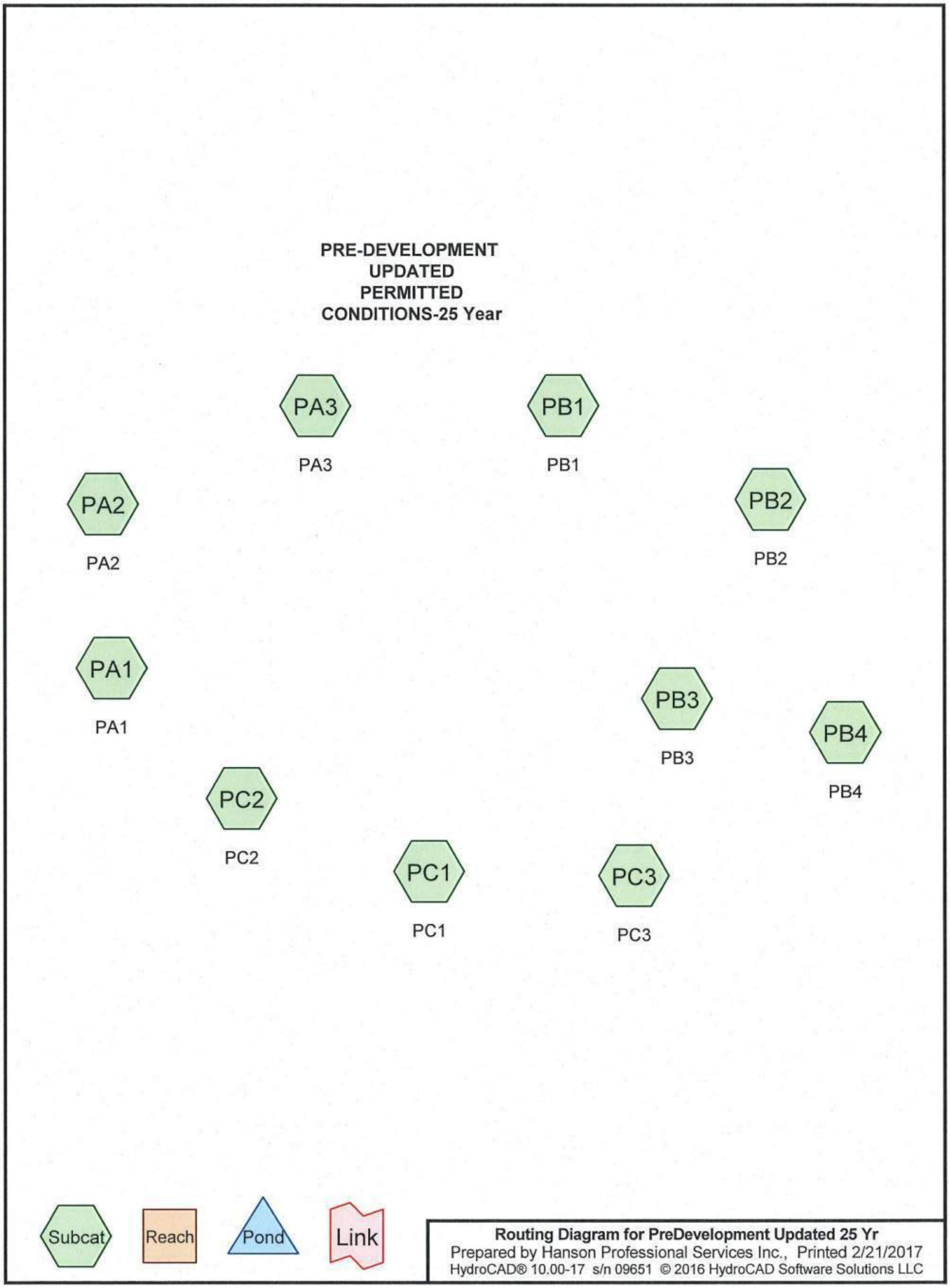

Routing Diagram for PreDevelopment Updated 25 Yr
Prepared by Hanson Professional Services Inc., Printed 2/21/2017
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
19.840	46	(PA1)
97.220	40	(PA2, PA3, PB1, PB3, PB4)
49.280	42	(PB2, PC1)
9.600	47	(PC2)
3.200	41	(PC3)
179.140	**42**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
179.140	Other	PA1, PA2, PA3, PB1, PB2, PB3, PB4, PC1, PC2, PC3
179.140		**TOTAL AREA**

PreDevelopment Updated 25 Yr
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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	179.140	179.140		PA1, PA2, PA3, PB1, PB2, PB3, PB4, PC1, PC2, PC3
0.000	**0.000**	**0.000**	**0.000**	**179.140**	**179.140**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PA1: PA1	Runoff Area=19.840 ac 0.00% Impervious Runoff Depth=2.23" Tc=24.0 min CN=46 Runoff=28.74 cfs 3.688 af
Subcatchment PA2: PA2	Runoff Area=32.000 ac 0.00% Impervious Runoff Depth=1.57" Tc=41.4 min CN=40 Runoff=22.31 cfs 4.186 af
Subcatchment PA3: PA3	Runoff Area=19.200 ac 0.00% Impervious Runoff Depth=1.57" Tc=38.4 min CN=40 Runoff=13.91 cfs 2.511 af
Subcatchment PB1: PB1	Runoff Area=26.240 ac 0.00% Impervious Runoff Depth=1.57" Tc=36.6 min CN=40 Runoff=19.49 cfs 3.432 af
Subcatchment PB2: PB2	Runoff Area=3.840 ac 0.00% Impervious Runoff Depth=1.79" Tc=19.2 min CN=42 Runoff=4.48 cfs 0.571 af
Subcatchment PB3: PB3	Runoff Area=6.400 ac 0.00% Impervious Runoff Depth=1.57" Tc=26.4 min CN=40 Runoff=5.49 cfs 0.837 af
Subcatchment PB4: PB4	Runoff Area=13.380 ac 0.00% Impervious Runoff Depth=1.57" Tc=15.6 min CN=40 Runoff=13.85 cfs 1.750 af
Subcatchment PC1: PC1	Runoff Area=45.440 ac 0.00% Impervious Runoff Depth=1.79" Tc=36.0 min CN=42 Runoff=40.94 cfs 6.761 af
Subcatchment PC2: PC2	Runoff Area=9.600 ac 0.00% Impervious Runoff Depth=2.34" Tc=16.8 min CN=47 Runoff=17.12 cfs 1.875 af
Subcatchment PC3: PC3	Runoff Area=3.200 ac 0.00% Impervious Runoff Depth=1.68" Tc=22.8 min CN=41 Runoff=3.20 cfs 0.447 af

Total Runoff Area = 179.140 ac Runoff Volume = 26.059 af Average Runoff Depth = 1.75"
100.00% Pervious = 179.140 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment PA1: PA1

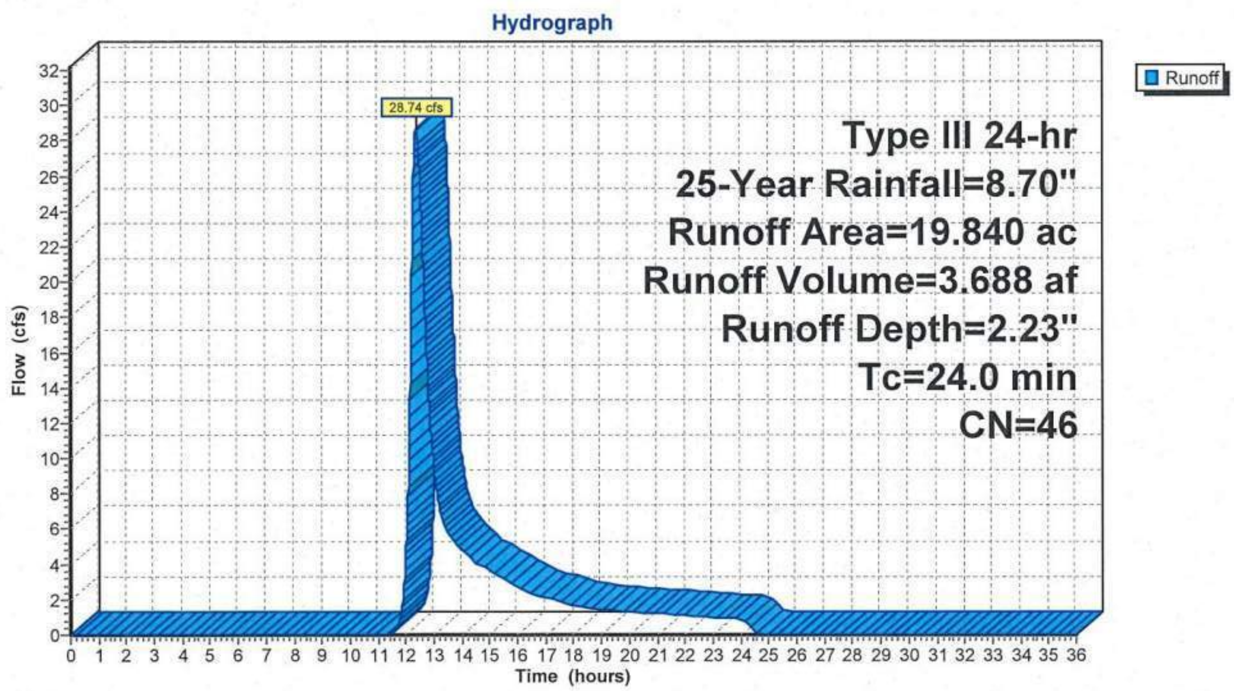
Runoff = 28.74 cfs @ 12.38 hrs, Volume= 3.688 af, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	19.840	46	
	19.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.0					**Direct Entry,**

Subcatchment PA1: PA1



Summary for Subcatchment PA2: PA2

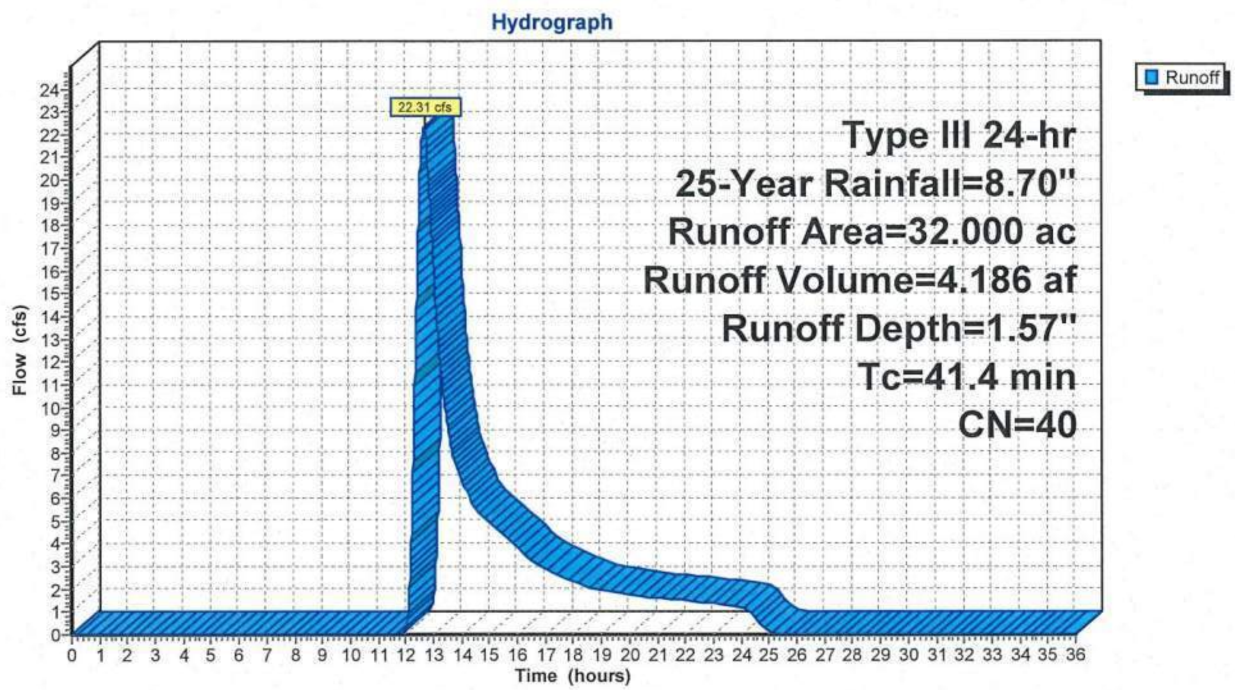
Runoff = 22.31 cfs @ 12.69 hrs, Volume= 4.186 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	32.000	40	
	32.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
41.4					**Direct Entry,**

Subcatchment PA2: PA2



Summary for Subcatchment PA3: PA3

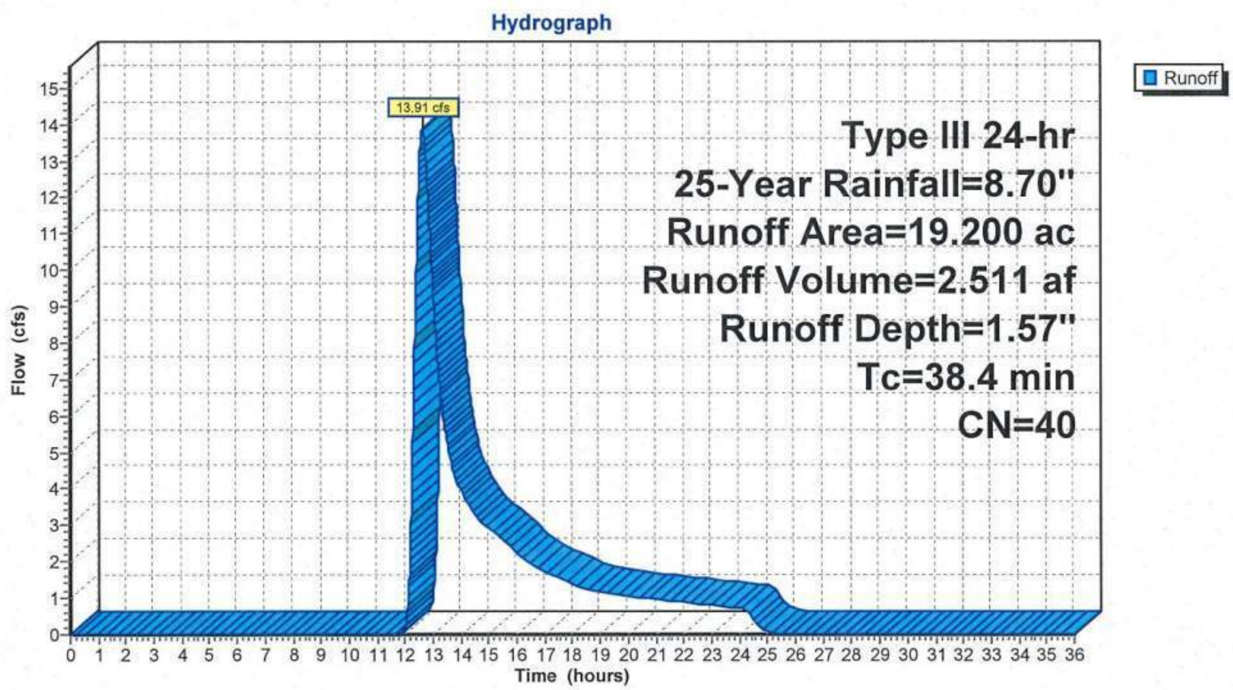
Runoff = 13.91 cfs @ 12.64 hrs, Volume= 2.511 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	19.200	40	
	19.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
38.4					**Direct Entry, Direct Entry**

Subcatchment PA3: PA3



Summary for Subcatchment PB1: PB1

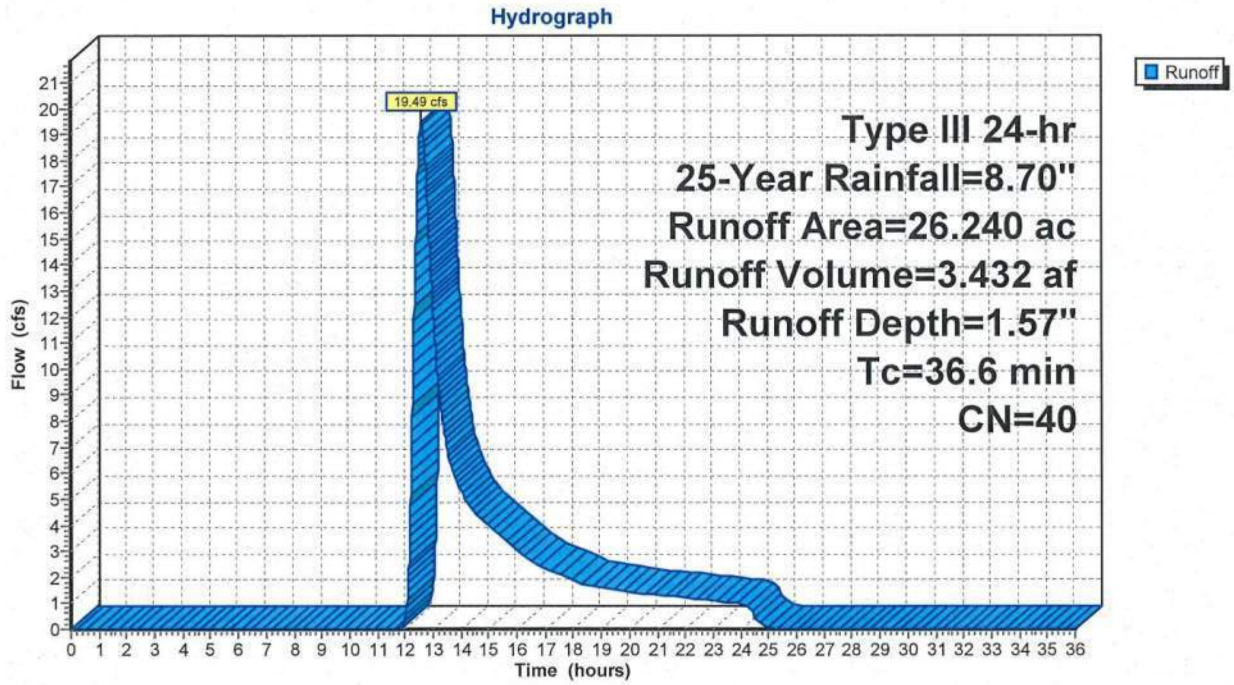
Runoff = 19.49 cfs @ 12.61 hrs, Volume= 3.432 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	26.240	40	
	26.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.6					**Direct Entry,**

Subcatchment PB1: PB1



Summary for Subcatchment PB2: PB2

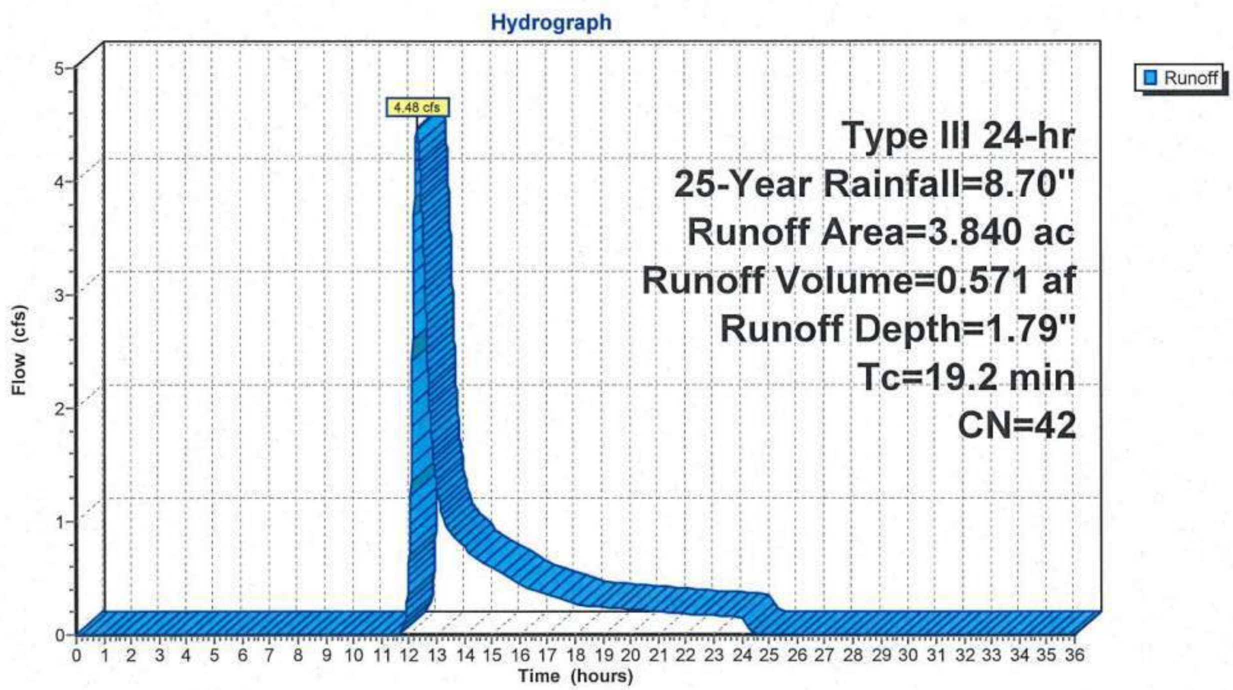
Runoff = 4.48 cfs @ 12.31 hrs, Volume= 0.571 af, Depth= 1.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	3.840	42	
	3.840		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.2					**Direct Entry,**

Subcatchment PB2: PB2



Summary for Subcatchment PB3: PB3

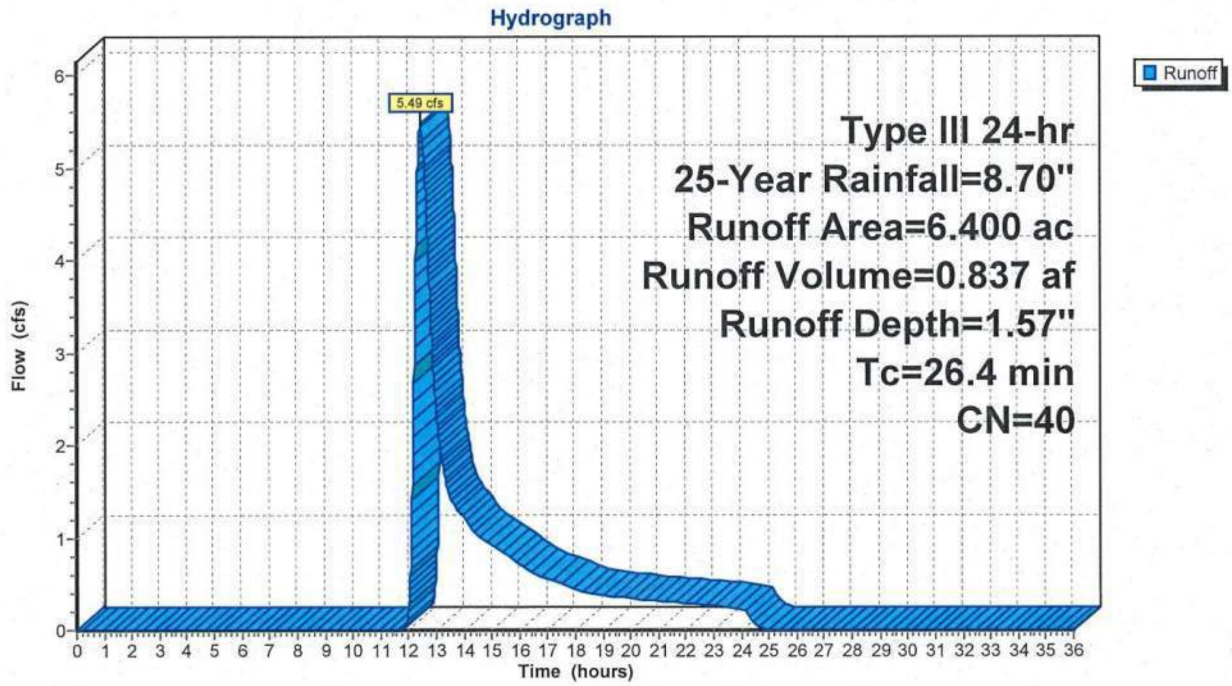
Runoff = 5.49 cfs @ 12.46 hrs, Volume= 0.837 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	6.400	40	
	6.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4					**Direct Entry,**

Subcatchment PB3: PB3



Summary for Subcatchment PB4: PB4

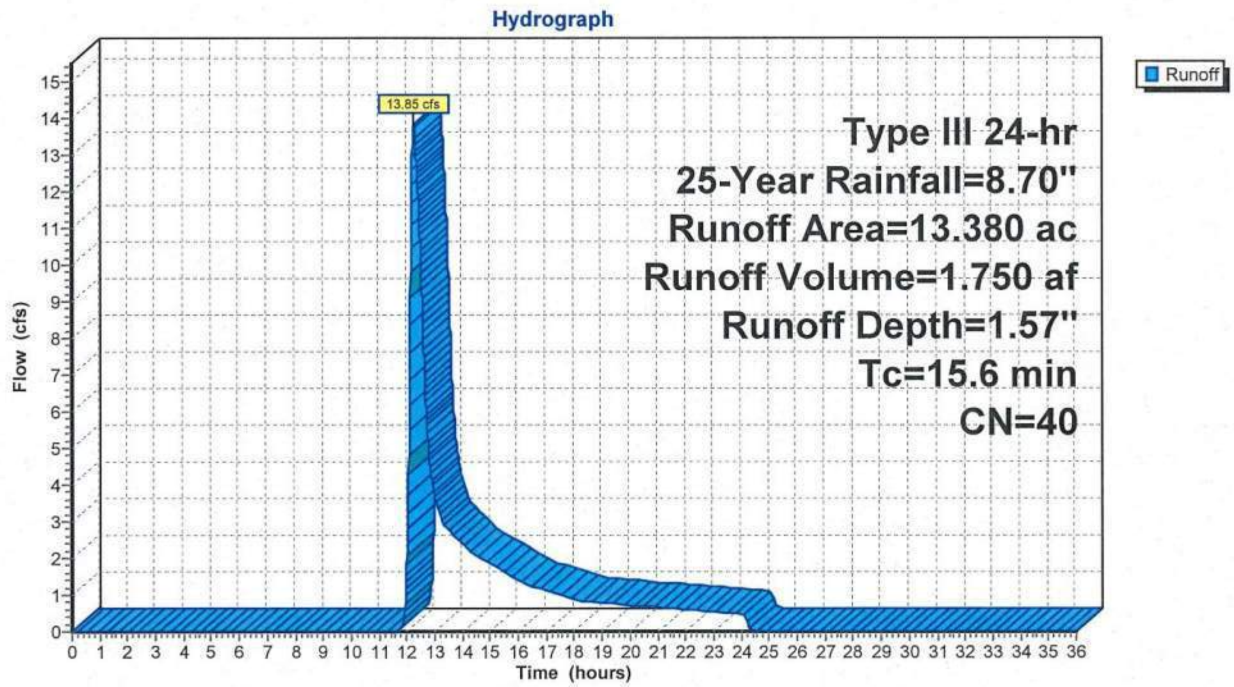
Runoff = 13.85 cfs @ 12.26 hrs, Volume= 1.750 af, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	13.380	40	
	13.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6					**Direct Entry,**

Subcatchment PB4: PB4



Summary for Subcatchment PC1: PC1

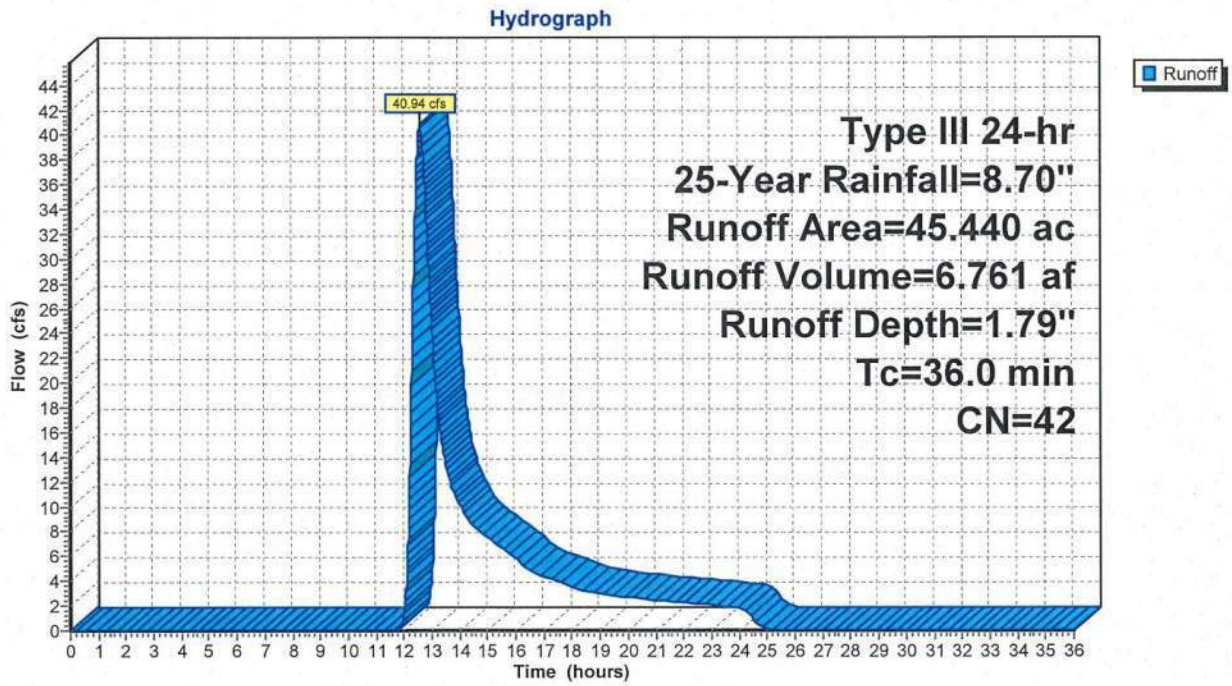
Runoff = 40.94 cfs @ 12.60 hrs, Volume= 6.761 af, Depth= 1.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	45.440	42	
	45.440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
36.0					**Direct Entry,**

Subcatchment PC1: PC1



Summary for Subcatchment PC2: PC2

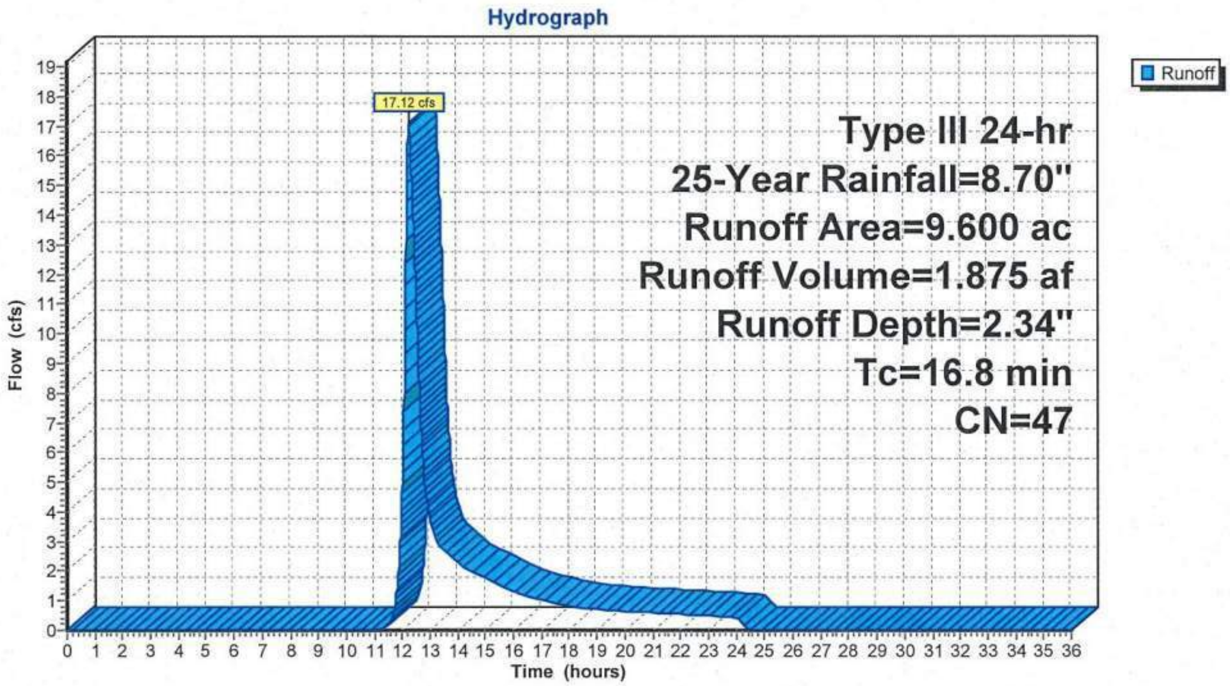
Runoff = 17.12 cfs @ 12.26 hrs, Volume= 1.875 af, Depth= 2.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	9.600	47	
	9.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.8					**Direct Entry,**

Subcatchment PC2: PC2



Summary for Subcatchment PC3: PC3

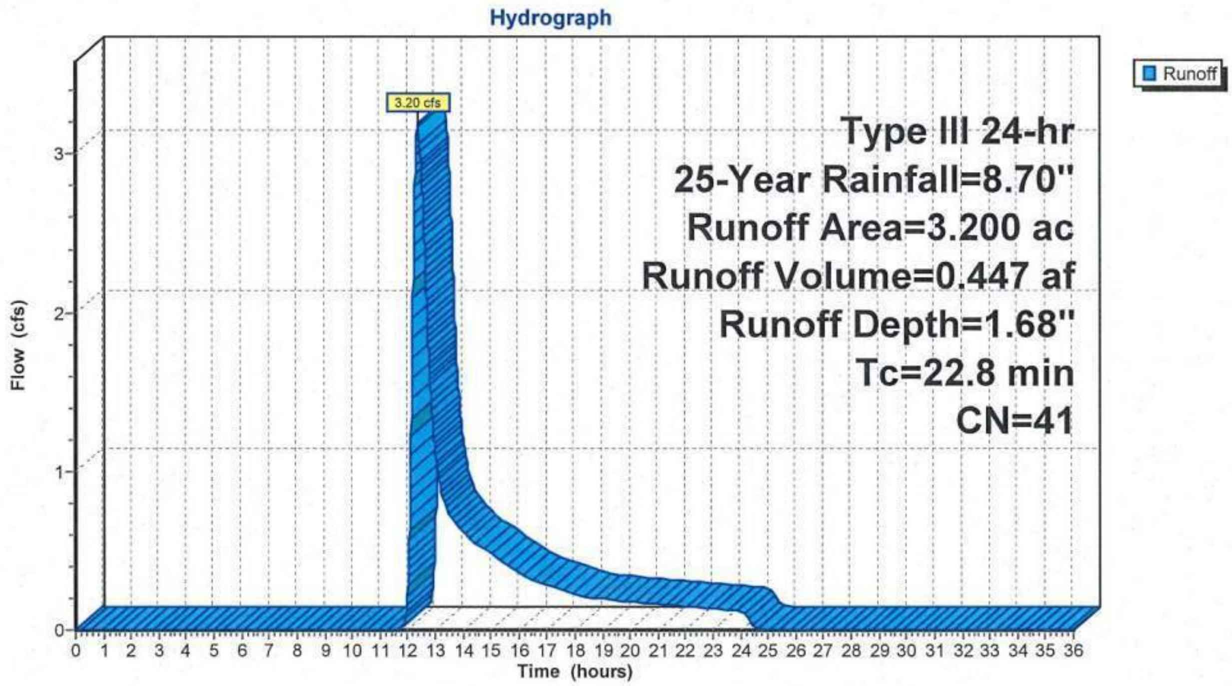
Runoff = 3.20 cfs @ 12.39 hrs, Volume= 0.447 af, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	3.200	41	
	3.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.8					**Direct Entry,**

Subcatchment PC3: PC3



APPENDIX 6A.2.6

NATIONAL ENGINEERING HANDBOOK (NEH), CHAPTER 15, FIGURE 15-4 VELOCITY VERSUS SLOPE FOR SHALLOW CONCENTRATED FLOW [ANNOTATED]

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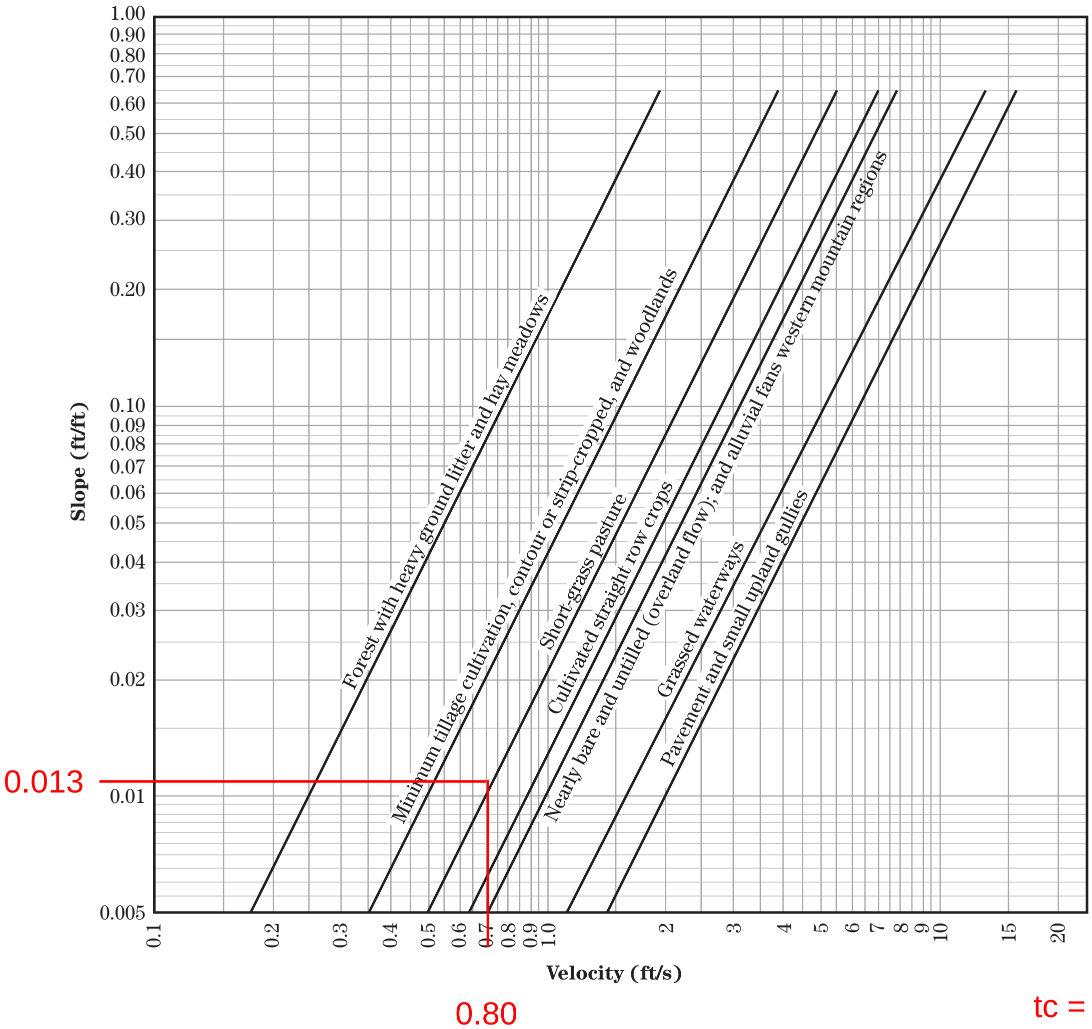
Figure 15–4 Velocity versus slope for shallow concentrated flow



PB4

Elev 60 ft → Elev 50 ft

s = 10 ft/750 ft =$0.01\overline{3}$

tc = 750 ft/0.80 ft/sec = 937.5 sec

tc = 937.5 sec/60 sec/min = 15.6 min

Table 15–3 Equations and assumptions developed from figure 15–4

Flow type	**Depth (ft)**	**Manning's *n***	**Velocity equation (ft/s)**
Pavement and small upland gullies	0.2	0.025	$V = 20.328(s)^{0.5}$
Grassed waterways	0.4	0.050	$V = 16.135(s)^{0.5}$
Nearly bare and untilled (overland flow); and alluvial fans in western mountain regions	0.2	0.051	$V = 9.965(s)^{0.5}$
Cultivated straight row crops	0.2	0.058	$V = 8.762(s)^{0.5}$
Short-grass pasture	0.2	0.073	$V = 6.962(s)^{0.5}$
Minimum tillage cultivation, contour or strip-cropped, and woodlands	0.2	0.101	$V = 5.032(s)^{0.5}$
Forest with heavy ground litter and hay meadows	0.2	0.202	$V = 2.516(s)^{0.5}$

APPENDIX 6A.2.7

PRE-DEVELOPMENT DRAINAGE MAP SOLID WASTE LANDFILL PERMIT 235-B AMENDMENT FIGURE A-1 (UPDATED PERMITTED CONDITIONS)

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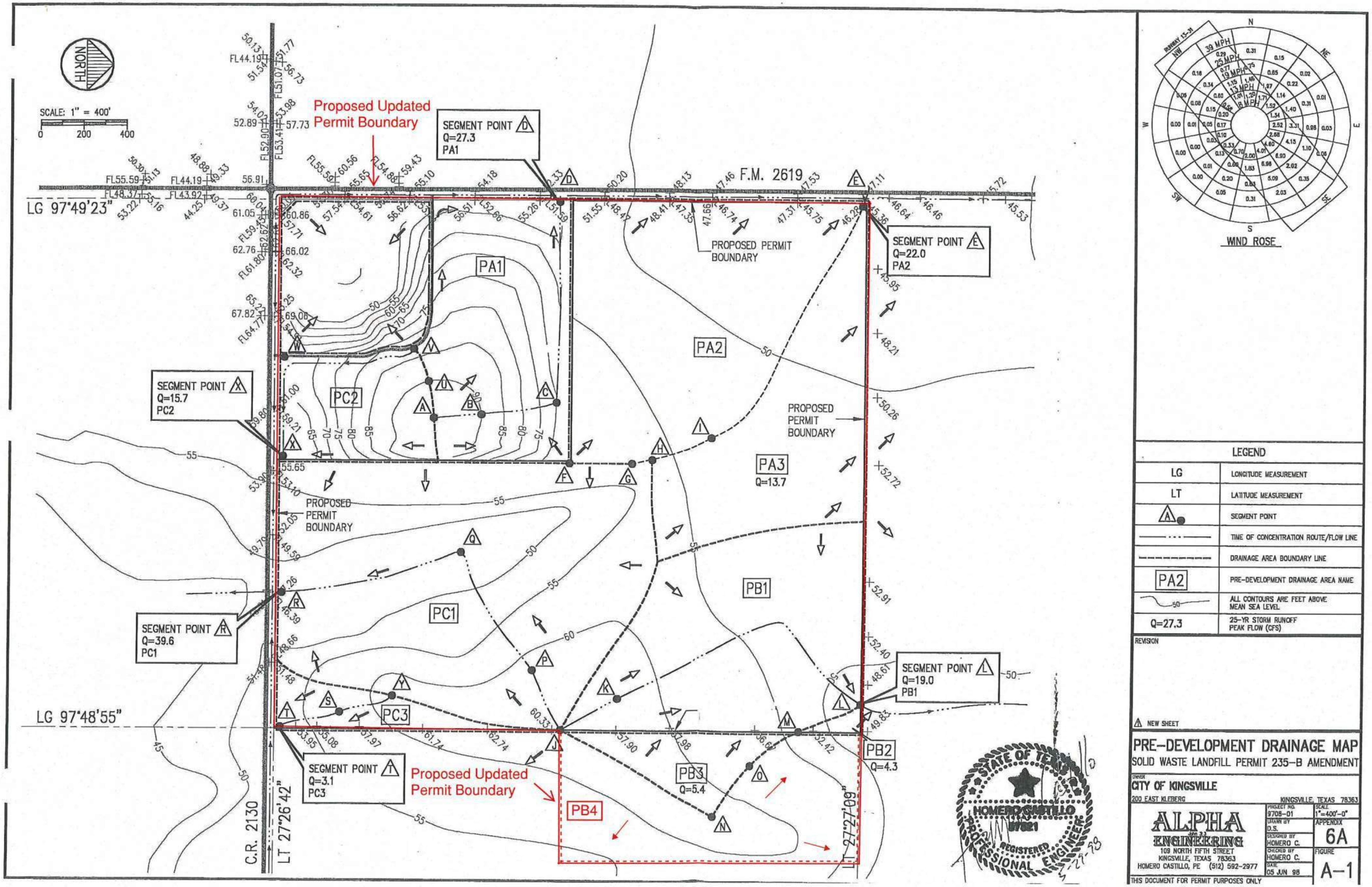

APPENDIX 6B

SITE POST-DEVELOPMENT CONDITIONS

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APPENDIX 6B.1

USGS ATLAS OF DEPTH-DURATION FREQUENCY OF PRECIPITATION ANNUAL MAXIMA FOR TEXAS-DEPTH OF PRECIPITATION FOR 25 YR-24 HR & 100 YR-24 HR [ANNOTATED]

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USGS
science for a changing world

In cooperation with the Texas Department of Transportation

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

Scientific Investigations Report 2004–5041
(TxDOT Implementation Report 5–1301–01–1)

U.S. Department of the Interior
U.S. Geological Survey

Technical Report Documentation Page

1. Report No. FHWA/TX-04/5-1301-01-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ATLAS OF DEPTH-DURATION FREQUENCY OF PRECIPITATION ANNUAL MAXIMA FOR TEXAS		5. Report Date June 2004 6. Performing Organization Code
7. Author(s) William H. Asquith and Meghan C. Roussel		8. Performing Organization Report No. SIR 2004–5041
9. Performing Organization Name and Address U.S. Geological Survey Water Resources Division 8027 Exchange Drive Austin, Texas 78754		10. Work Unit No. (TRAIS) 11. Contract or Grant No. Project 5–1301
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office 4000 Jackson Ave., Bldg. 1 P.O. Box 5080 Austin, TX 78731	U.S. Geological Survey Water Resources Division 8027 Exchange Drive Austin, Texas 78754	13. Type of Report and Period Covered Research from 2003 to 2004 14. Sponsoring Agency Code
15. Supplementary Notes Project conducted in cooperation with the Texas Department of Transportation and the Federal Highway Administration.		
16. Abstract Ninety-six maps depicting the spatial variation of the depth-duration frequency of precipitation annual maxima for Texas are presented. The recurrence intervals represented are 2, 5, 10, 25, 50, 100, 250, and 500 years. The storm durations represented are 15 and 30 minutes; 1, 2, 3, 6, and 12 hours; and 1, 2, 3, 5, and 7 days. The maps were derived using geographically referenced parameter maps of probability distributions used in previously published research by the U.S. Geological Survey to model the magnitude and frequency of precipitation annual maxima for Texas. The maps in this report apply that research and update depth-duration frequency of precipitation maps available in earlier studies performed by the National Weather Service.		
17. Key Words Precipitation, Depth duration frequency, Annual precipitation maxima, L-moments, Texas		18. Distribution Statement No restrictions.
19. Security Classif. (of report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of pages 106 22. Price $4.00

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Cover:

West Sister Creek near Sisterdale, Texas, on FM 473, Kendall County, May 10, 2004.

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

By William H. Asquith and Meghan C. Roussel

In cooperation with the Texas Department of Transportation

Scientific Investigations Report 2004–5041
(TxDOT Implementation Report 5–1301–01–1)

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U.S. Geological Survey

U.S. Department of the Interior
Gale A. Norton, Secretary

U.S. Geological Survey
Charles G. Groat, Director

U.S. Geological Survey, Reston, Virginia: 2004
For sale by U.S. Geological Survey, Information Services
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Denver, CO 80225

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Suggested citation:

Asquith, W.H., and Roussel, M.C., 2004, Atlas of depth-duration frequency of precipitation annual maxima for Texas: U.S. Geological Survey Scientific Investigations Report 2004–5041, 106 p.

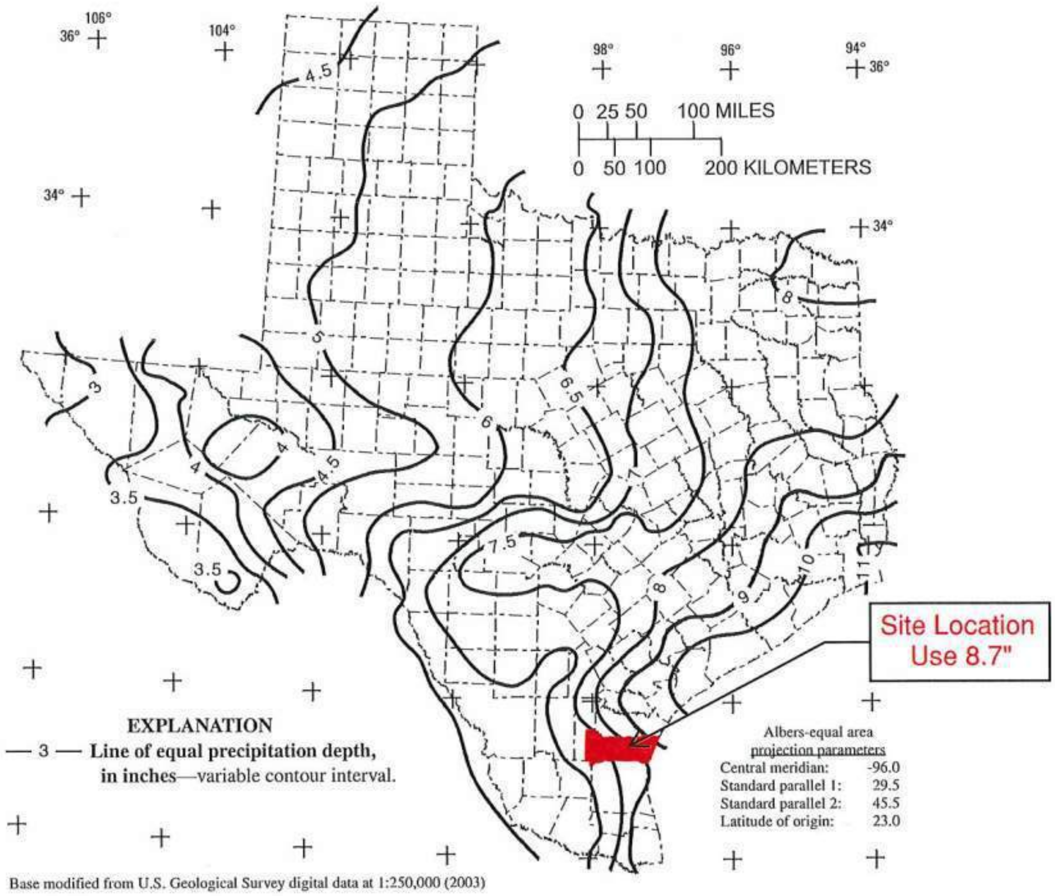

Figure 47. Depth of precipitation for 25-year storm for 1-day duration in Texas.

78 Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

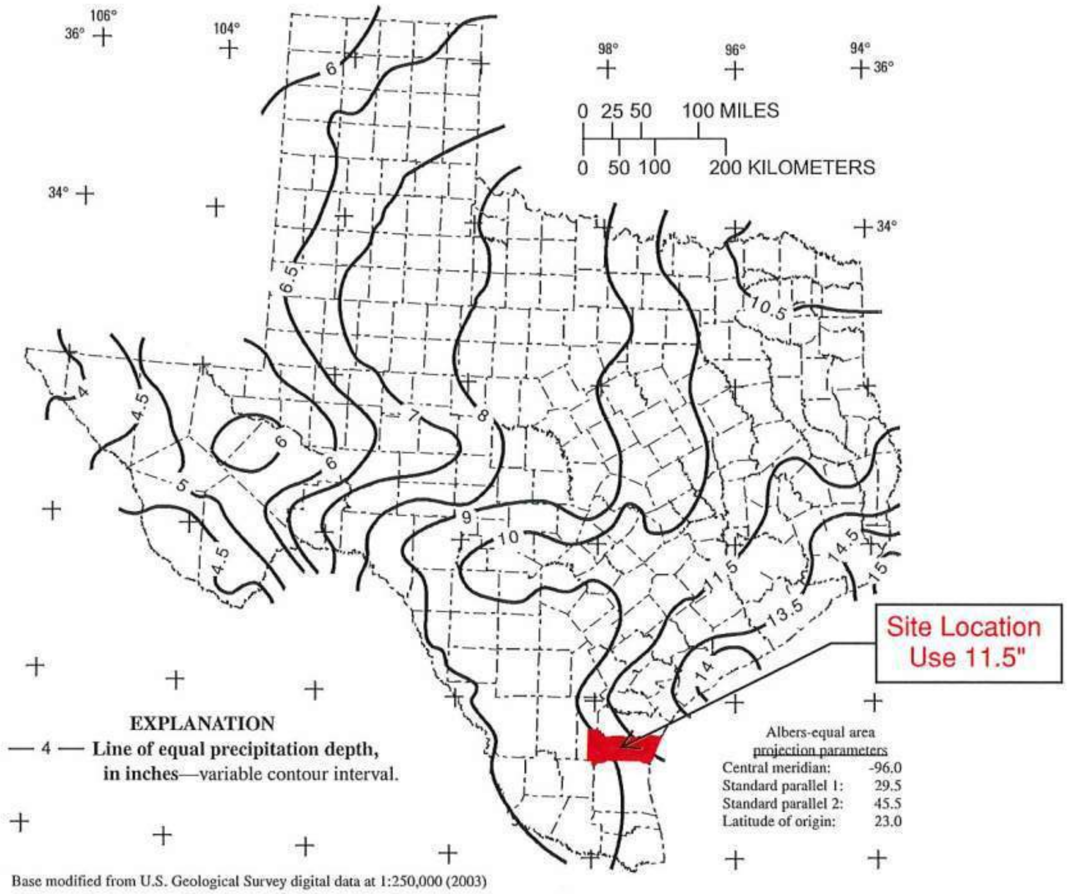

Figure 71. Depth of precipitation for 100-year storm for 1-day duration in Texas.

APPENDIX 6B.2

TABLE 6B-1 HYDROLOGIC SOIL GROUPS FOR ON-SITE SOILS (FROM NRCS, 2015) AND CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL FINAL DRAINAGE AREAS

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Table 6B-1. Hydrologic Soil Groups for On-Site Soils
(from NRCS, 2015)

RUSLE2 Related Attributes - Kenedy and Kleberg Counties, Texas									
Map Symbol and Soil Name	Percent of AOI	Pct of Map Unit	Slope Length (ft)	Hydrologic Soil Group	Kf	T Factor	Representative Value		
							% Sand	% Silt	% Clay
CkA - Clareville Clay Loam 0 to 1 percent slopes	10.7	90	98	C	0.24	5	33.5	36.5	30.0
CmA - Colmena Fine Sandy Loam 0 to 1 percent slopes	9.3	90	98	B	0.2	5	66.1	19.9	14.0
PIT - Pits, Quarry	80.0	-	-	-	-	-	-	-	-

City of Kingsville Municipal Solid Waste Landfill Final Drainage Areas

Drainage Area Designation	Area (Acres)
A1T	7.425
A1S	8.009
A2T	5.120
A2S	12.241
A3T	7.489
A3S	10.760
B1T	7.499
B1S	14.884
B2T	4.309
B2S	8.806
C1T	6.292
C1S	11.506
C2T	5.249
C2S	10.038
C3	3.500
C4	9.500
C5	2.690
C6	3.982
1C	1.000
2C	1.480
3C	1.640
4C	0.910
5C	1.000
6C	1.000
7C	1.00
PAR	7.440
PBR	4.290
PCR	4.540
C1SN1	0.250
C1SN2	0.250
C1SS1	0.250
C1SS2	0.250
Total	164.60

APPENDIX 6B.3

PERMIT AMENDMENT-POST DEVELOPMENT-TOP DRAINAGE AREAS/SLOPES HYDROCAD (Tc-TIME OF CONCENTRATION) INPUT DATA

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HANSON

JOB NO. 8514-03 City of Kingsville Landfill

SHEET NO. 1 of 2

DESCRIPTION Permit Amendment – Post Development – Top Drainage Areas / Slopes

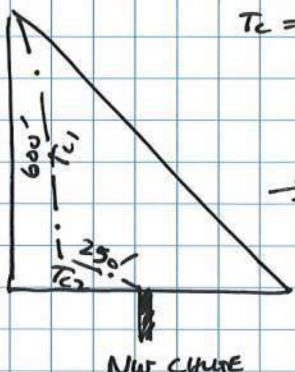
DATE 8/26/18

HydroCAD – T_c (Time of Concentration) Input Data

BY JCG

TOP

B2T



$$T_c = \overset{T_{c1}}{\frac{600\text{ ft}}{1.3\text{ ft/sec}}} + \overset{T_{c2}}{\frac{250\text{ ft}}{0.7\text{ ft/sec}}} = 818.68\text{ sec}$$

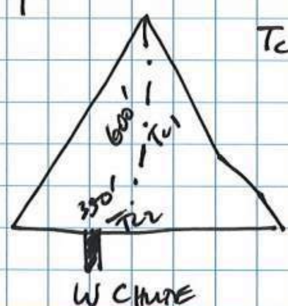
$$461.54\text{ sec} + 357.14\text{ sec} \Rightarrow \frac{818.68\text{ sec}}{60\text{ sec/min}} \Rightarrow 13.64\text{ min}$$

→ Overland flow @ 4% slope to Diversion Berm @ 1% slope to chute

SLOPES

B2S use conservative value of T_c = 10 min
→ water being diverted to chutes by diversion berms

B1T



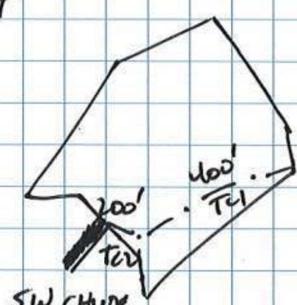
$$T_c = \overset{T_{c1}}{\frac{600\text{ ft}}{1.3\text{ ft/sec}}} + \overset{T_{c2}}{\frac{350\text{ ft}}{0.7\text{ ft/sec}}} = 961.54\text{ sec}$$

$$461.54\text{ sec} + 500\text{ sec} \Rightarrow \frac{961.54\text{ sec}}{60\text{ sec/min}} \Rightarrow 16.02\text{ min}$$

→ Overland Flow @ 4% Slope to Diversion Berm @ 1% Slope to chute

B1S use conservative value of T_c = 10 min
→ water being diverted to chutes by diversion berms

A1T



$$T_c = \frac{400\text{ ft}}{1.3\text{ ft/sec}} + \frac{200\text{ ft}}{0.7\text{ ft/sec}} \Rightarrow 593\text{ sec}$$

$$307.7\text{ sec} + 285.7\text{ sec} \Rightarrow \frac{593\text{ sec}}{60\text{ sec/min}} \Rightarrow 9.89\text{ min}$$

use 10 min

→ Overland Flow @ 4% Slope to Diversion Berm @ 1% Slope to chute

A1S use conservative value of T_c = 10 min
→ water being diverted to chutes by diversion berms.

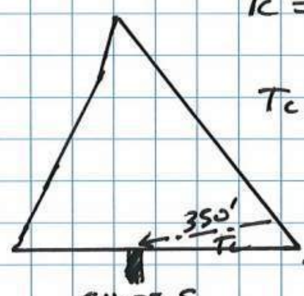
HANSON
Engineering | Planning | Allied Services

JOB NO. 8514-03 City of Kingsville Landfill	SHEET NO. 2 of 2
DESCRIPTION Permit Amendment – Post Development – Top Drainage Areas/Slopes	DATE 8/26/18
HydroCAD – Tc (Time of Concentration) Input Data	BY JCG

TOP

SLOPES

A2T



$$T_c = \frac{350\text{ ft}}{0.7\text{ ft/sec}} \Rightarrow 500\text{ SEC}$$

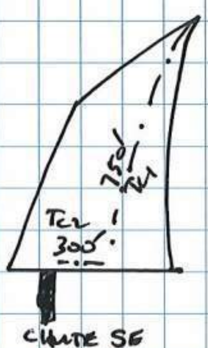
$$T_c = \frac{500\text{ sec}}{60\ \frac{\text{sec}}{\text{min}}} \Rightarrow 8.3\text{ min}$$

USE 10 min

→ FLOW @ 1% SLOPE TO CHUTE

A2S USE CONSERVATIVE VALUE OF T_c = 10 min, → WATER being DIVERTED TO CHUTES BY DIVERSION BERMS.

A3T



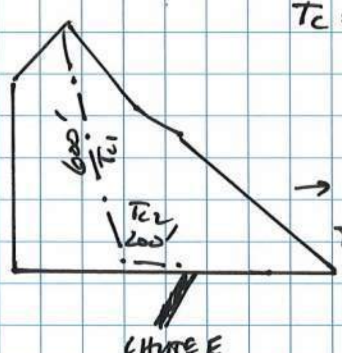
$$T_c = \overset{T_{c1}}{\frac{750\text{ ft}}{1.3\text{ ft/sec}}} + \overset{T_{c2}}{\frac{300\text{ ft}}{0.7\text{ ft/sec}}} \Rightarrow 1005.49\text{ SEC}$$

$$T_c = 576.92 + 428.57 \Rightarrow \frac{1005.49\text{ sec}}{60\text{ sec/min}} \Rightarrow 16.76\text{ min}$$

→ OVERLAND FLOW @ 4% SLOPE TO DIVERSION BERM @ 1% to CHUTE

A3S USE CONSERVATIVE VALUE OF T_c=10min → WATER BEING DIVERTED TO CHUTES BY DIVERSION BERMS

C1T



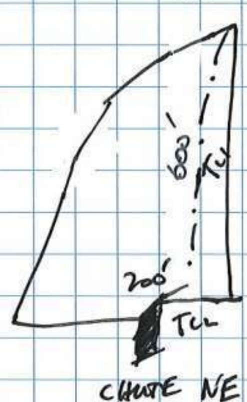
$$T_c = \overset{T_{c1}}{\frac{600\text{ ft}}{1.3\text{ ft/sec}}} + \overset{T_{c2}}{\frac{200\text{ ft}}{0.7\text{ ft/sec}}} \Rightarrow 747.25\text{ sec}$$

$$461.54\text{ sec} + 285.71\text{ sec} \Rightarrow \frac{747.25\text{ sec}}{60\text{ sec/min}} \Rightarrow 12.45\text{ min}$$

→ OVERLAND FLOW @ 4% SLOPE TO DIVERSION BERM @ 1% to CHUTE

C1S USE CONSERVATIVE VALUE OF T_c = 10 min → WATER BEING DIVERTED TO CHUTES BY DIVERSION BERMS.

C2T



$$T_c = \overset{T_{c1}}{\frac{600\text{ ft}}{1.3\text{ ft/sec}}} + \overset{T_{c2}}{\frac{200\text{ ft}}{0.7\text{ ft/sec}}} \Rightarrow 747.25\text{ sec}$$

$$461.54\text{ sec} + 285.71\text{ sec} \Rightarrow \frac{747.25\text{ sec}}{60\ \frac{\text{sec}}{\text{min}}} \Rightarrow 12.45\text{ min}$$

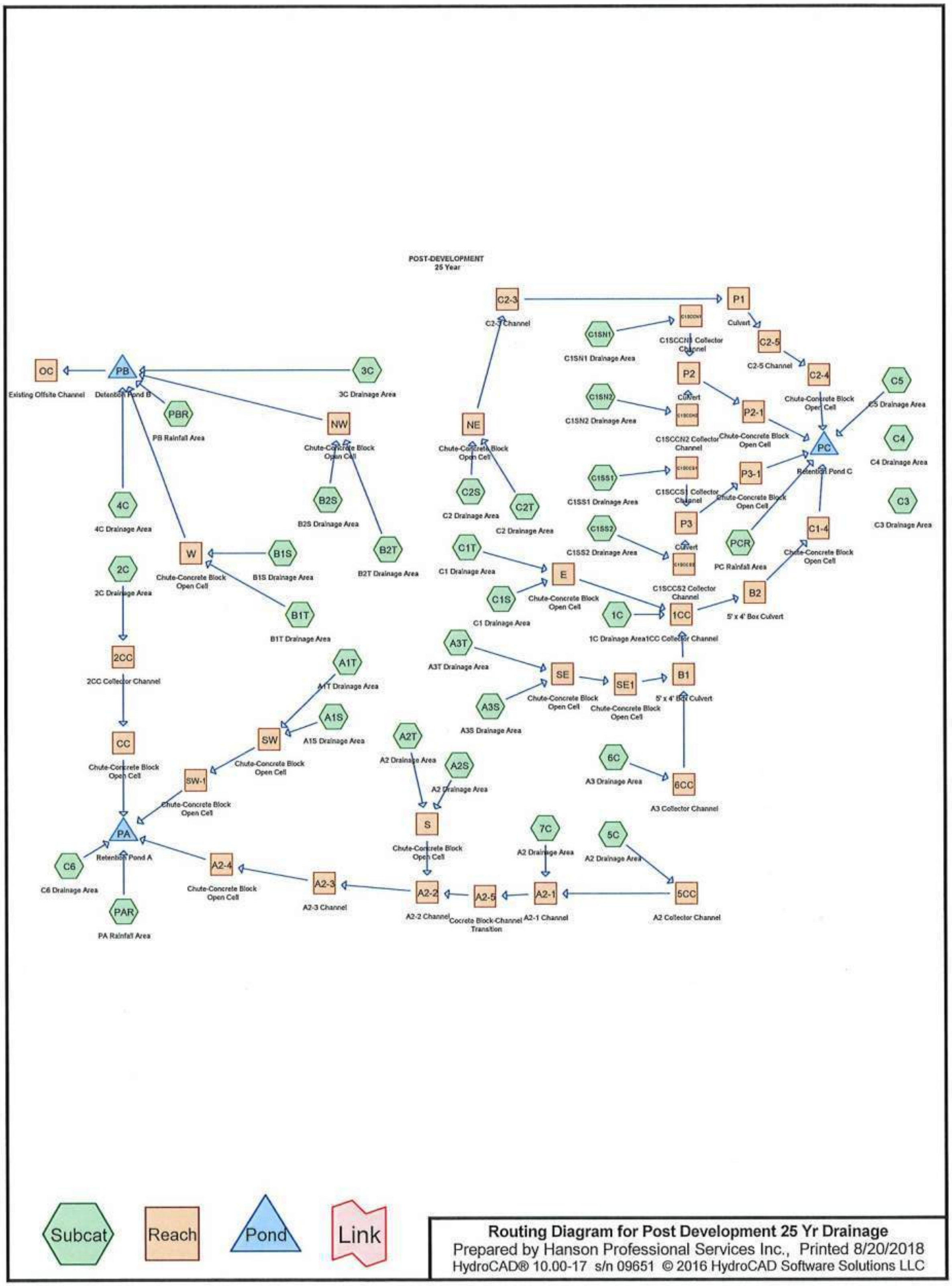
→ OVERLAND FLOW @ 4% SLOPE TO DIVERSION BERM @ 1% SLOPE to CHUTE

C2S USE CONSERVATIVE VALUE OF T_c = 10 min → WATER BEING DIVERTED TO CHUTES BY DIVERSION BERMS.

APPENDIX 6B.4

HYDROCAD MODEL POST DEVELOPMENT-25 YEAR

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.


POST-DEVELOPMENT
25 Year
Subcat
Reach
Pond
Link
Routing Diagram for Post Development 25 Yr Drainage
Prepared by Hanson Professional Services Inc., Printed 8/20/2018
HydroCAD® 10.00-17 s/n 09651 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
128.657	79	50-75% Grass cover, Fair, HSG C (1C, 2C, 3C, 4C, 5C, 6C, 7C, A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1SN1, C1SN2, C1SS1, C1SS2, C1T, C2S, C2T)
19.672	86	<50% Grass cover, Poor, HSG C (C3, C4, C5, C6)
16.270	98	Water Surface, 0% imp, HSG C (PAR, PBR, PCR)
164.599	**82**	**TOTAL AREA**

Post Development 25 Yr Drainage
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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
164.599	HSG C	1C, 2C, 3C, 4C, 5C, 6C, 7C, A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1SN1, C1SN2, C1SS1, C1SS2, C1T, C2S, C2T, C3, C4, C5, C6, PAR, PBR, PCR
0.000	HSG D	
0.000	Other	
164.599		**TOTAL AREA**

Post Development 25 Yr Drainage
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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	128.657	0.000	0.000	128.657	50-75% Grass cover, Fair	1C, 2C, 3C, 4C, 5C, 6C, 7C, A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1SN1, C1SN2, C1SS1, C1SS2, C1T, C2S, C2T
0.000	0.000	19.672	0.000	0.000	19.672	<50% Grass cover, Poor	C3, C4, C5, C6
0.000	0.000	16.270	0.000	0.000	16.270	Water Surface, 0% imp	PAR, PBR, PCR
0.000	**0.000**	**164.599**	**0.000**	**0.000**	**164.599**	**TOTAL AREA**	

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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	B1	56.54	53.89	464.0	0.0057	0.013	60.0	48.0	0.0
2	B2	53.45	49.80	200.0	0.0183	0.013	60.0	48.0	0.0
3	P1	51.75	51.11	64.0	0.0100	0.011	48.0	0.0	0.0
4	P2	54.39	53.31	72.0	0.0150	0.011	18.0	0.0	0.0
5	P3	55.41	54.33	72.0	0.0150	0.011	18.0	0.0	0.0
6	PB	47.00	46.75	128.0	0.0020	0.013	21.0	0.0	0.0
7	PB	47.00	46.75	128.0	0.0020	0.013	21.0	0.0	0.0

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1C: 1C Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=6.22 cfs 0.514 af

Subcatchment 2C: 2C Drainage Area Runoff Area=1.480 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=9.20 cfs 0.760 af

Subcatchment 3C: 3C Drainage Area Runoff Area=1.640 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=10.20 cfs 0.842 af

Subcatchment 4C: 4C Drainage Area Runoff Area=0.910 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=5.66 cfs 0.467 af

Subcatchment 5C: A2 Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=6.22 cfs 0.514 af

Subcatchment 6C: A3 Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=6.22 cfs 0.514 af

Subcatchment 7C: A2 Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=6.22 cfs 0.514 af

Subcatchment A1S: A1S Drainage Area Runoff Area=8.009 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=49.80 cfs 4.113 af

Subcatchment A1T: A1T Drainage Area Runoff Area=7.425 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=46.16 cfs 3.813 af

Subcatchment A2S: A2 Drainage Area Runoff Area=12.241 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=76.11 cfs 6.287 af

Subcatchment A2T: A2 Drainage Area Runoff Area=5.120 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=31.83 cfs 2.629 af

Subcatchment A3S: A3S Drainage Area Runoff Area=10.760 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=66.90 cfs 5.526 af

Subcatchment A3T: A3T Drainage Area Runoff Area=7.489 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=1,050' Tc=16.7 min CN=79 Runoff=38.81 cfs 3.846 af

Subcatchment B1S: B1S Drainage Area Runoff Area=14.884 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=92.54 cfs 7.644 af

Subcatchment B1T: B1T Drainage Area Runoff Area=7.499 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=950' Tc=16.0 min CN=79 Runoff=39.52 cfs 3.851 af

Subcatchment B2S: B2S Drainage Area Runoff Area=8.806 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=54.75 cfs 4.522 af

Subcatchment B2T: B2T Drainage Area Runoff Area=4.309 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=850' Tc=13.7 min CN=79 Runoff=24.07 cfs 2.213 af

Subcatchment C1S: C1 Drainage Area Runoff Area=11.506 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=71.54 cfs 5.909 af

Subcatchment C1SN1: C1SN1 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=1.55 cfs 0.128 af

Subcatchment C1SN2: C1SN2 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=1.55 cfs 0.128 af

Subcatchment C1SS1: C1SS1 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=1.55 cfs 0.128 af

Subcatchment C1SS2: C1SS2 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=1.55 cfs 0.128 af

Subcatchment C1T: C1 Drainage Area Runoff Area=6.292 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=800' Tc=12.5 min CN=79 Runoff=36.29 cfs 3.231 af

Subcatchment C2S: C2 Drainage Area Runoff Area=10.038 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=62.41 cfs 5.155 af

Subcatchment C2T: C2 Drainage Area Runoff Area=5.249 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=800' Tc=12.5 min CN=79 Runoff=30.27 cfs 2.696 af

Subcatchment C3: C3 Drainage Area Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=7.01"
Tc=10.0 min CN=86 Runoff=24.05 cfs 2.045 af

Subcatchment C4: C4 Drainage Area Runoff Area=9.500 ac 0.00% Impervious Runoff Depth=7.01"
Tc=10.0 min CN=86 Runoff=65.28 cfs 5.551 af

Subcatchment C5: C5 Drainage Area Runoff Area=2.690 ac 0.00% Impervious Runoff Depth=7.01"
Tc=10.0 min CN=86 Runoff=18.49 cfs 1.572 af

Subcatchment C6: C6 Drainage Area Runoff Area=3.982 ac 0.00% Impervious Runoff Depth=7.01"
Tc=10.0 min CN=86 Runoff=27.36 cfs 2.327 af

Subcatchment PAR: PA Rainfall Area Runoff Area=7.440 ac 0.00% Impervious Runoff Depth=8.46"
Tc=0.0 min CN=98 Runoff=77.55 cfs 5.245 af

Subcatchment PBR: PB Rainfall Area Runoff Area=4.290 ac 0.00% Impervious Runoff Depth=8.46"
Tc=0.0 min CN=98 Runoff=44.71 cfs 3.024 af

Subcatchment PCR: PC Rainfall Area Runoff Area=4.540 ac 0.00% Impervious Runoff Depth=8.46"
Tc=0.0 min CN=98 Runoff=47.32 cfs 3.201 af

Reach 1CC: 1CC Collector Channel Avg. Flow Depth=4.52' Max Vel=3.89 fps Inflow=213.11 cfs 19.540 af
n=0.030 L=222.0' S=0.0020 '/' Capacity=2,157.50 cfs Outflow=211.91 cfs 19.540 af

Reach 2CC: 2CC Collector Channel Avg. Flow Depth=1.28' Max Vel=1.58 fps Inflow=9.20 cfs 0.760 af
n=0.030 L=650.0' S=0.0020 '/' Capacity=46.53 cfs Outflow=7.72 cfs 0.760 af

Reach 5CC: A2 Collector Channel Avg. Flow Depth=0.97' Max Vel=1.36 fps Inflow=6.22 cfs 0.514 af
n=0.030 L=595.0' S=0.0015 '/' Capacity=68.72 cfs Outflow=5.17 cfs 0.514 af

Reach 6CC: A3 Collector Channel Avg. Flow Depth=0.77' Max Vel=1.97 fps Inflow=6.22 cfs 0.514 af
n=0.030 L=740.0' S=0.0040 '/' Capacity=50.02 cfs Outflow=5.34 cfs 0.514 af

Reach A2-1: A2-1 Channel Avg. Flow Depth=1.24' Max Vel=1.57 fps Inflow=8.74 cfs 1.027 af
n=0.030 L=250.5' S=0.0015 '/' Capacity=83.47 cfs Outflow=8.70 cfs 1.027 af

Reach A2-2: A2-2 Channel Avg. Flow Depth=2.53' Max Vel=3.72 fps Inflow=114.51 cfs 9.943 af
n=0.025 L=257.0' S=0.0020 '/' Capacity=338.68 cfs Outflow=113.50 cfs 9.943 af

Reach A2-3: A2-3 Channel Avg. Flow Depth=2.57' Max Vel=3.19 fps Inflow=113.50 cfs 9.943 af
n=0.030 L=582.0' S=0.0020 '/' Capacity=532.10 cfs Outflow=108.05 cfs 9.943 af

Reach A2-4: Chute-Concrete Block Avg. Flow Depth=0.75' Max Vel=11.15 fps Inflow=108.05 cfs 9.943 af
n=0.025 L=250.0' S=0.0697 '/' Capacity=692.98 cfs Outflow=107.90 cfs 9.943 af

Reach A2-5: Cocrete Block-Channel Avg. Flow Depth=0.30' Max Vel=11.21 fps Inflow=8.70 cfs 1.027 af
n=0.025 L=5.6' S=0.2482 '/' Capacity=903.50 cfs Outflow=8.70 cfs 1.027 af

Reach B1: 5' x 4' Box Culvert Avg. Flow Depth=2.17' Max Vel=9.54 fps Inflow=103.76 cfs 9.886 af
60.0" x 48.0" Box Pipe n=0.013 L=464.0' S=0.0057 '/' Capacity=185.34 cfs Outflow=103.38 cfs 9.886 af

Reach B2: 5' x 4' Box Culvert Avg. Flow Depth=2.40' Max Vel=17.67 fps Inflow=211.91 cfs 19.540 af
60.0" x 48.0" Box Pipe n=0.013 L=200.0' S=0.0183 '/' Capacity=331.32 cfs Outflow=211.71 cfs 19.540 af

Reach C1-4: Chute-Concrete Block Avg. Flow Depth=1.01' Max Vel=23.03 fps Inflow=211.71 cfs 19.540 af
n=0.025 L=76.0' S=0.2474 '/' Capacity=872.67 cfs Outflow=211.66 cfs 19.540 af

Reach C1SCCN1: C1SCCN1 Collector Avg. Flow Depth=0.33' Max Vel=1.19 fps Inflow=1.55 cfs 0.128 af
n=0.030 L=285.0' S=0.0033 '/' Capacity=24.47 cfs Outflow=1.44 cfs 0.128 af

Reach C1SCCN2: C1SCCN2 Collector Avg. Flow Depth=0.33' Max Vel=1.19 fps Inflow=1.55 cfs 0.128 af
n=0.030 L=287.5' S=0.0033 '/' Capacity=24.36 cfs Outflow=1.44 cfs 0.128 af

Reach C1SCCS1: C1SCCS1 Collector Avg. Flow Depth=0.33' Max Vel=1.19 fps Inflow=1.55 cfs 0.128 af
n=0.030 L=280.0' S=0.0033 '/' Capacity=24.30 cfs Outflow=1.44 cfs 0.128 af

Reach C1SCCS2: C1SCCS2 Collector Avg. Flow Depth=0.33' Max Vel=1.19 fps Inflow=1.55 cfs 0.128 af
n=0.030 L=280.0' S=0.0033 '/' Capacity=24.30 cfs Outflow=1.44 cfs 0.128 af

Reach C2-3: C2-3 Channel Avg. Flow Depth=2.82' Max Vel=3.06 fps Inflow=91.74 cfs 7.851 af
n=0.030 L=882.0' S=0.0020 '/' Capacity=178.76 cfs Outflow=82.99 cfs 7.851 af

Reach C2-4: Chute-Concrete Block Avg. Flow Depth=0.58' Max Vel=19.49 fps Inflow=82.89 cfs 7.851 af
n=0.025 L=52.0' S=0.3269 '/' Capacity=1,003.23 cfs Outflow=82.88 cfs 7.851 af

Post Development 25 Yr Drainage *Type III 24-hr 25-Year Rainfall=8.70"*
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Reach C2-5: C2-5 Channel Avg. Flow Depth=1.08' Max Vel=8.22 fps Inflow=82.96 cfs 7.851 af
n=0.025 L=106.0' S=0.0293 '/' Capacity=492.25 cfs Outflow=82.89 cfs 7.851 af

Reach CC: Chute-Concrete Block Open Avg. Flow Depth=0.21' Max Vel=6.18 fps Inflow=7.72 cfs 0.760 af
n=0.025 L=160.0' S=0.1028 '/' Capacity=562.60 cfs Outflow=7.71 cfs 0.760 af

Reach E: Chute-Concrete Block Avg. Flow Depth=0.71' Max Vel=19.11 fps Inflow=106.93 cfs 9.140 af
n=0.025 L=462.0' S=0.2511 '/' Capacity=879.20 cfs Outflow=106.72 cfs 9.140 af

Reach NE: Chute-Concrete Block Avg. Flow Depth=0.66' Max Vel=18.27 fps Inflow=91.93 cfs 7.851 af
n=0.025 L=464.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=91.74 cfs 7.851 af

Reach NW: Chute-Concrete Block Avg. Flow Depth=0.60' Max Vel=17.38 fps Inflow=77.52 cfs 6.735 af
n=0.025 L=464.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=77.39 cfs 6.735 af

Reach OC: Existing Offsite Channel Avg. Flow Depth=1.82' Max Vel=1.72 fps Inflow=33.70 cfs 21.821 af
n=0.030 L=2,800.0' S=0.0010 '/' Capacity=44.23 cfs Outflow=32.78 cfs 21.722 af

Reach P1: Culvert Avg. Flow Depth=1.97' Max Vel=13.43 fps Inflow=82.99 cfs 7.851 af
48.0" Round Pipe n=0.011 L=64.0' S=0.0100 '/' Capacity=169.76 cfs Outflow=82.96 cfs 7.851 af

Reach P2: Culvert Avg. Flow Depth=0.44' Max Vel=6.62 fps Inflow=2.88 cfs 0.257 af
18.0" Round Pipe n=0.011 L=72.0' S=0.0150 '/' Capacity=15.20 cfs Outflow=2.88 cfs 0.257 af

Reach P2-1: Chute-Concrete Block Avg. Flow Depth=0.14' Max Vel=8.63 fps Inflow=2.88 cfs 0.257 af
n=0.025 L=60.0' S=0.3718 '/' Capacity=316.81 cfs Outflow=2.88 cfs 0.257 af

Reach P3: Culvert Avg. Flow Depth=0.44' Max Vel=6.62 fps Inflow=2.89 cfs 0.257 af
18.0" Round Pipe n=0.011 L=72.0' S=0.0150 '/' Capacity=15.20 cfs Outflow=2.89 cfs 0.257 af

Reach P3-1: Chute-Concrete Block Avg. Flow Depth=0.14' Max Vel=8.81 fps Inflow=2.89 cfs 0.257 af
n=0.025 L=60.0' S=0.3942 '/' Capacity=326.18 cfs Outflow=2.89 cfs 0.257 af

Reach S: Chute-Concrete Block Avg. Flow Depth=0.72' Max Vel=19.13 fps Inflow=107.94 cfs 8.916 af
n=0.025 L=459.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=107.70 cfs 8.916 af

Reach SE: Chute-Concrete Block Avg. Flow Depth=0.69' Max Vel=18.76 fps Inflow=100.71 cfs 9.372 af
n=0.025 L=450.0' S=0.2499 '/' Capacity=877.14 cfs Outflow=100.58 cfs 9.372 af

Reach SE1: Chute-Concrete Block Avg. Flow Depth=0.92' Max Vel=12.50 fps Inflow=100.58 cfs 9.372 af
n=0.025 L=62.0' S=0.0806 '/' Capacity=498.27 cfs Outflow=100.54 cfs 9.372 af

Reach SW: Chute-Concrete Block Avg. Flow Depth=0.67' Max Vel=18.50 fps Inflow=95.96 cfs 7.926 af
n=0.025 L=404.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=95.76 cfs 7.926 af

Reach SW-1: Chute-Concrete Block Avg. Flow Depth=0.80' Max Vel=14.51 fps Inflow=95.76 cfs 7.926 af
n=0.025 L=266.0' S=0.1269 '/' Capacity=624.99 cfs Outflow=95.59 cfs 7.926 af

Reach W: Chute-Concrete Block Avg. Flow Depth=0.78' Max Vel=20.06 fps Inflow=127.46 cfs 11.495 af
n=0.025 L=464.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=127.27 cfs 11.495 af

Pond PA: Retention Pond A Peak Elev=47.33' Storage=26.200 af Inflow=225.75 cfs 26.201 af
Outflow=0.00 cfs 0.000 af

Pond PB: Detention Pond B Peak Elev=50.87' Storage=11.562 af Inflow=235.89 cfs 22.565 af
Outflow=33.70 cfs 21.821 af

Pond PC: Retention Pond C Peak Elev=42.36' Storage=32.676 af Inflow=313.19 cfs 32.676 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 164.599 ac Runoff Volume = 89.038 af Average Runoff Depth = 6.49"
100.00% Pervious = 164.599 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1C: 1C Drainage Area

Use Conservative Value of Tc=10 min

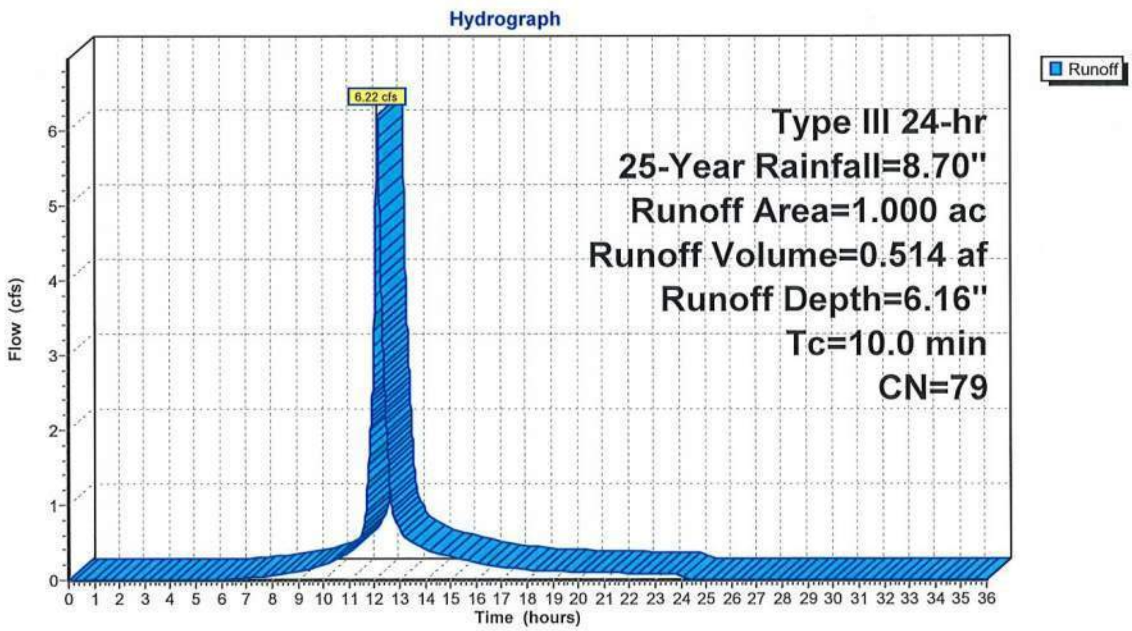
Runoff = 6.22 cfs @ 12.14 hrs, Volume= 0.514 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 1C: 1C Drainage Area



Summary for Subcatchment 2C: 2C Drainage Area

Use Conservative Value of Tc=10 min

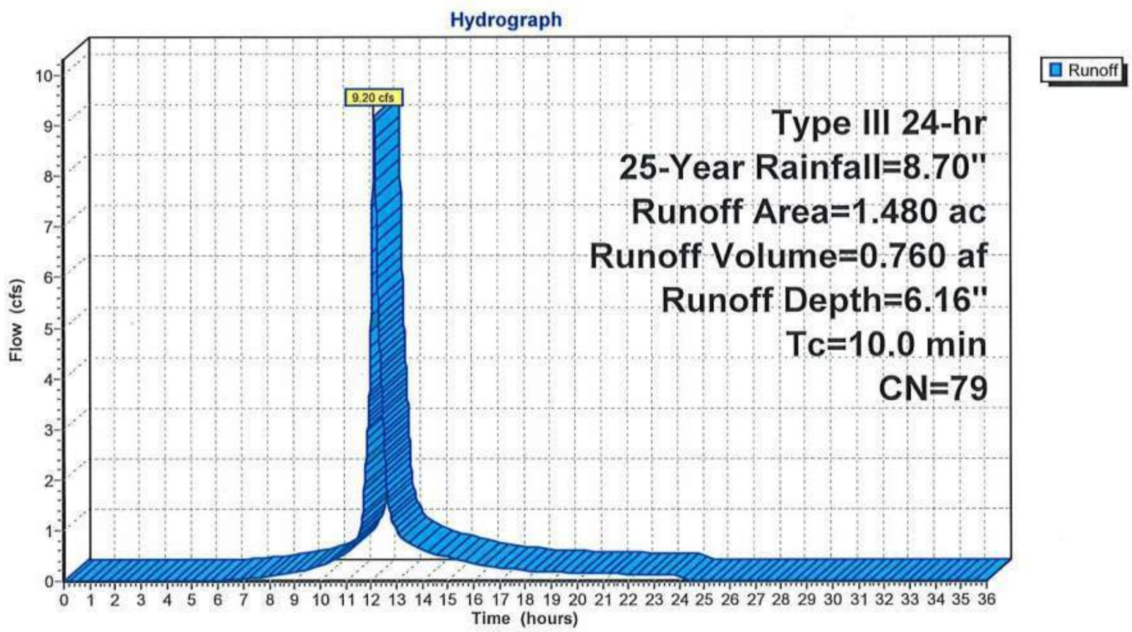
Runoff = 9.20 cfs @ 12.14 hrs, Volume= 0.760 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
1.480	79	50-75% Grass cover, Fair, HSG C
1.480		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 2C: 2C Drainage Area



Summary for Subcatchment 3C: 3C Drainage Area

Use Conservative Value of Tc=10 min

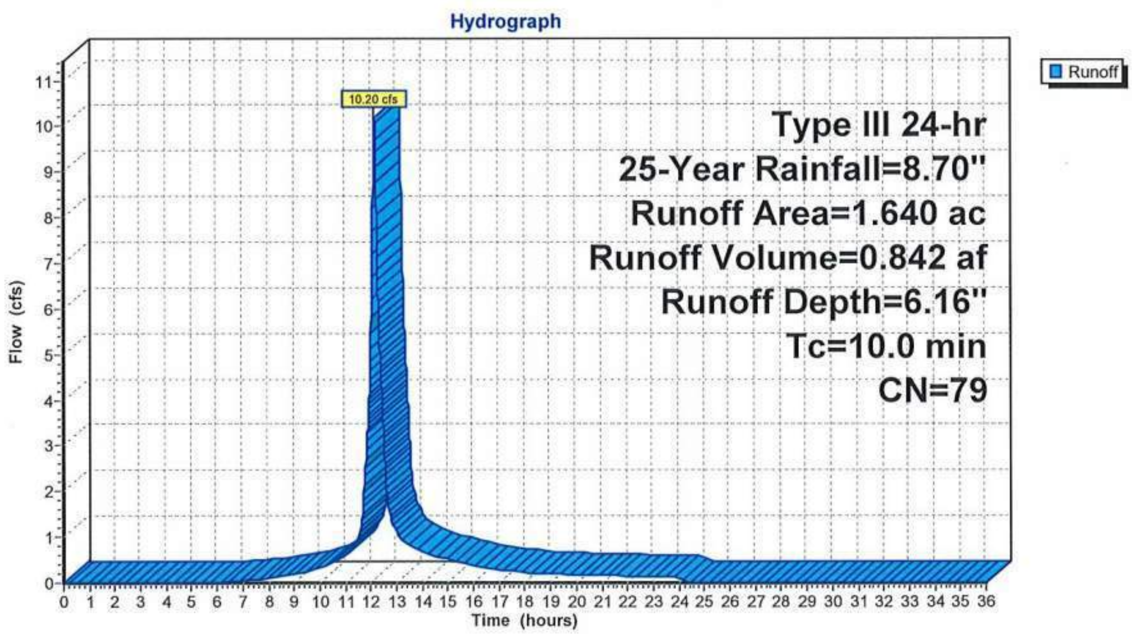
Runoff = 10.20 cfs @ 12.14 hrs, Volume= 0.842 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
1.640	79	50-75% Grass cover, Fair, HSG C
1.640		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Surface Drainage to Pond B**

Subcatchment 3C: 3C Drainage Area



Summary for Subcatchment 4C: 4C Drainage Area

Use Conservative Value of Tc=10 min

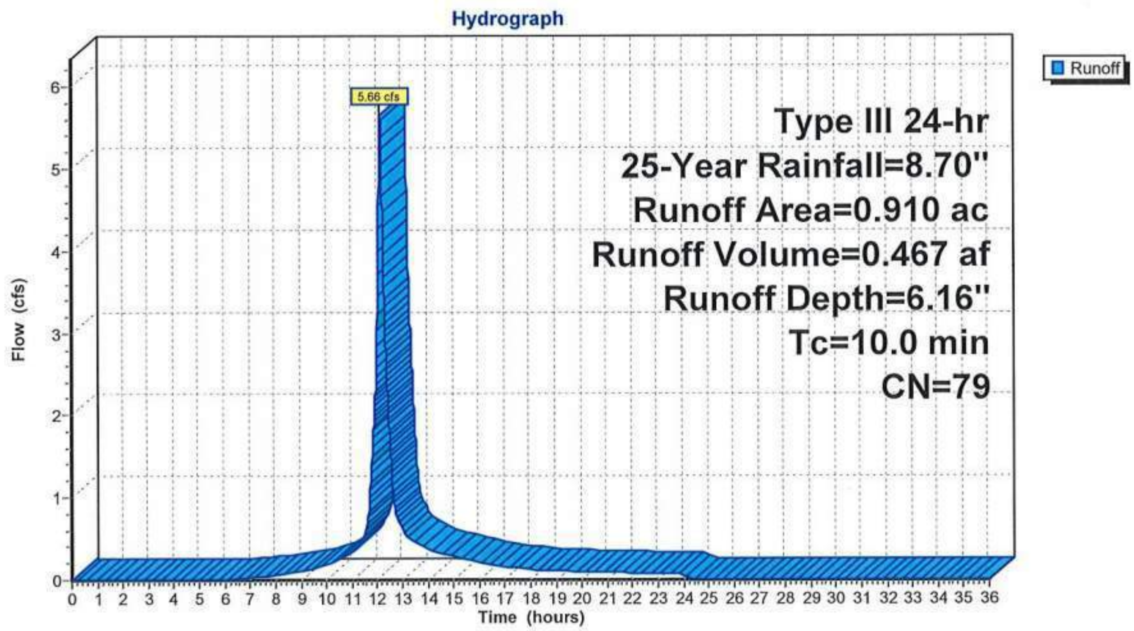
Runoff = 5.66 cfs @ 12.14 hrs, Volume= 0.467 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
0.910	79	50-75% Grass cover, Fair, HSG C
0.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Surface Drainage to Pond B**

Subcatchment 4C: 4C Drainage Area



Summary for Subcatchment 5C: A2 Drainage Area

Use Conservative Value of Tc=10 min

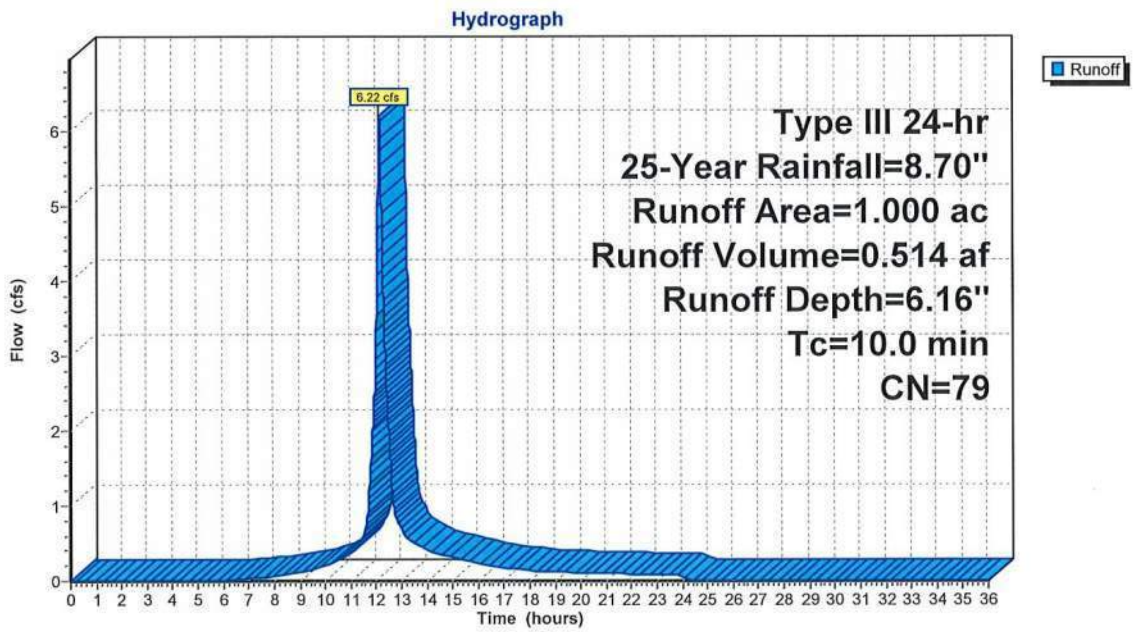
Runoff = 6.22 cfs @ 12.14 hrs, Volume= 0.514 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 5C: A2 Drainage Area



Summary for Subcatchment 6C: A3 Drainage Area

Use Conservative Value of Tc=10 min

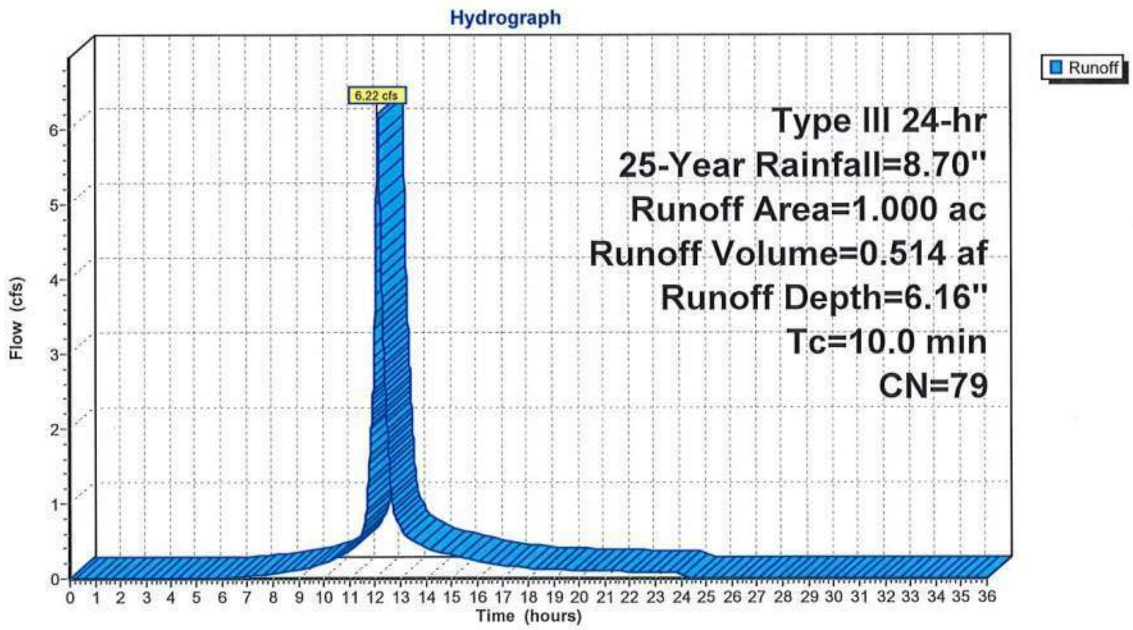
Runoff = 6.22 cfs @ 12.14 hrs, Volume= 0.514 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 6C: A3 Drainage Area



Summary for Subcatchment 7C: A2 Drainage Area

Use Conservative Value of Tc=10 min

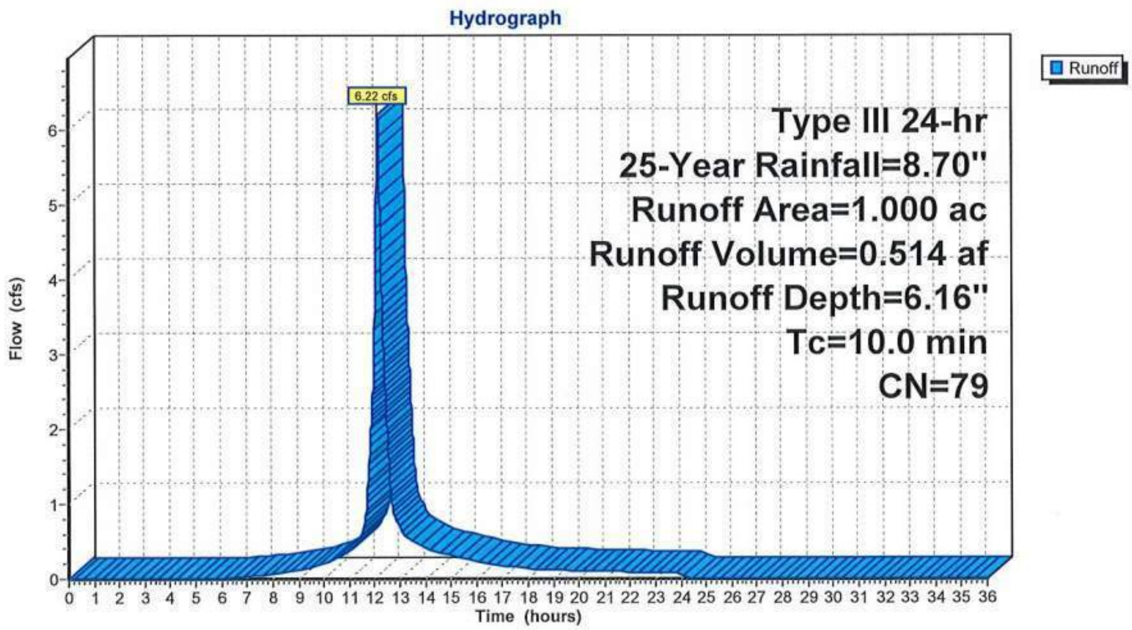
Runoff = 6.22 cfs @ 12.14 hrs, Volume= 0.514 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 7C: A2 Drainage Area



Summary for Subcatchment A1S: A1S Drainage Area

Use Conservative Value of Tc=10 min.

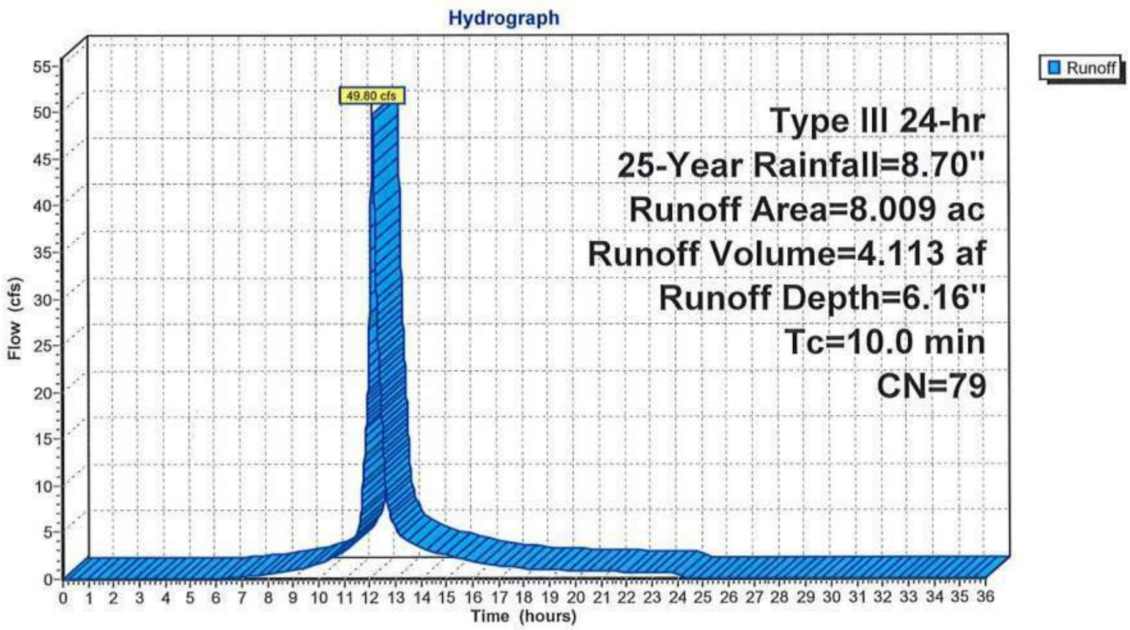
Runoff = 49.80 cfs @ 12.14 hrs, Volume= 4.113 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
8.009	79	50-75% Grass cover, Fair, HSG C
8.009		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1S-Chute Flow Evaluation**

Subcatchment A1S: A1S Drainage Area



Summary for Subcatchment A1T: A1T Drainage Area

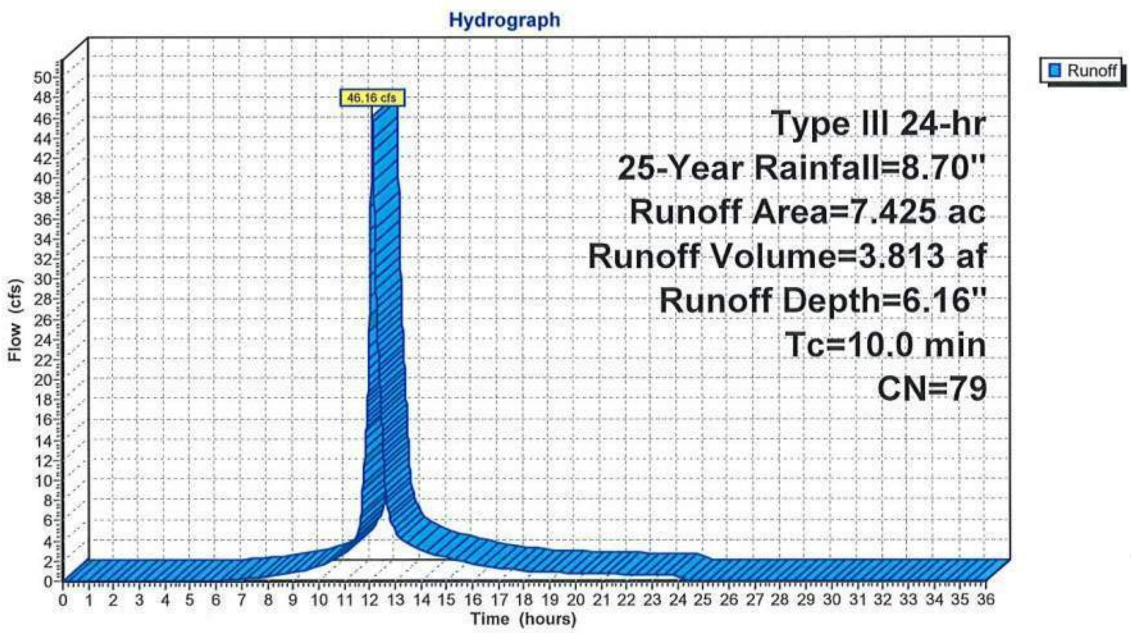
Runoff = 46.16 cfs @ 12.14 hrs, Volume= 3.813 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
7.425	79	50-75% Grass cover, Fair, HSG C
7.425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1T-Chute Flow Evaluation**

Subcatchment A1T: A1T Drainage Area



Summary for Subcatchment A2S: A2 Drainage Area

Use Conservative Value of Tc=10 min.

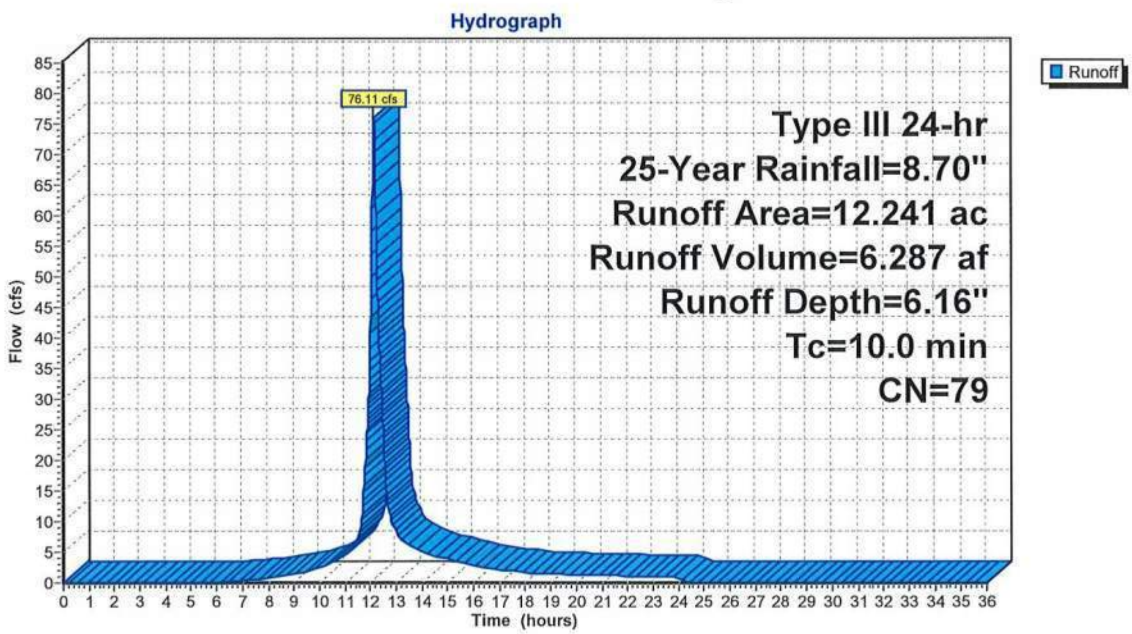
Runoff = 76.11 cfs @ 12.14 hrs, Volume= 6.287 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
12.241	79	50-75% Grass cover, Fair, HSG C
12.241		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry, A2 Drainage Area

Subcatchment A2S: A2 Drainage Area



Summary for Subcatchment A2T: A2 Drainage Area

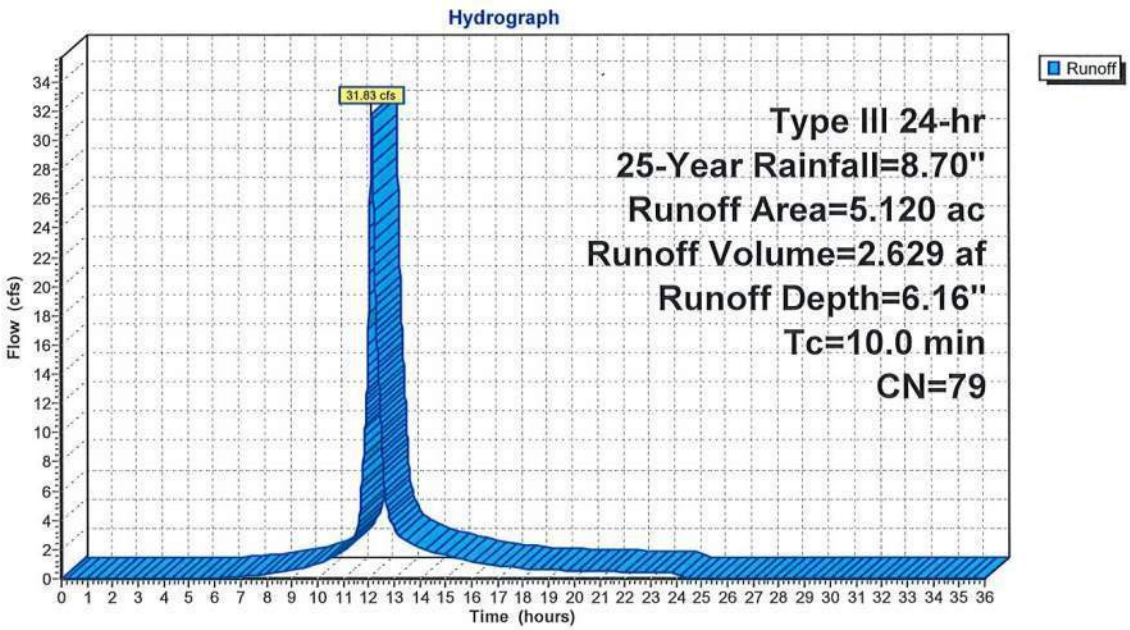
Runoff = 31.83 cfs @ 12.14 hrs, Volume= 2.629 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
5.120	79	50-75% Grass cover, Fair, HSG C
5.120		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A2 Drainage Area**

Subcatchment A2T: A2 Drainage Area



Summary for Subcatchment A3S: A3S Drainage Area

Use Conservative Value of Tc=10 min.

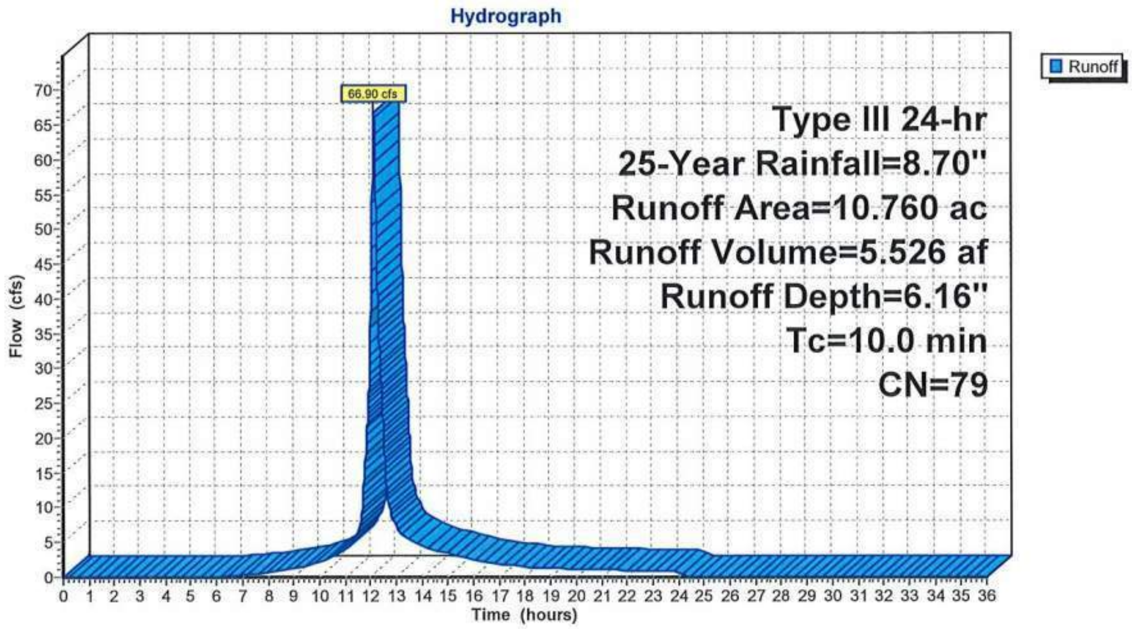
Runoff = 66.90 cfs @ 12.14 hrs, Volume= 5.526 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
10.760	79	50-75% Grass cover, Fair, HSG C
10.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A3S-Chute Flow Evaluation**

Subcatchment A3S: A3S Drainage Area



Summary for Subcatchment A3T: A3T Drainage Area

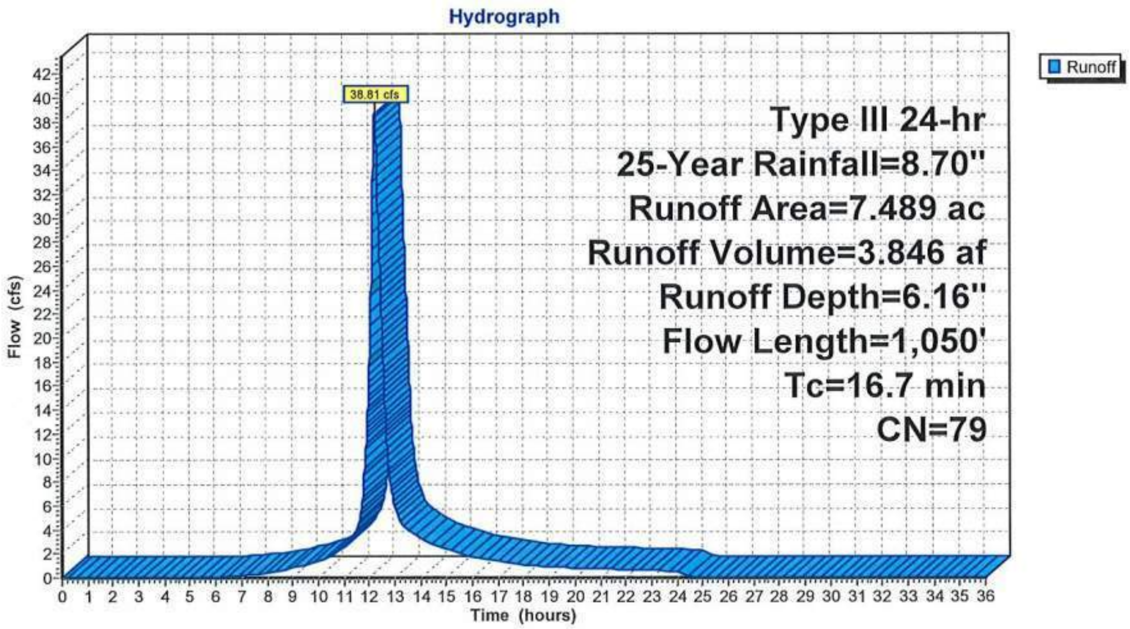
Runoff = 38.81 cfs @ 12.23 hrs, Volume= 3.846 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
7.489	79	50-75% Grass cover, Fair, HSG C
7.489		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	750		1.30		**Direct Entry, A3T-Chute Flow Evaluation**
7.1	300		0.70		**Direct Entry,**
16.7	1,050	Total			

Subcatchment A3T: A3T Drainage Area



Summary for Subcatchment B1S: B1S Drainage Area

Use Conservative Value of Tc= 10 min.

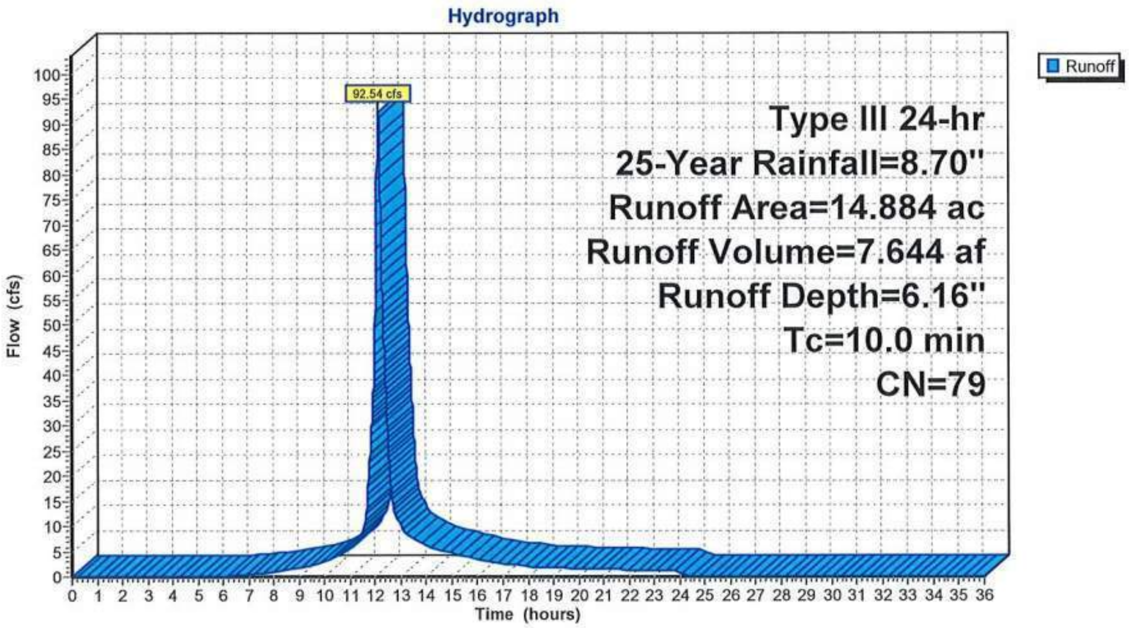
Runoff = 92.54 cfs @ 12.14 hrs, Volume= 7.644 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
14.884	79	50-75% Grass cover, Fair, HSG C
14.884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S-Chute Flow Evaluation**

Subcatchment B1S: B1S Drainage Area



Summary for Subcatchment B1T: B1T Drainage Area

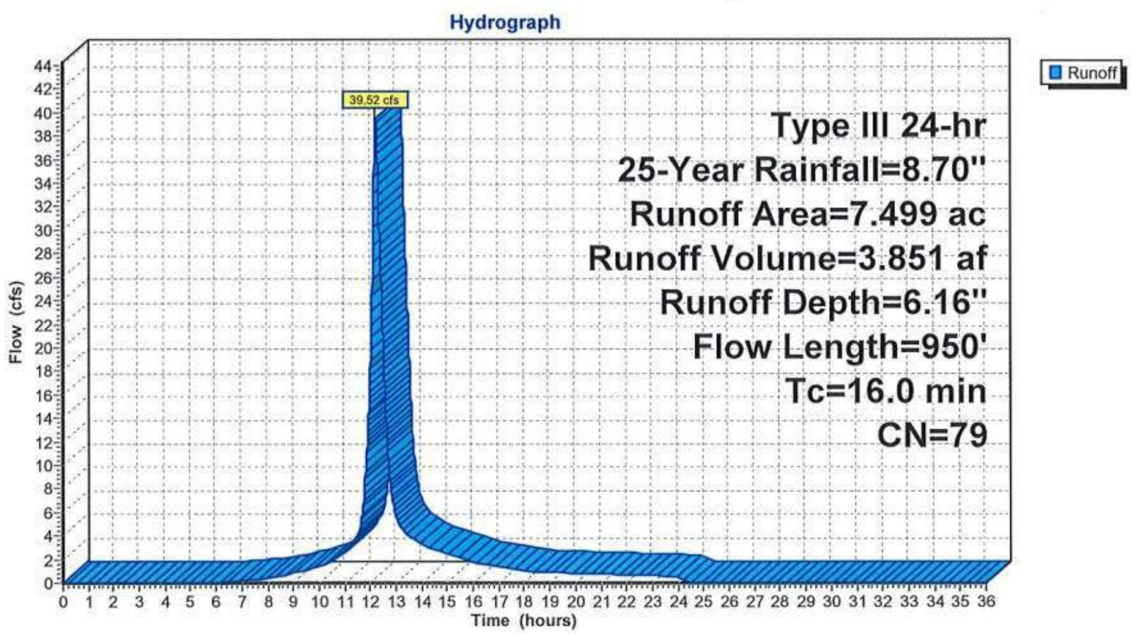
Runoff = 39.52 cfs @ 12.21 hrs, Volume= 3.851 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
7.499	79	50-75% Grass cover, Fair, HSG C
7.499		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T-Chute Flow Evaluation**
8.3	350		0.70		**Direct Entry,**
16.0	950	Total			

Subcatchment B1T: B1T Drainage Area



Summary for Subcatchment B2S: B2S Drainage Area

Use Conservative Value of Tc=10 min.

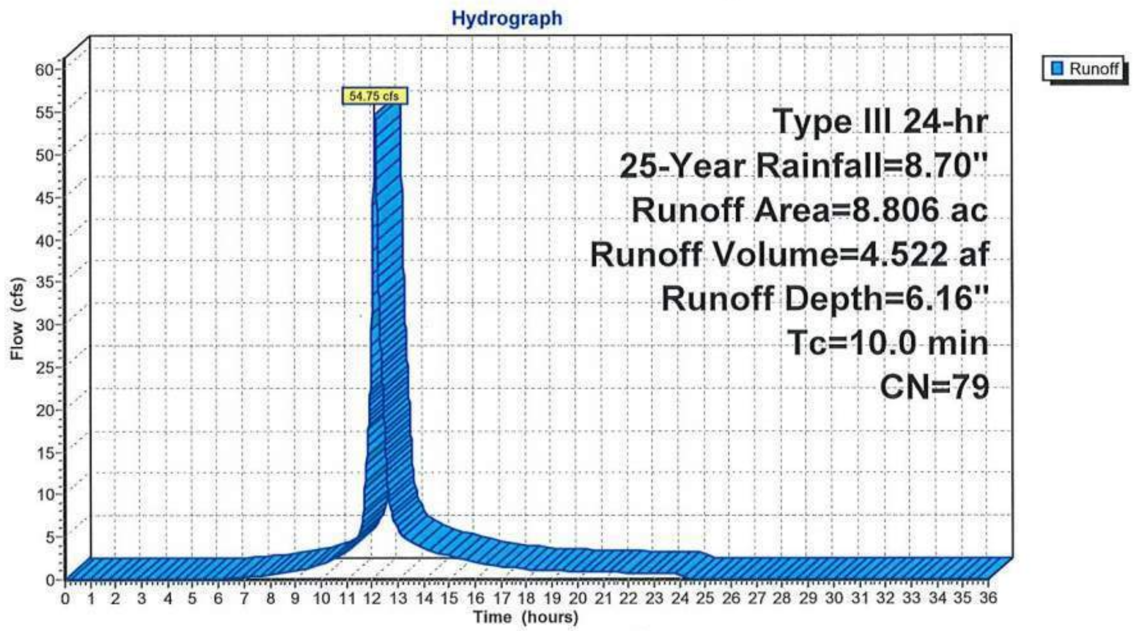
Runoff = 54.75 cfs @ 12.14 hrs, Volume= 4.522 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
8.806	79	50-75% Grass cover, Fair, HSG C
8.806		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B2S-Chute Flow Evaluation**

Subcatchment B2S: B2S Drainage Area



Summary for Subcatchment B2T: B2T Drainage Area

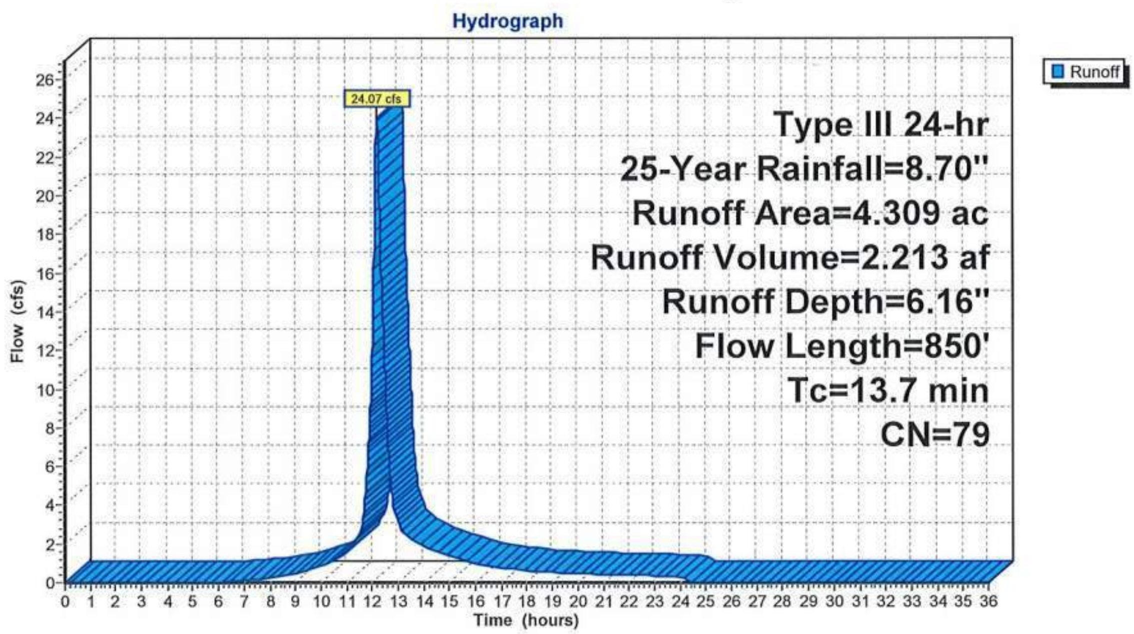
Runoff = 24.07 cfs @ 12.19 hrs, Volume= 2.213 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
4.309	79	50-75% Grass cover, Fair, HSG C
4.309		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B2T-Chute Flow Evaluation**
6.0	250		0.70		**Direct Entry,**
13.7	850	Total			

Subcatchment B2T: B2T Drainage Area



Summary for Subcatchment C1S: C1 Drainage Area

Use Conservative Value of Tc=10 min.

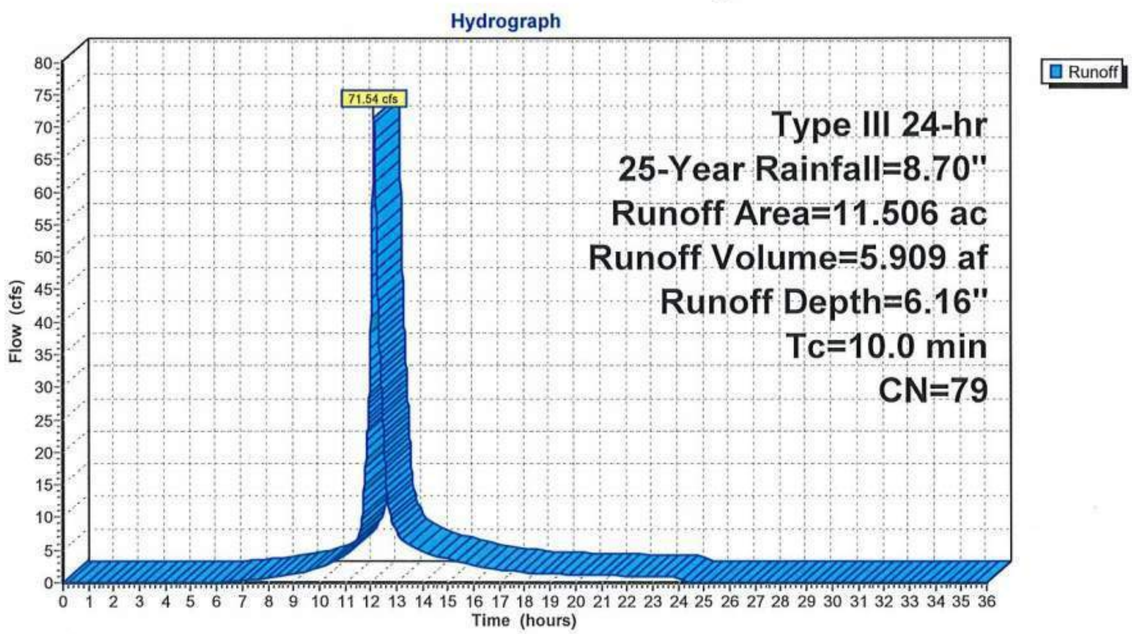
Runoff = 71.54 cfs @ 12.14 hrs, Volume= 5.909 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
11.506	79	50-75% Grass cover, Fair, HSG C
11.506		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C1 Drainage Area**

Subcatchment C1S: C1 Drainage Area



Summary for Subcatchment C1SN1: C1SN1 Drainage Area

Use Conservative Value of Tc=10 min

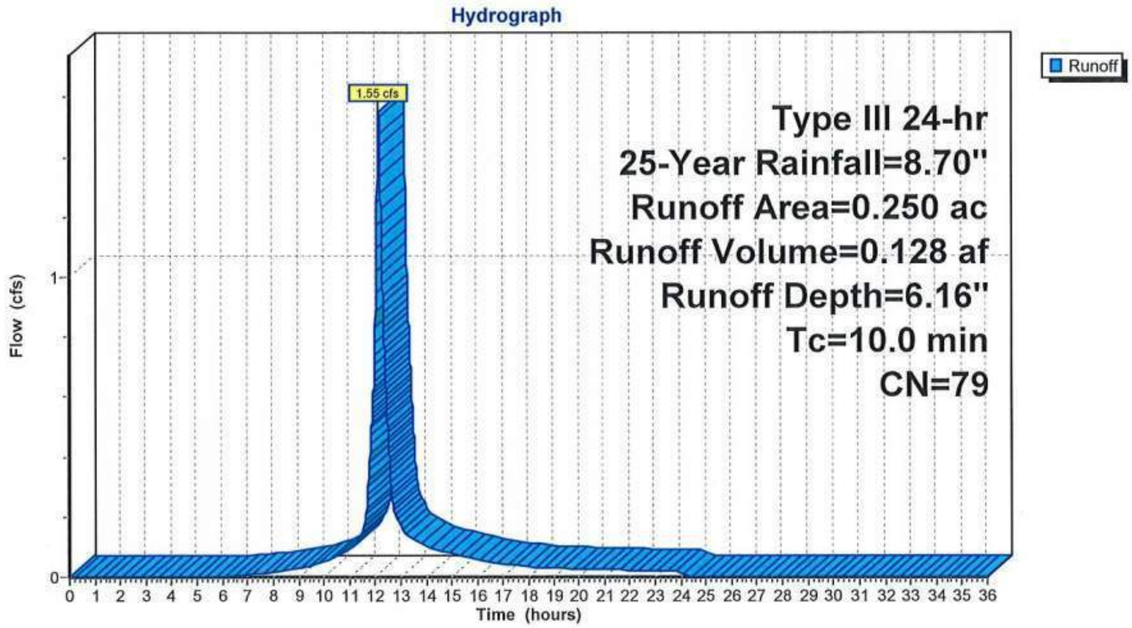
Runoff = 1.55 cfs @ 12.14 hrs, Volume= 0.128 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SN1: C1SN1 Drainage Area



Summary for Subcatchment C1SN2: C1SN2 Drainage Area

Use Conservative Value of Tc=10 min

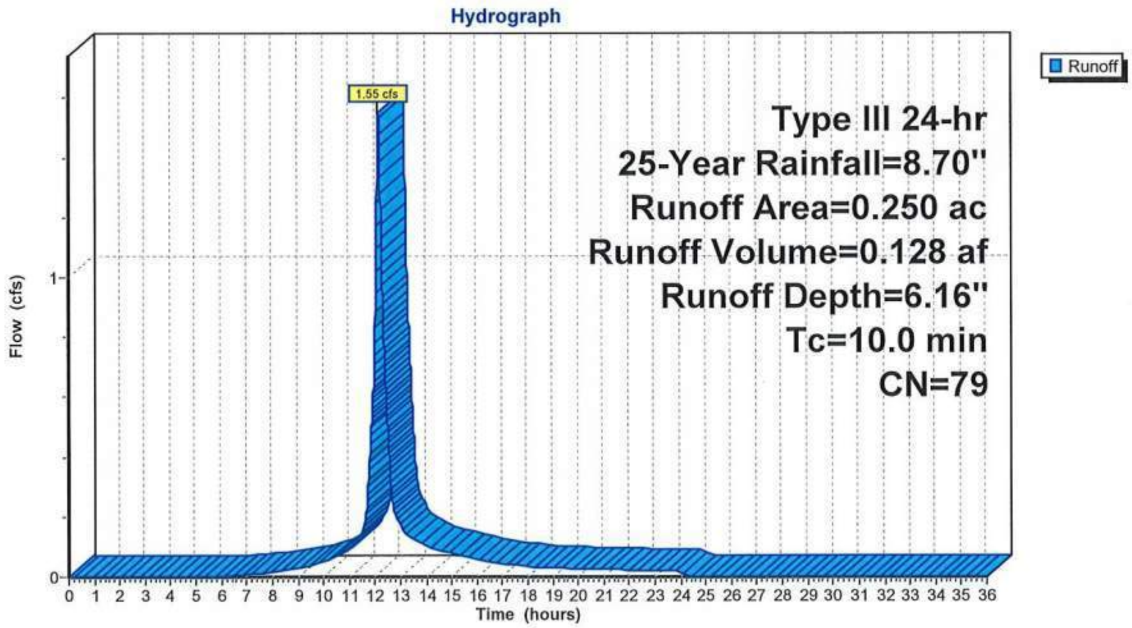
Runoff = 1.55 cfs @ 12.14 hrs, Volume= 0.128 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SN2: C1SN2 Drainage Area



Summary for Subcatchment C1SS1: C1SS1 Drainage Area

Use Conservative Value of Tc=10 min

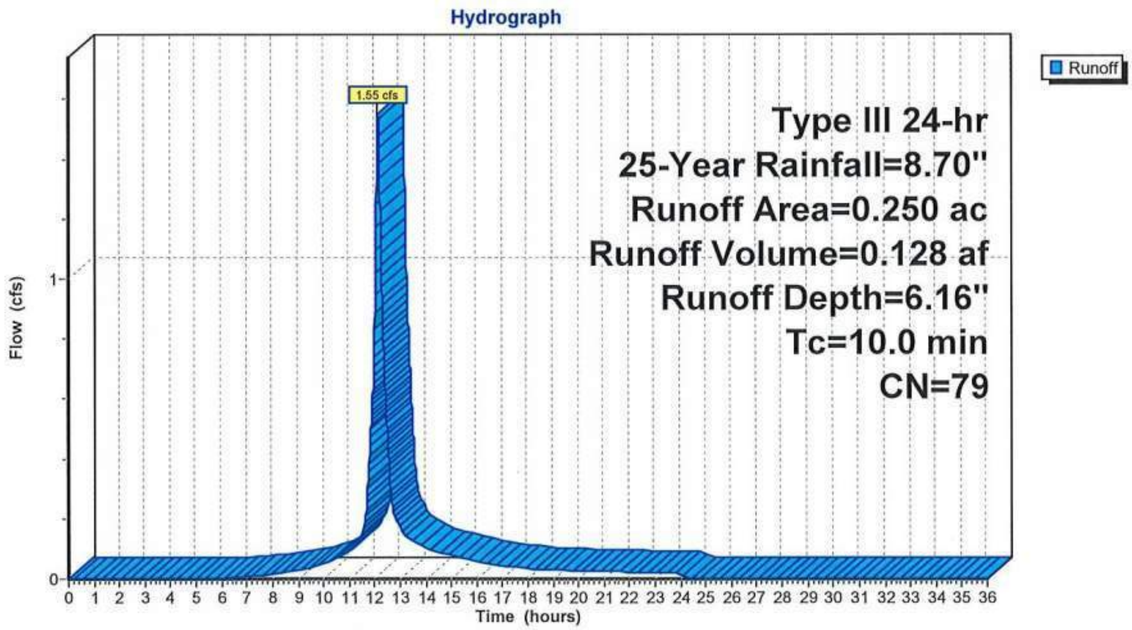
Runoff = 1.55 cfs @ 12.14 hrs, Volume= 0.128 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SS1: C1SS1 Drainage Area



Summary for Subcatchment C1SS2: C1SS2 Drainage Area

Use Conservative Value of Tc=10 min

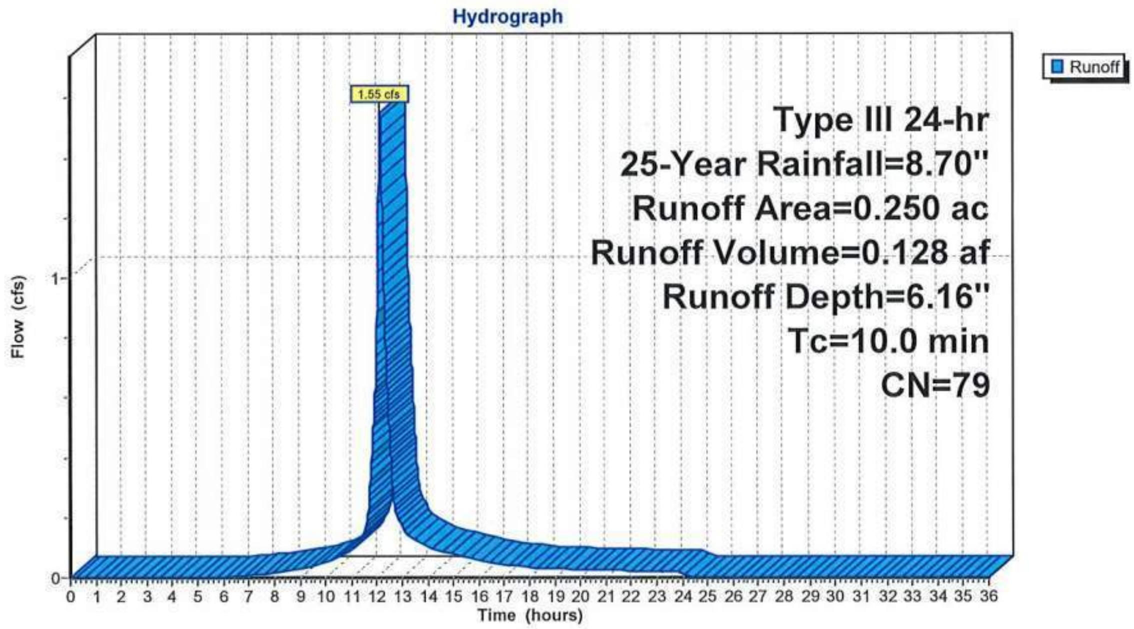
Runoff = 1.55 cfs @ 12.14 hrs, Volume= 0.128 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SS2: C1SS2 Drainage Area



Summary for Subcatchment C1T: C1 Drainage Area

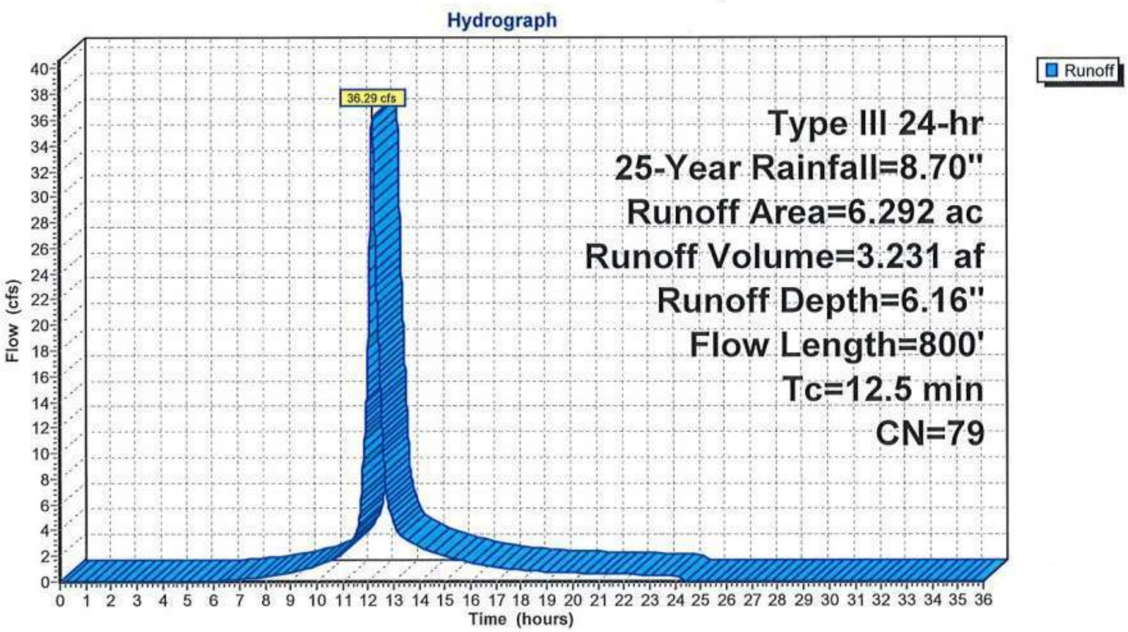
Runoff = 36.29 cfs @ 12.17 hrs, Volume= 3.231 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
6.292	79	50-75% Grass cover, Fair, HSG C
6.292		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C1 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C1T: C1 Drainage Area



Summary for Subcatchment C2S: C2 Drainage Area

Use Conservative Value of Tc=10 min.

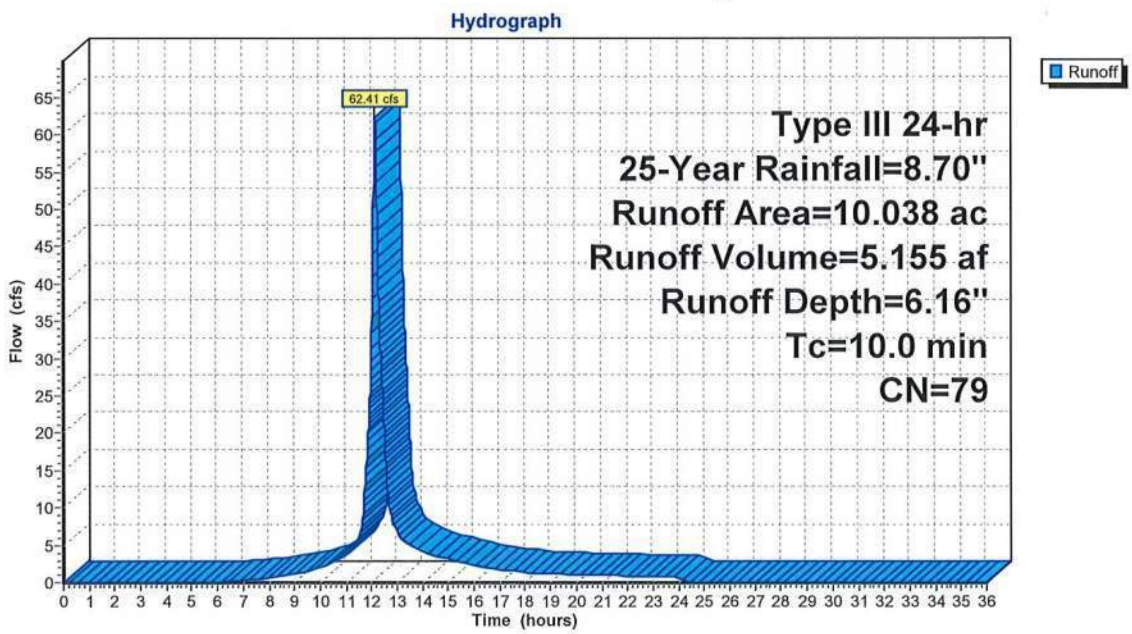
Runoff = 62.41 cfs @ 12.14 hrs, Volume= 5.155 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
10.038	79	50-75% Grass cover, Fair, HSG C
10.038		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C2 Drainage Area**

Subcatchment C2S: C2 Drainage Area



Summary for Subcatchment C2T: C2 Drainage Area

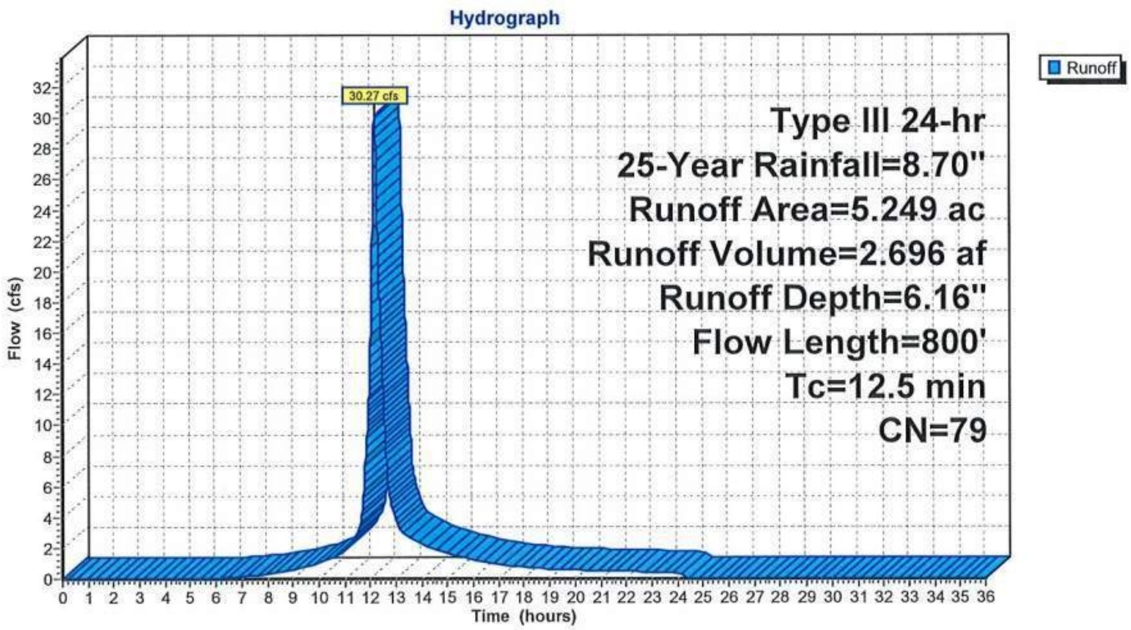
Runoff = 30.27 cfs @ 12.17 hrs, Volume= 2.696 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
5.249	79	50-75% Grass cover, Fair, HSG C
5.249		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C2 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C2T: C2 Drainage Area



Summary for Subcatchment C3: C3 Drainage Area

Existing Drainage Area Surface Drains to the North, Into Existing Low-Lying Excavated Pit C4 Drainage Area.

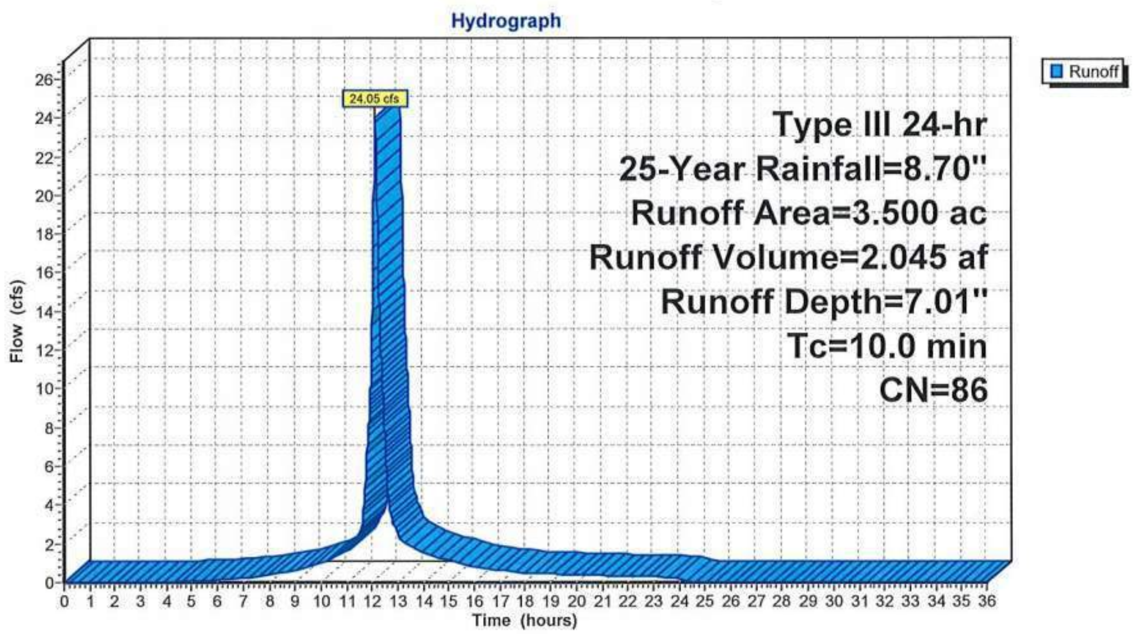
Runoff = 24.05 cfs @ 12.14 hrs, Volume= 2.045 af, Depth= 7.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
3.500	86	<50% Grass cover, Poor, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C3 Drainage Area**

Subcatchment C3: C3 Drainage Area



Summary for Subcatchment C4: C4 Drainage Area

Existing Low-Lying Excavated Pit Area. Infiltration and Evaporation Occur Here.

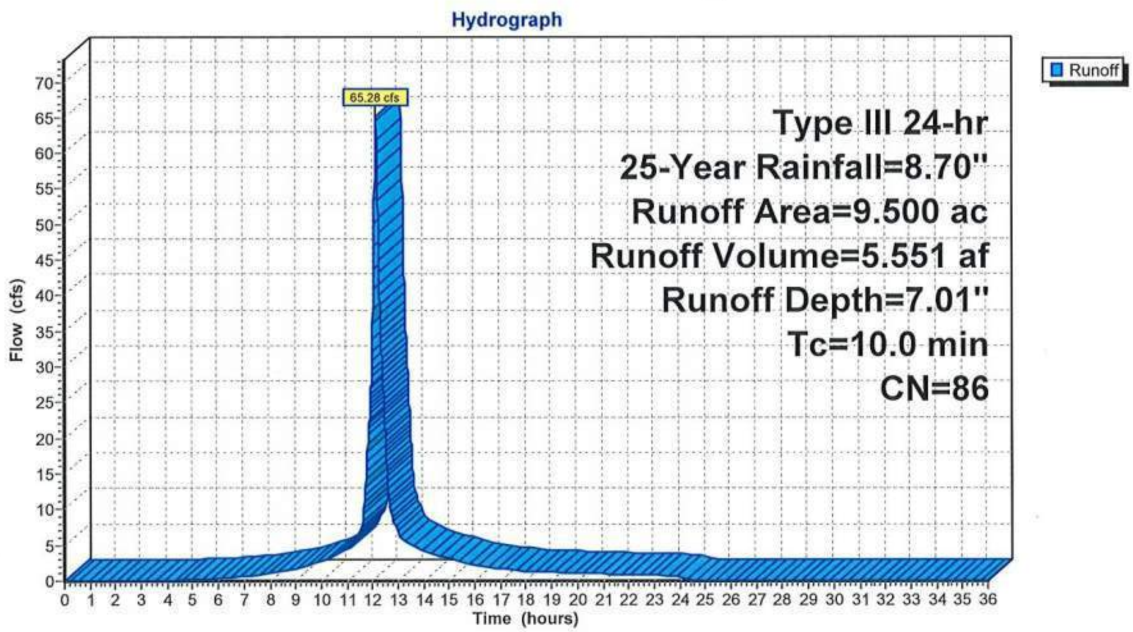
Runoff = 65.28 cfs @ 12.14 hrs, Volume= 5.551 af, Depth= 7.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
9.500	86	<50% Grass cover, Poor, HSG C
9.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C4 Drainage Area**

Subcatchment C4: C4 Drainage Area



Summary for Subcatchment C5: C5 Drainage Area

Side Slope Drainage Area that Flows Into Pond C.

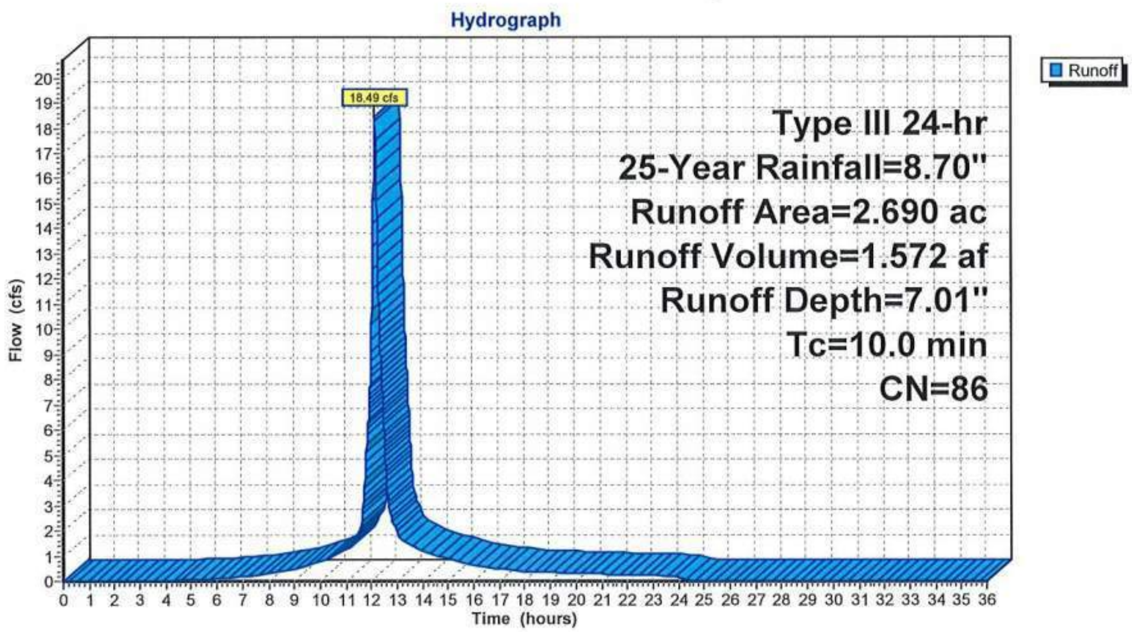
Runoff = 18.49 cfs @ 12.14 hrs, Volume= 1.572 af, Depth= 7.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
2.690	86	<50% Grass cover, Poor, HSG C
2.690		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C5 Drainage Area**

Subcatchment C5: C5 Drainage Area



Summary for Subcatchment C6: C6 Drainage Area

Surrounding Drainage Area that Flows Into Pond A.

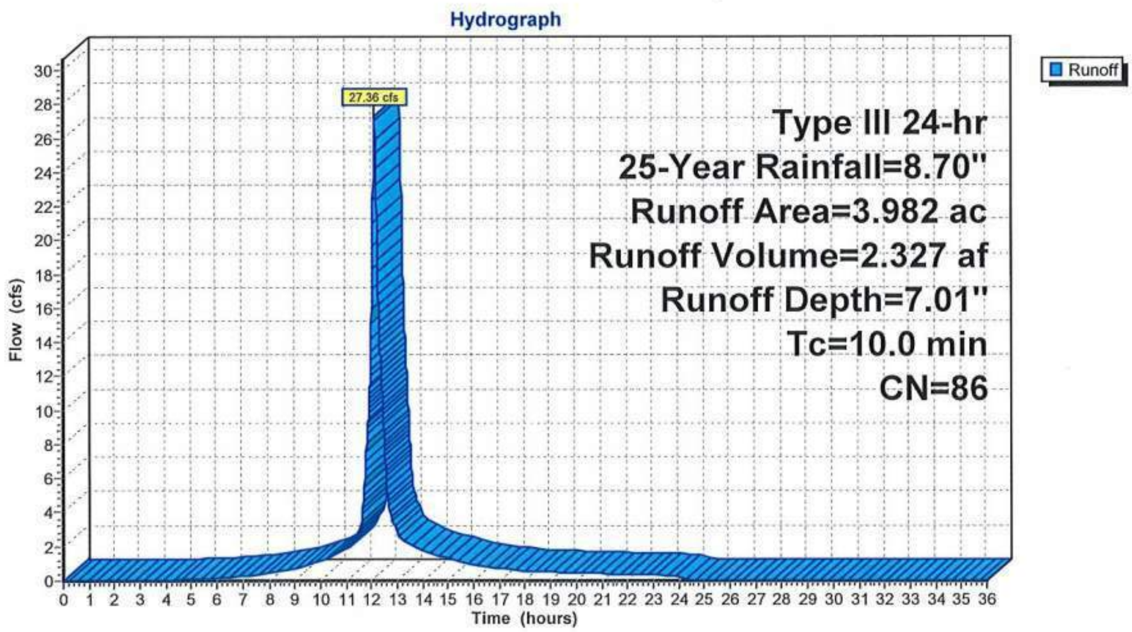
Runoff = 27.36 cfs @ 12.14 hrs, Volume= 2.327 af, Depth= 7.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
3.982	86	<50% Grass cover, Poor, HSG C
3.982		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C6 Drainage Area**

Subcatchment C6: C6 Drainage Area



Summary for Subcatchment PAR: PA Rainfall Area

Use Conservative Value of Tc=10 min

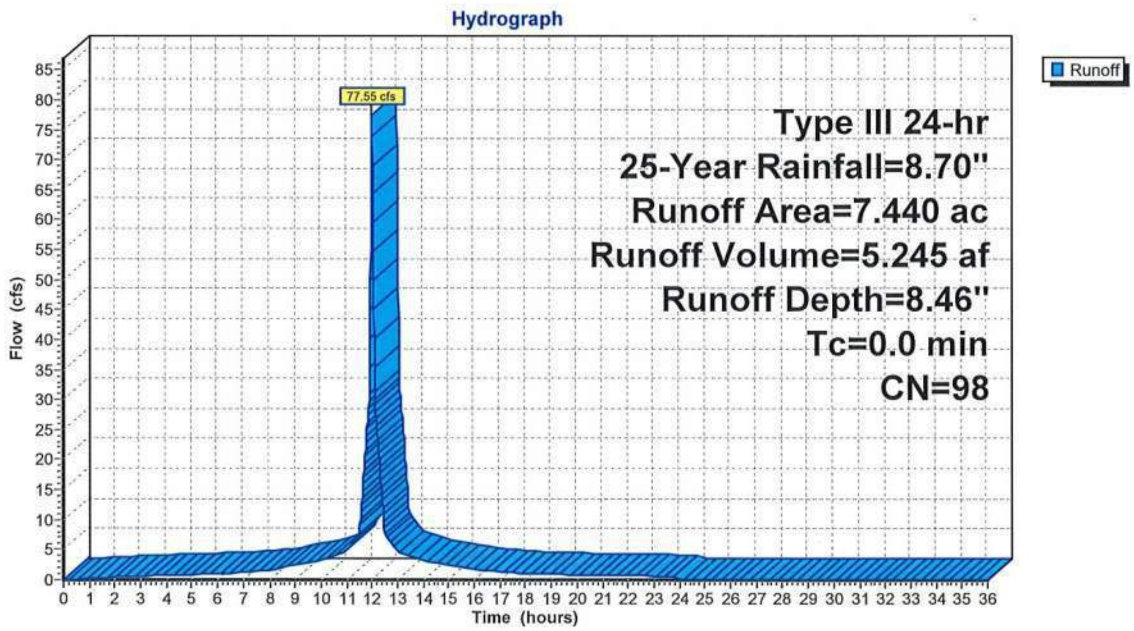
Runoff = 77.55 cfs @ 12.00 hrs, Volume= 5.245 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
7.440	98	Water Surface, 0% imp, HSG C
7.440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Rainfall at Pond A**

Subcatchment PAR: PA Rainfall Area



Summary for Subcatchment PBR: PB Rainfall Area

Use Conservative Value of Tc=10 min

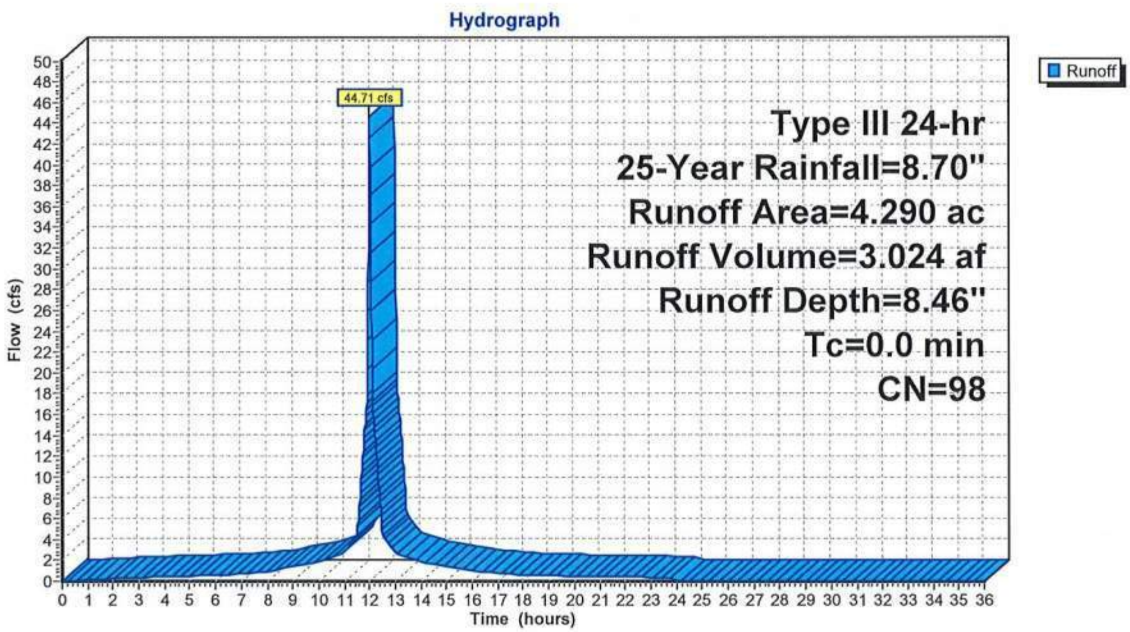
Runoff = 44.71 cfs @ 12.00 hrs, Volume= 3.024 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
4.290	98	Water Surface, 0% imp, HSG C
4.290		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Rainfall at Pond B**

Subcatchment PBR: PB Rainfall Area



Summary for Subcatchment PCR: PC Rainfall Area

Use Conservative Value of Tc=10 min

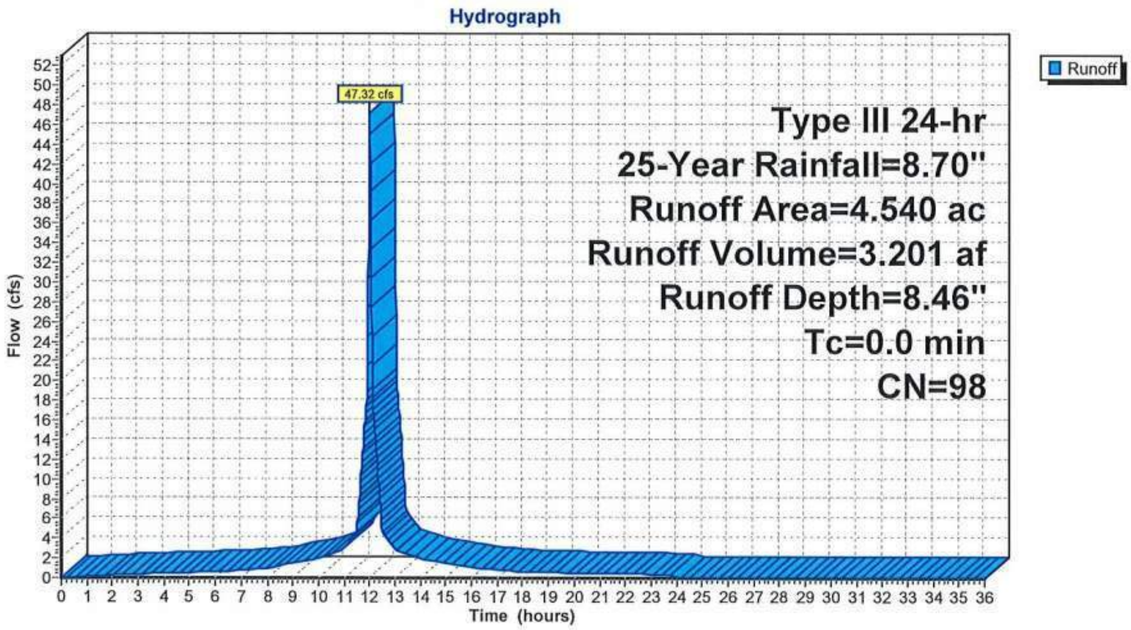
Runoff = 47.32 cfs @ 12.00 hrs, Volume= 3.201 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
4.540	98	Water Surface, 0% imp, HSG C
4.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Rainfall at Pond C**

Subcatchment PCR: PC Rainfall Area



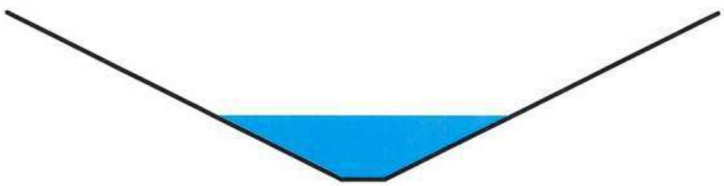
Summary for Reach 1CC: 1CC Collector Channel

Inflow Area = 38.047 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 213.11 cfs @ 12.17 hrs, Volume= 19.540 af
Outflow = 211.91 cfs @ 12.20 hrs, Volume= 19.540 af, Atten= 1%, Lag= 1.7 min

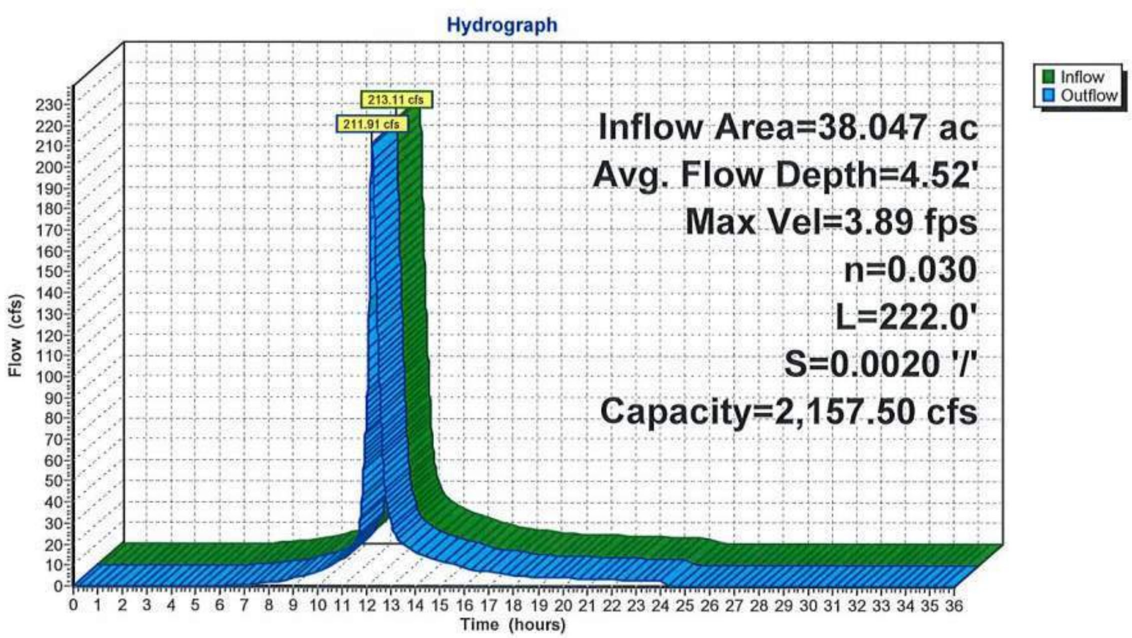
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.89 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.32 fps, Avg. Travel Time= 2.8 min

Peak Storage= 12,092 cf @ 12.19 hrs
Average Depth at Peak Storage= 4.52'
Bank-Full Depth= 11.73' Flow Area= 310.4 sf, Capacity= 2,157.50 cfs

3.00' x 11.73' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 49.92'
Length= 222.0' Slope= 0.0020 '/'
Inlet Invert= 53.89', Outlet Invert= 53.45'



Reach 1CC: 1CC Collector Channel



Post Development 25 Yr Drainage *Type III 24-hr 25-Year Rainfall=8.70"*
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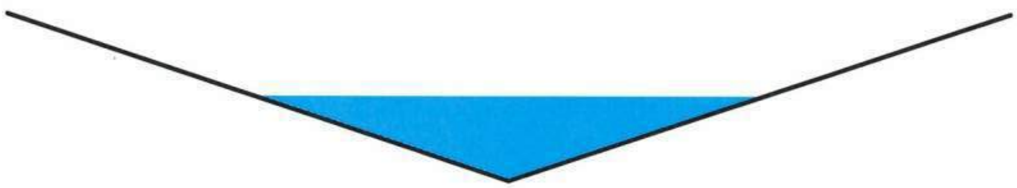
Summary for Reach 2CC: 2CC Collector Channel

Inflow Area = 1.480 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 9.20 cfs @ 12.14 hrs, Volume= 0.760 af
Outflow = 7.72 cfs @ 12.32 hrs, Volume= 0.760 af, Atten= 16%, Lag= 11.0 min

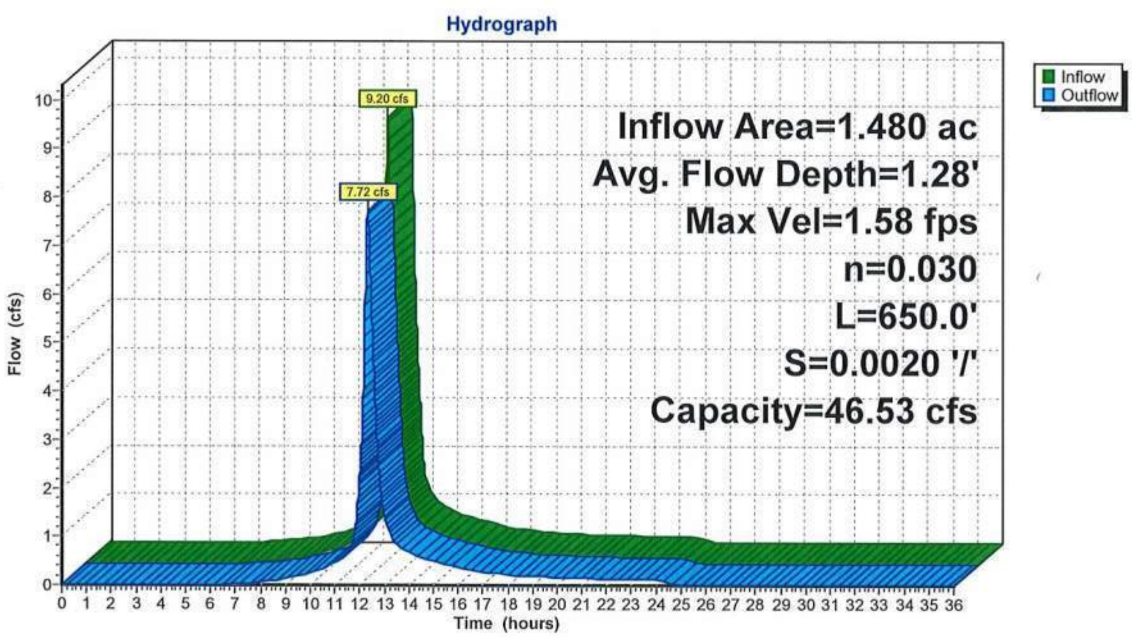
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.58 fps, Min. Travel Time= 6.8 min
Avg. Velocity = 0.52 fps, Avg. Travel Time= 20.9 min

Peak Storage= 3,170 cf @ 12.21 hrs
Average Depth at Peak Storage= 1.28'
Bank-Full Depth= 2.50' Flow Area= 18.8 sf, Capacity= 46.53 cfs

0.00' x 2.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 650.0' Slope= 0.0020 '/'
Inlet Invert= 54.50', Outlet Invert= 53.20'



Reach 2CC: 2CC Collector Channel



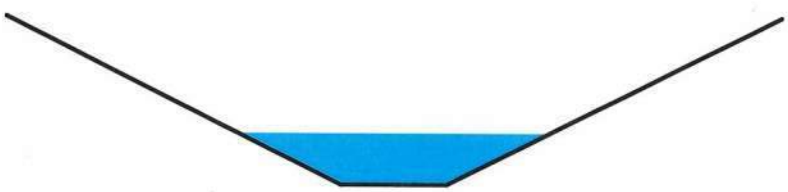
Summary for Reach 5CC: A2 Collector Channel

Inflow Area = 1.000 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 6.22 cfs @ 12.14 hrs, Volume= 0.514 af
Outflow = 5.17 cfs @ 12.33 hrs, Volume= 0.514 af, Atten= 17%, Lag= 11.5 min

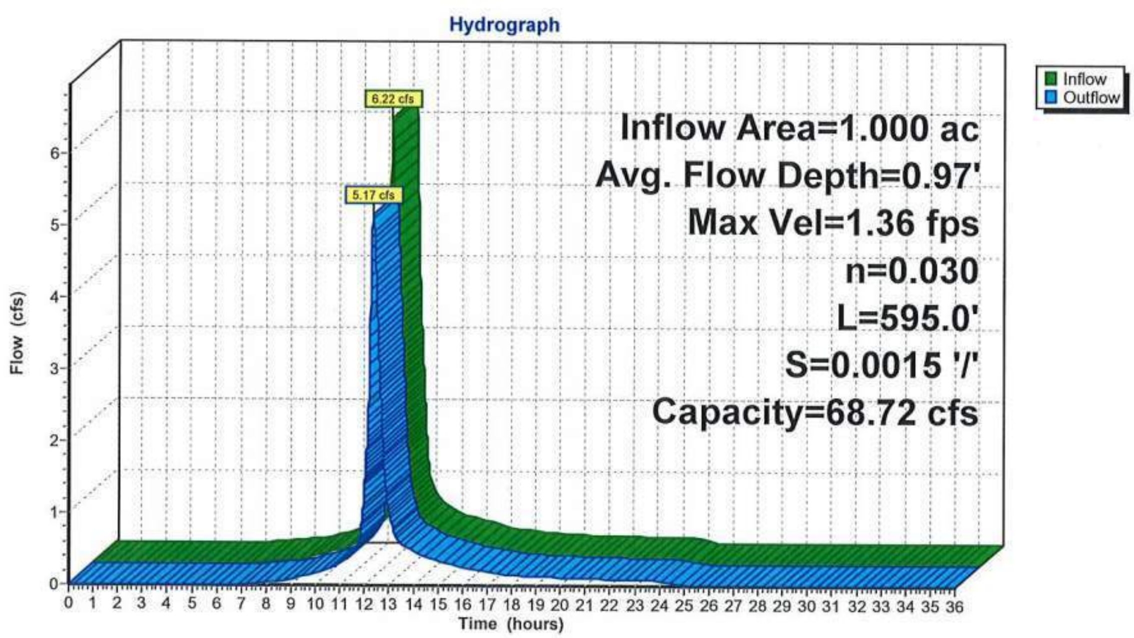
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.36 fps, Min. Travel Time= 7.3 min
Avg. Velocity = 0.42 fps, Avg. Travel Time= 23.7 min

Peak Storage= 2,258 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.97'
Bank-Full Depth= 3.14' Flow Area= 26.0 sf, Capacity= 68.72 cfs

2.00' x 3.14' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 14.56'
Length= 595.0' Slope= 0.0015 '/'
Inlet Invert= 58.50', Outlet Invert= 57.61'



Reach 5CC: A2 Collector Channel



Summary for Reach 6CC: A3 Collector Channel

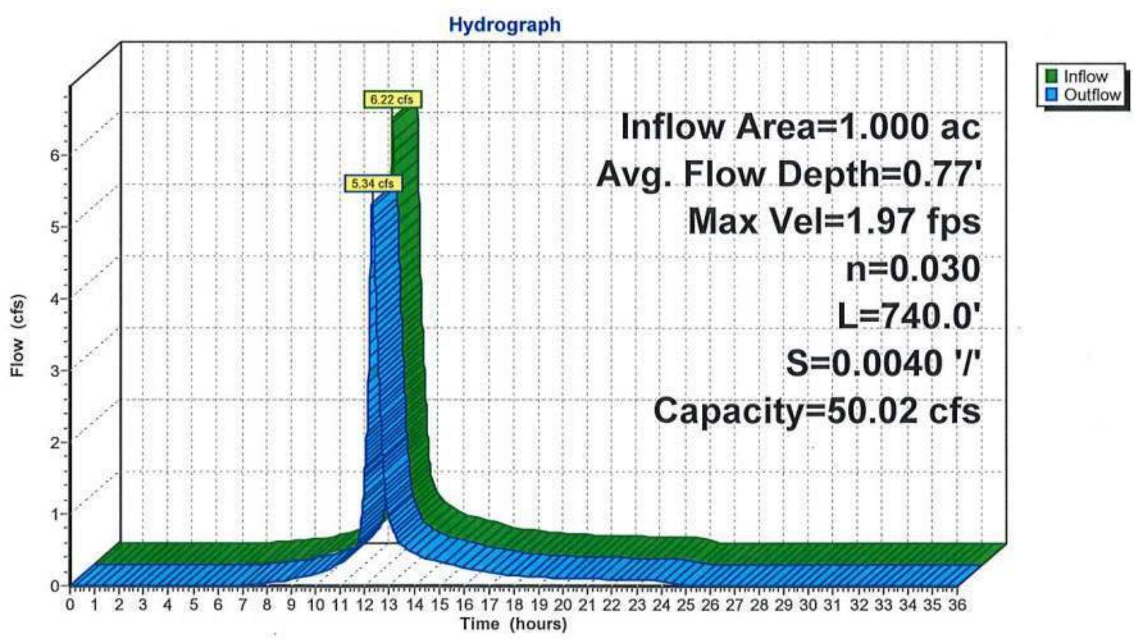
Inflow Area = 1.000 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 6.22 cfs @ 12.14 hrs, Volume= 0.514 af
Outflow = 5.34 cfs @ 12.30 hrs, Volume= 0.514 af, Atten= 14%, Lag= 10.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.97 fps, Min. Travel Time= 6.3 min
Avg. Velocity = 0.58 fps, Avg. Travel Time= 21.1 min

Peak Storage= 2,006 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.77'
Bank-Full Depth= 2.21' Flow Area= 14.2 sf, Capacity= 50.02 cfs

2.00' x 2.21' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 10.84'
Length= 740.0' Slope= 0.0040 '/'
Inlet Invert= 59.50', Outlet Invert= 56.54'

Reach 6CC: A3 Collector Channel



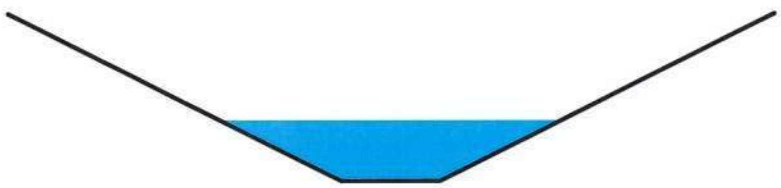
Summary for Reach A2-1: A2-1 Channel

Inflow Area = 2.000 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 8.74 cfs @ 12.28 hrs, Volume= 1.027 af
Outflow = 8.70 cfs @ 12.35 hrs, Volume= 1.027 af, Atten= 0%, Lag= 3.9 min

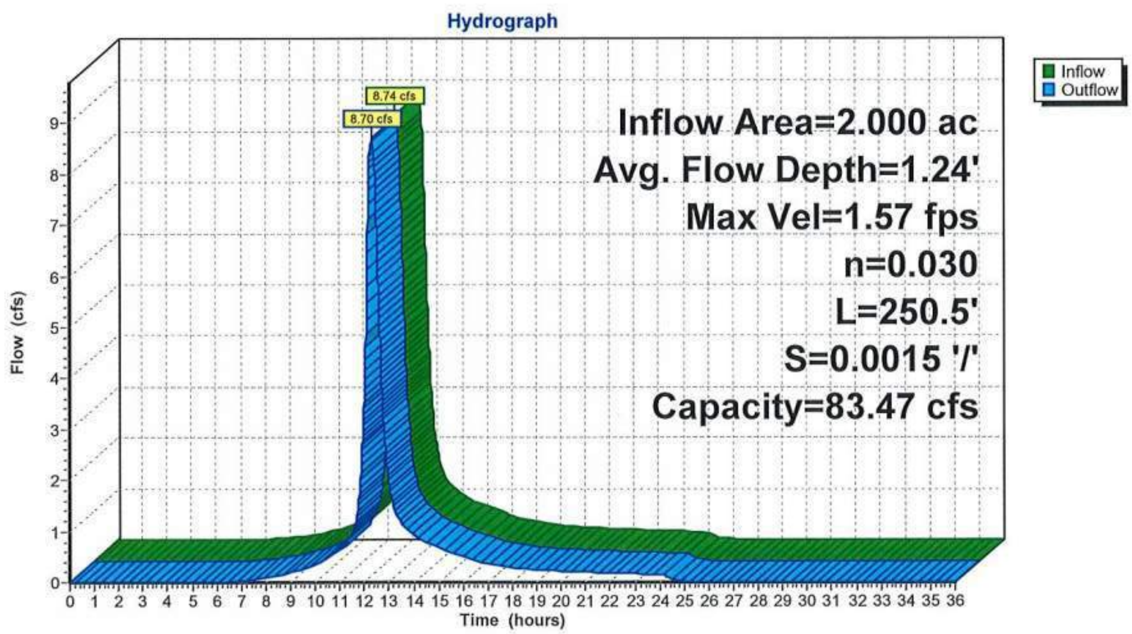
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.57 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.51 fps, Avg. Travel Time= 8.2 min

Peak Storage= 1,387 cf @ 12.30 hrs
Average Depth at Peak Storage= 1.24'
Bank-Full Depth= 3.40' Flow Area= 29.9 sf, Capacity= 83.47 cfs

2.00' x 3.40' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 15.60'
Length= 250.5' Slope= 0.0015 '/'
Inlet Invert= 57.61', Outlet Invert= 57.23'



Reach A2-1: A2-1 Channel



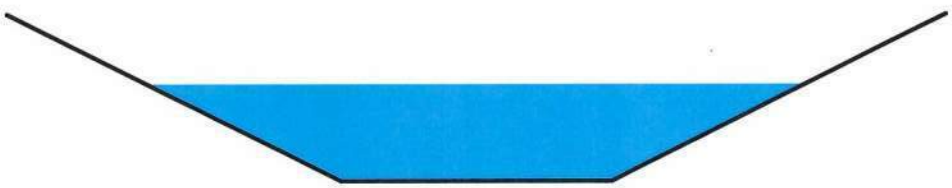
Summary for Reach A2-2: A2-2 Channel

Inflow Area = 19.361 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 114.51 cfs @ 12.15 hrs, Volume= 9.943 af
Outflow = 113.50 cfs @ 12.19 hrs, Volume= 9.943 af, Atten= 1%, Lag= 2.0 min

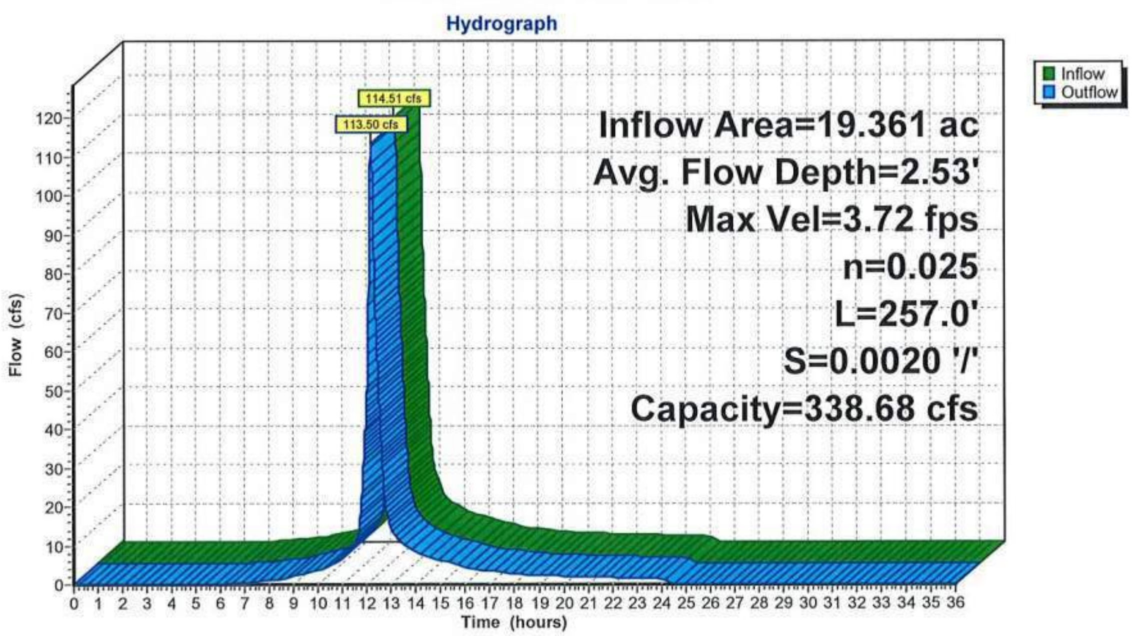
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.72 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 4.3 min

Peak Storage= 7,841 cf @ 12.17 hrs
Average Depth at Peak Storage= 2.53'
Bank-Full Depth= 4.34' Flow Area= 68.1 sf, Capacity= 338.68 cfs

7.00' x 4.34' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 2.0 '/' Top Width= 24.36'
Length= 257.0' Slope= 0.0020 '/'
Inlet Invert= 55.84', Outlet Invert= 55.33'



Reach A2-2: A2-2 Channel



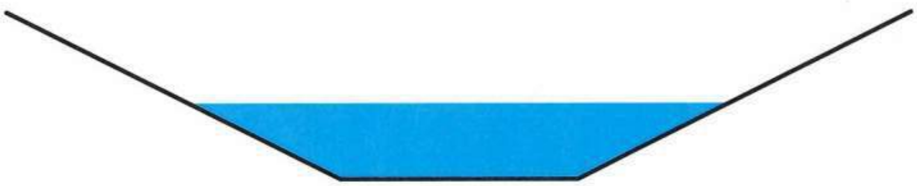
Summary for Reach A2-3: A2-3 Channel

Inflow Area = 19.361 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 113.50 cfs @ 12.19 hrs, Volume= 9.943 af
Outflow = 108.05 cfs @ 12.27 hrs, Volume= 9.943 af, Atten= 5%, Lag= 5.2 min

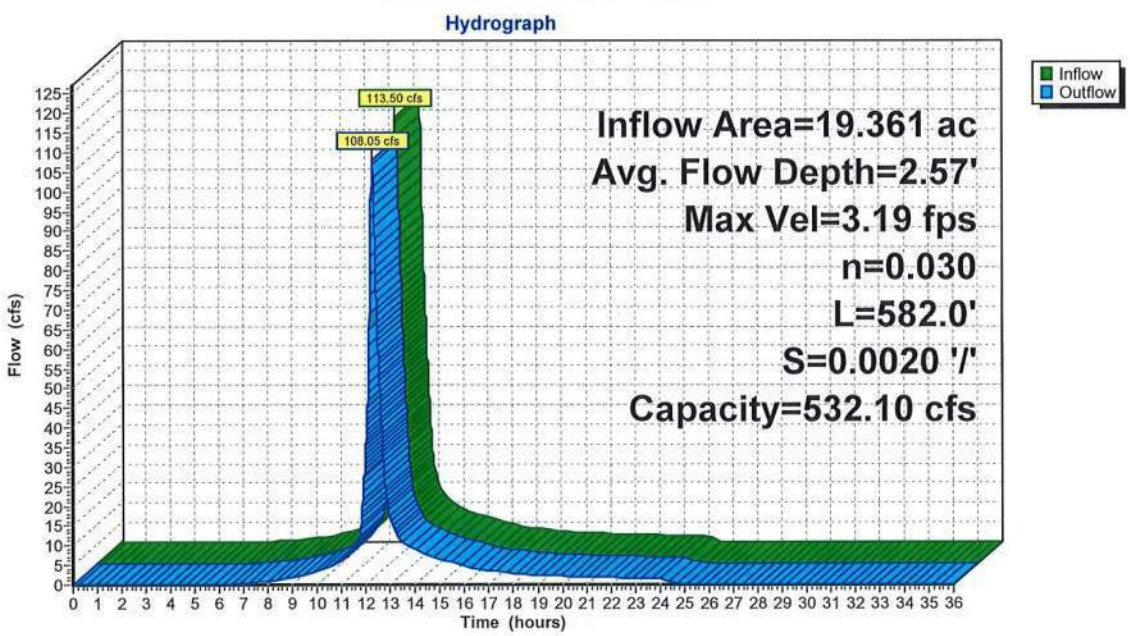
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.19 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 11.3 min

Peak Storage= 19,700 cf @ 12.22 hrs
Average Depth at Peak Storage= 2.57'
Bank-Full Depth= 5.65' Flow Area= 109.0 sf, Capacity= 532.10 cfs

8.00' x 5.65' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 30.60'
Length= 582.0' Slope= 0.0020 '/'
Inlet Invert= 55.33', Outlet Invert= 54.17'



Reach A2-3: A2-3 Channel



Post Development 25 Yr Drainage *Type III 24-hr 25-Year Rainfall=8.70"*
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Summary for Reach A2-4: Chute-Concrete Block Open Cell

Inflow Area = 19.361 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 108.05 cfs @ 12.27 hrs, Volume= 9.943 af
Outflow = 107.90 cfs @ 12.28 hrs, Volume= 9.943 af, Atten= 0%, Lag= 0.6 min

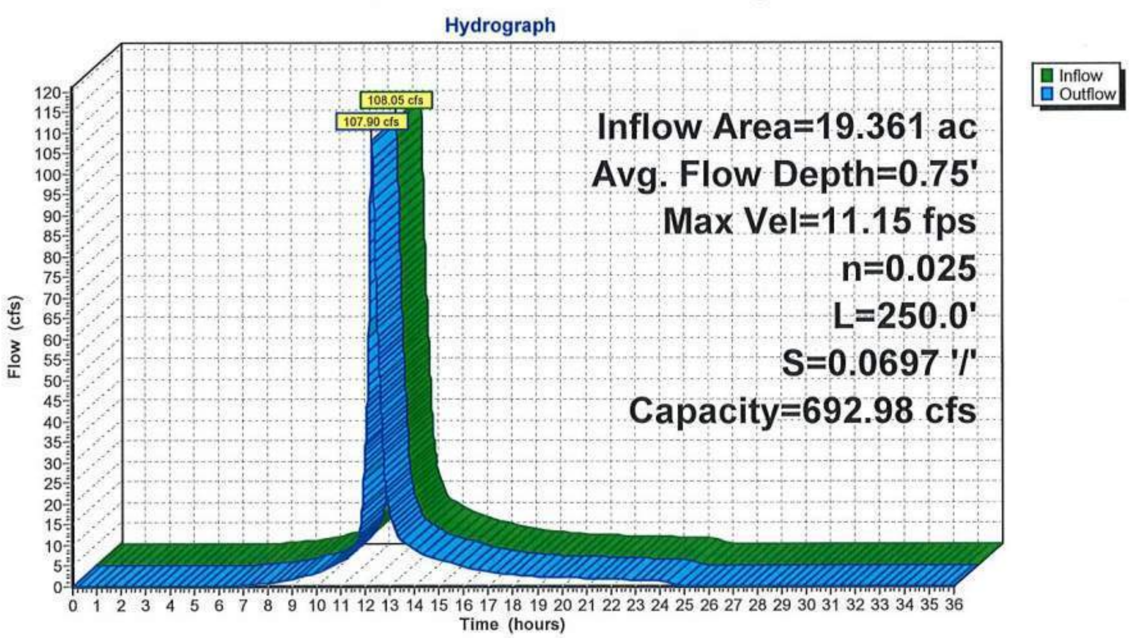
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.15 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.81 fps, Avg. Travel Time= 1.5 min

Peak Storage= 2,420 cf @ 12.28 hrs
Average Depth at Peak Storage= 0.75'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 692.98 cfs

10.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 250.0' Slope= 0.0697 '/'
Inlet Invert= 54.17', Outlet Invert= 36.75'

‡

Reach A2-4: Chute-Concrete Block Open Cell



Summary for Reach A2-5: Cocrete Block-Channel Transition

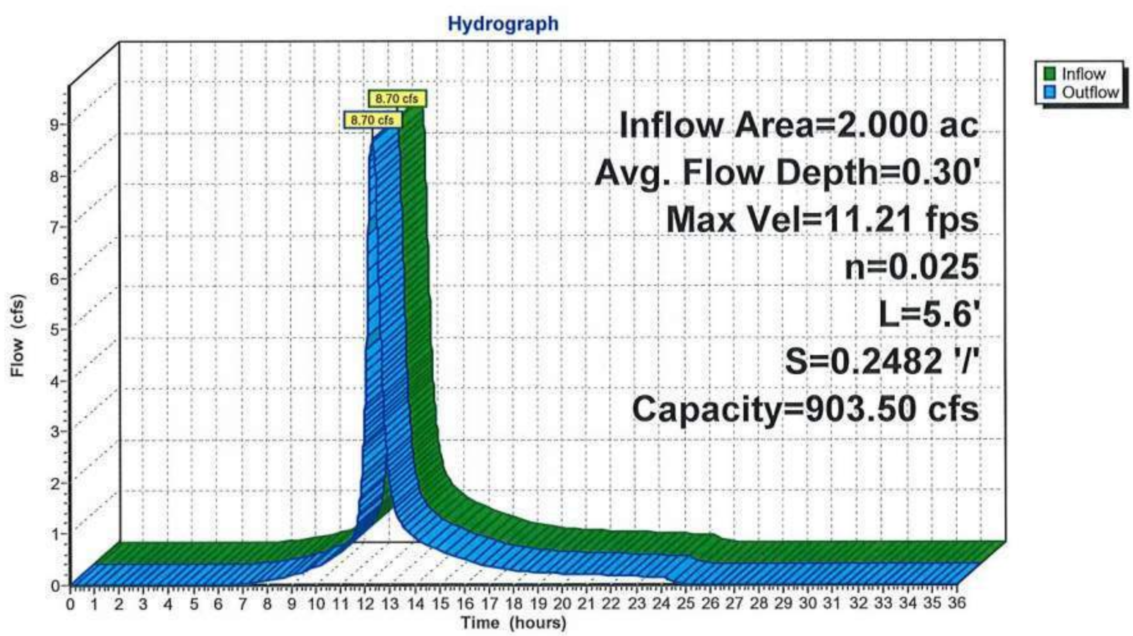
Inflow Area = 2.000 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 8.70 cfs @ 12.35 hrs, Volume= 1.027 af
Outflow = 8.70 cfs @ 12.35 hrs, Volume= 1.027 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.21 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 3.73 fps, Avg. Travel Time= 0.0 min

Peak Storage= 4 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 2.93' Flow Area= 23.0 sf, Capacity= 903.50 cfs

2.00' x 2.93' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 2.0 '/' Top Width= 13.72'
Length= 5.6' Slope= 0.2482 '/'
Inlet Invert= 57.23', Outlet Invert= 55.84'

Reach A2-5: Cocrete Block-Channel Transition



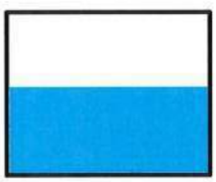
Summary for Reach B1: 5' x 4' Box Culvert

Inflow Area = 19.249 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 103.76 cfs @ 12.17 hrs, Volume= 9.886 af
Outflow = 103.38 cfs @ 12.20 hrs, Volume= 9.886 af, Atten= 0%, Lag= 1.5 min

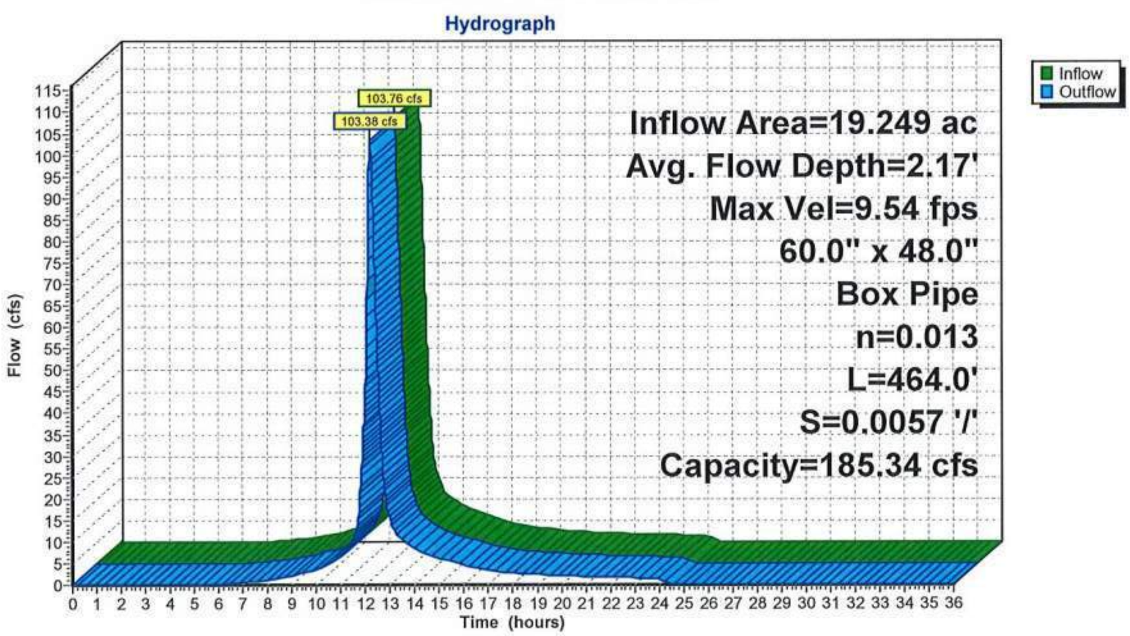
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.54 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 2.65 fps, Avg. Travel Time= 2.9 min

Peak Storage= 5,030 cf @ 12.18 hrs
Average Depth at Peak Storage= 2.17'
Bank-Full Depth= 4.00' Flow Area= 20.0 sf, Capacity= 185.34 cfs

60.0" W x 48.0" H Box Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 464.0' Slope= 0.0057 '/'
Inlet Invert= 56.54', Outlet Invert= 53.89'



Reach B1: 5' x 4' Box Culvert



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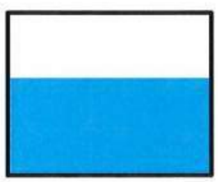
Summary for Reach B2: 5' x 4' Box Culvert

Inflow Area =	38.047 ac,	0.00% Impervious,	Inflow Depth = 6.16"	for 25-Year event	
Inflow =	211.91 cfs @	12.20 hrs,	Volume=	19.540 af	
Outflow =	211.71 cfs @	12.21 hrs,	Volume=	19.540 af,	Atten= 0%, Lag= 0.3 min

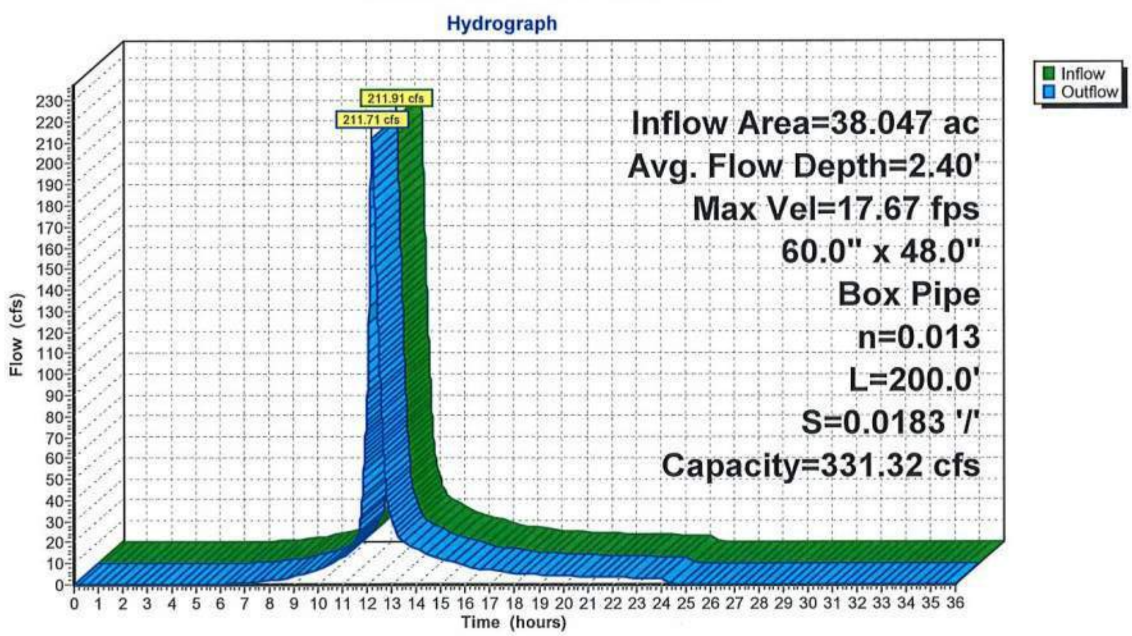
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 17.67 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.94 fps, Avg. Travel Time= 0.7 min

Peak Storage= 2,398 cf @ 12.20 hrs
Average Depth at Peak Storage= 2.40'
Bank-Full Depth= 4.00' Flow Area= 20.0 sf, Capacity= 331.32 cfs

60.0" W x 48.0" H Box Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 200.0' Slope= 0.0183 '/'
Inlet Invert= 53.45', Outlet Invert= 49.80'



Reach B2: 5' x 4' Box Culvert



Summary for Reach C1-4: Chute-Concrete Block Open Cell

Inflow Area = 38.047 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 211.71 cfs @ 12.21 hrs, Volume= 19.540 af
Outflow = 211.66 cfs @ 12.21 hrs, Volume= 19.540 af, Atten= 0%, Lag= 0.1 min

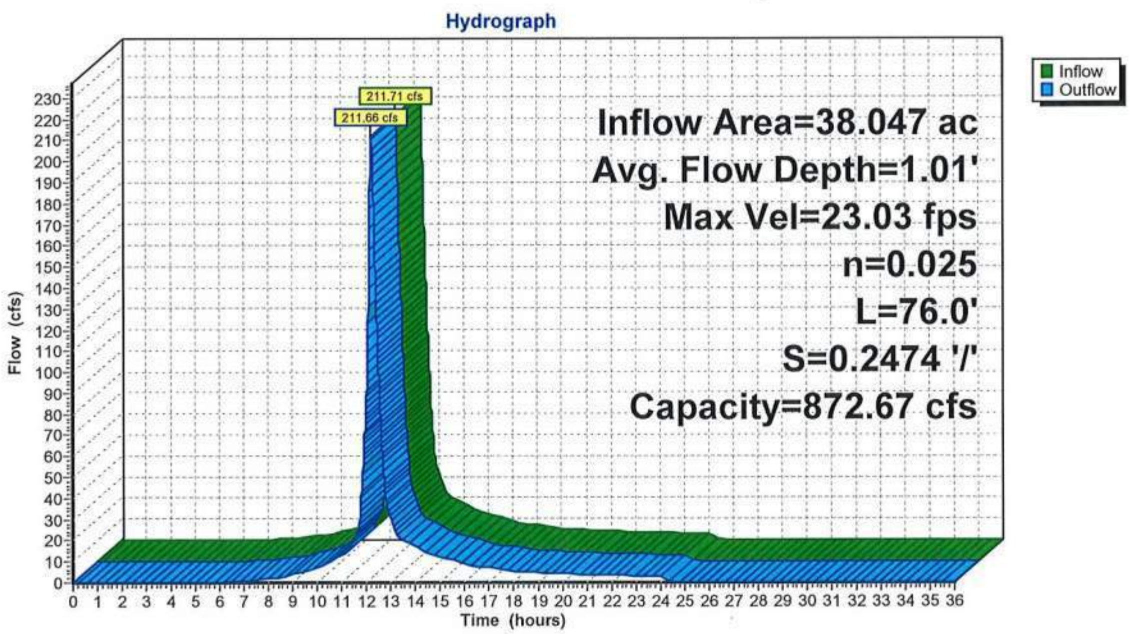
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 23.03 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.80 fps, Avg. Travel Time= 0.2 min

Peak Storage= 699 cf @ 12.21 hrs
Average Depth at Peak Storage= 1.01'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 872.67 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 76.0' Slope= 0.2474 '/'
Inlet Invert= 49.80', Outlet Invert= 31.00'

‡

Reach C1-4: Chute-Concrete Block Open Cell



Summary for Reach C1SCCN1: C1SCCN1 Collector Channel

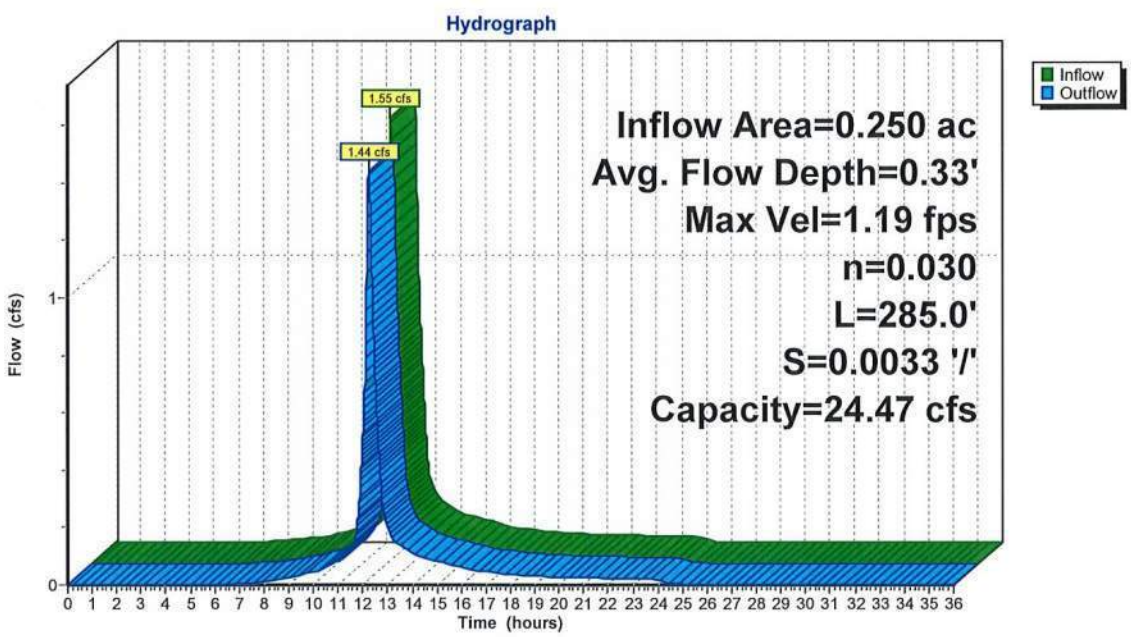
Inflow Area = 0.250 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 1.55 cfs @ 12.14 hrs, Volume= 0.128 af
Outflow = 1.44 cfs @ 12.25 hrs, Volume= 0.128 af, Atten= 7%, Lag= 6.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.19 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 14.4 min

Peak Storage= 344 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.47 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 285.0' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.55'

Reach C1SCCN1: C1SCCN1 Collector Channel



Summary for Reach C1SCCN2: C1SCCN2 Collector Channel

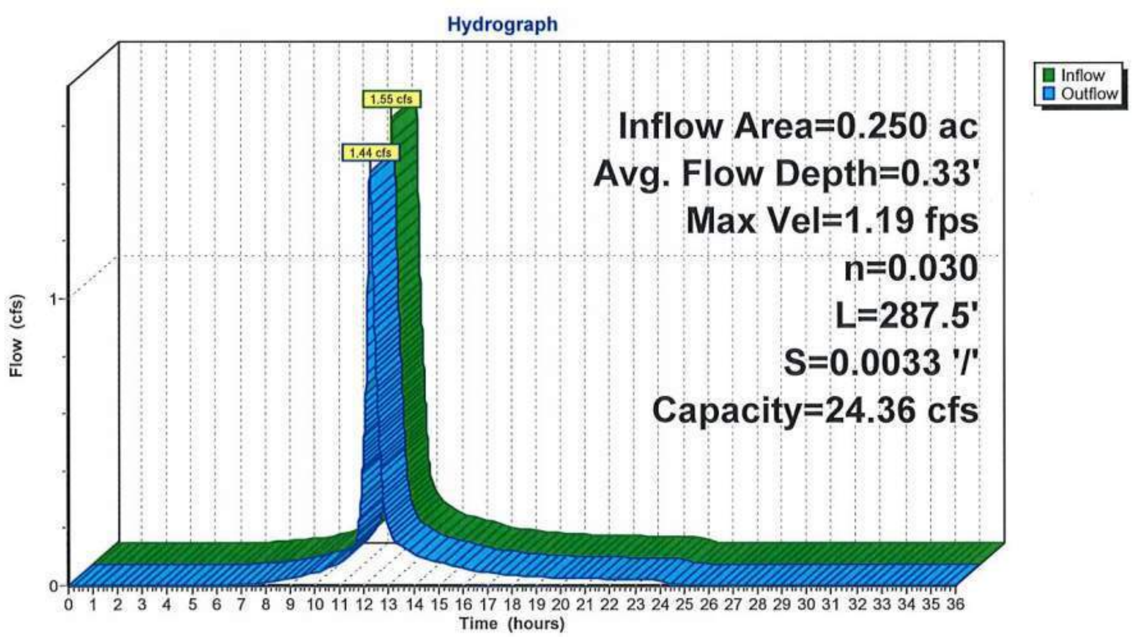
Inflow Area = 0.250 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 1.55 cfs @ 12.14 hrs, Volume= 0.128 af
Outflow = 1.44 cfs @ 12.25 hrs, Volume= 0.128 af, Atten= 7%, Lag= 6.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.19 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 14.6 min

Peak Storage= 348 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.36 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 287.5' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.55'

Reach C1SCCN2: C1SCCN2 Collector Channel



Summary for Reach C1SCCS1: C1SCCS1 Collector Channel

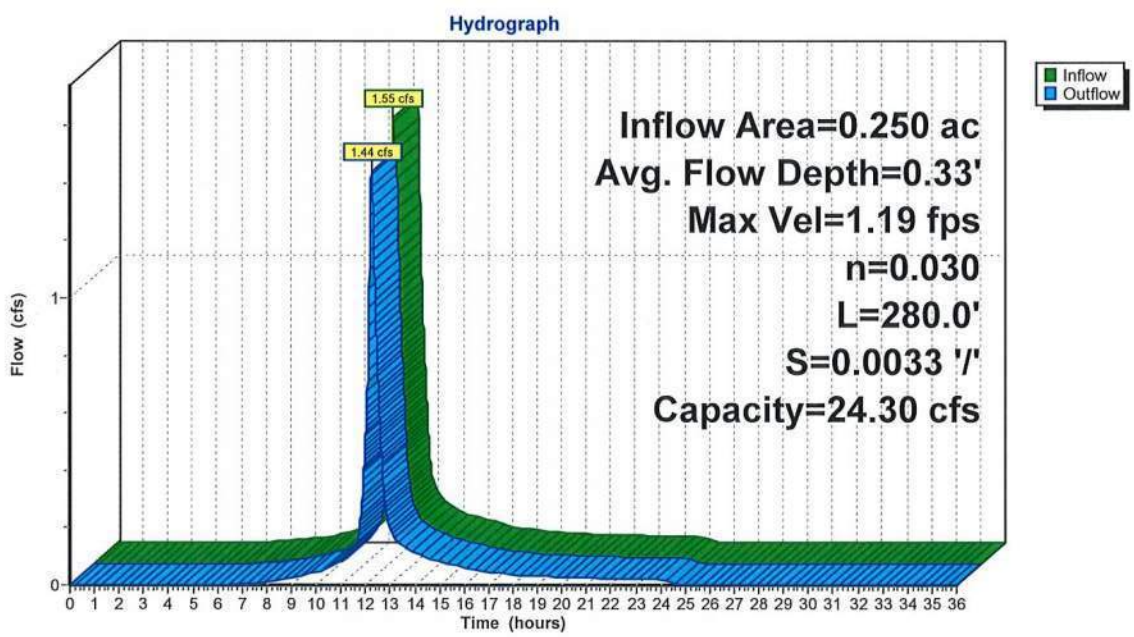
Inflow Area = 0.250 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 1.55 cfs @ 12.14 hrs, Volume= 0.128 af
Outflow = 1.44 cfs @ 12.24 hrs, Volume= 0.128 af, Atten= 7%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.19 fps, Min. Travel Time= 3.9 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 14.2 min

Peak Storage= 340 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.30 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 280.0' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.58'

Reach C1SCCS1: C1SCCS1 Collector Channel



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Summary for Reach C1SCCS2: C1SCCS2 Collector Channel

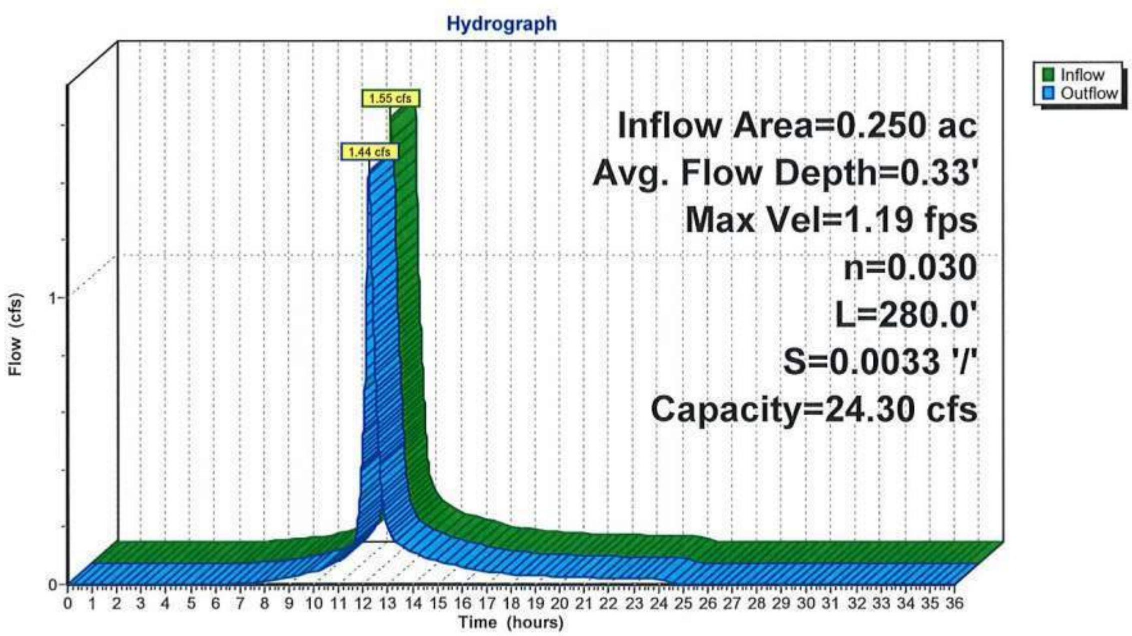
Inflow Area =	0.250 ac, 0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event
Inflow =	1.55 cfs @ 12.14 hrs, Volume=	0.128 af
Outflow =	1.44 cfs @ 12.24 hrs, Volume=	0.128 af, Atten= 7%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.19 fps, Min. Travel Time= 3.9 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 14.2 min

Peak Storage= 340 cf @ 12.18 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.30 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 280.0' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.58'

Reach C1SCCS2: C1SCCS2 Collector Channel



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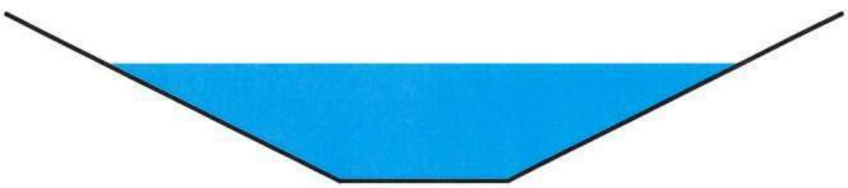
Summary for Reach C2-3: C2-3 Channel

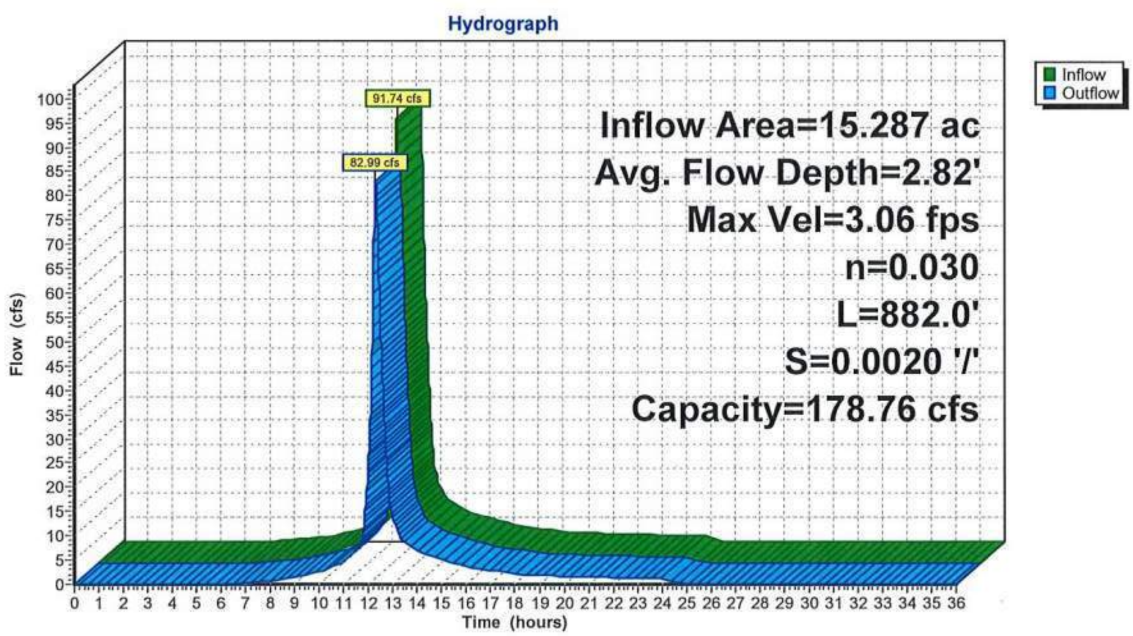
Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 91.74 cfs @ 12.16 hrs, Volume= 7.851 af
Outflow = 82.99 cfs @ 12.29 hrs, Volume= 7.851 af, Atten= 10%, Lag= 8.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.06 fps, Min. Travel Time= 4.8 min
Avg. Velocity = 0.88 fps, Avg. Travel Time= 16.8 min

Peak Storage= 23,911 cf @ 12.21 hrs
Average Depth at Peak Storage= 2.82'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 178.76 cfs

4.00' x 4.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 20.00'
Length= 882.0' Slope= 0.0020 '/'
Inlet Invert= 53.50', Outlet Invert= 51.75'





Summary for Reach C2-4: Chute-Concrete Block Open Cell

Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 82.89 cfs @ 12.30 hrs, Volume= 7.851 af
Outflow = 82.88 cfs @ 12.30 hrs, Volume= 7.851 af, Atten= 0%, Lag= 0.1 min

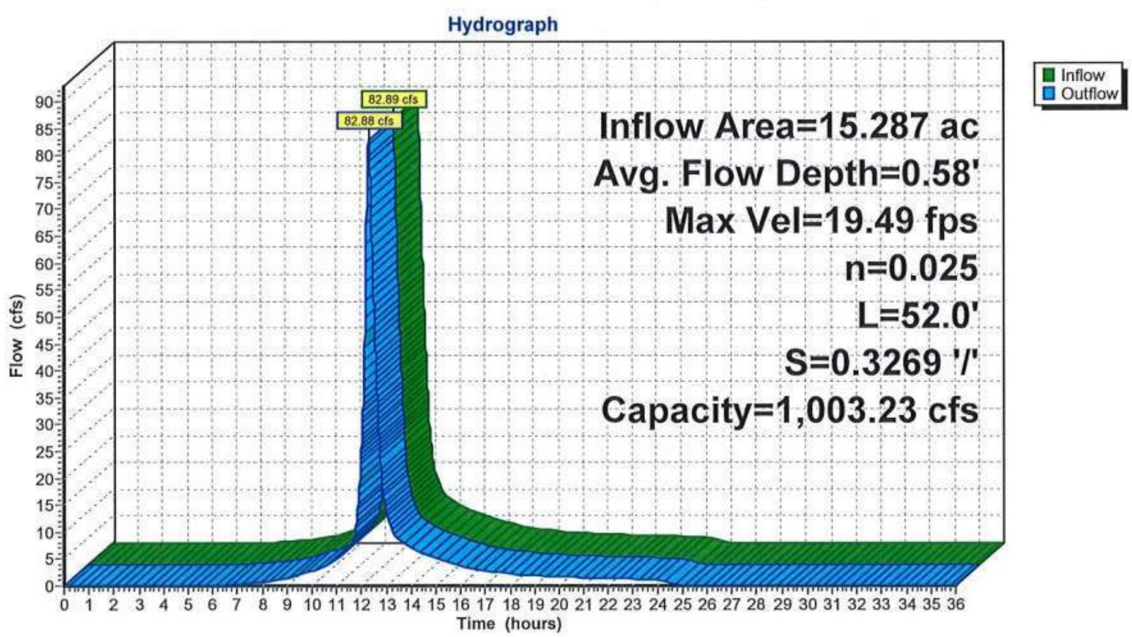
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.49 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 5.37 fps, Avg. Travel Time= 0.2 min

Peak Storage= 221 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.58'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 1,003.23 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 52.0' Slope= 0.3269 '/'
Inlet Invert= 48.00', Outlet Invert= 31.00'

‡

Reach C2-4: Chute-Concrete Block Open Cell



Summary for Reach C2-5: C2-5 Channel

Inflow Area =	15.287 ac,	0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event
Inflow =	82.96 cfs @	12.29 hrs, Volume=	7.851 af
Outflow =	82.89 cfs @	12.30 hrs, Volume=	7.851 af, Atten= 0%, Lag= 0.4 min

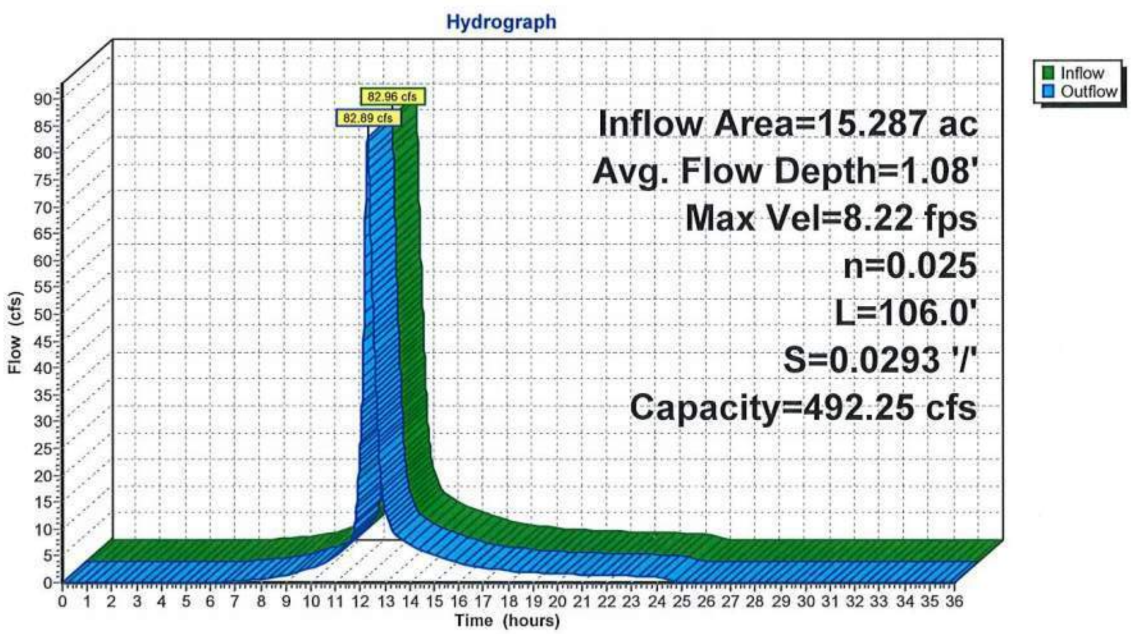
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.22 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.31 fps, Avg. Travel Time= 0.8 min

Peak Storage= 1,070 cf @ 12.30 hrs
Average Depth at Peak Storage= 1.08'
Bank-Full Depth= 2.50' Flow Area= 37.5 sf, Capacity= 492.25 cfs

5.00' x 2.50' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 25.00'
Length= 106.0' Slope= 0.0293 '/'
Inlet Invert= 51.11', Outlet Invert= 48.00'

‡

Reach C2-5: C2-5 Channel



Summary for Reach CC: Chute-Concrete Block Open Cell

Inflow Area = 1.480 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 7.72 cfs @ 12.32 hrs, Volume= 0.760 af
Outflow = 7.71 cfs @ 12.33 hrs, Volume= 0.760 af, Atten= 0%, Lag= 0.7 min

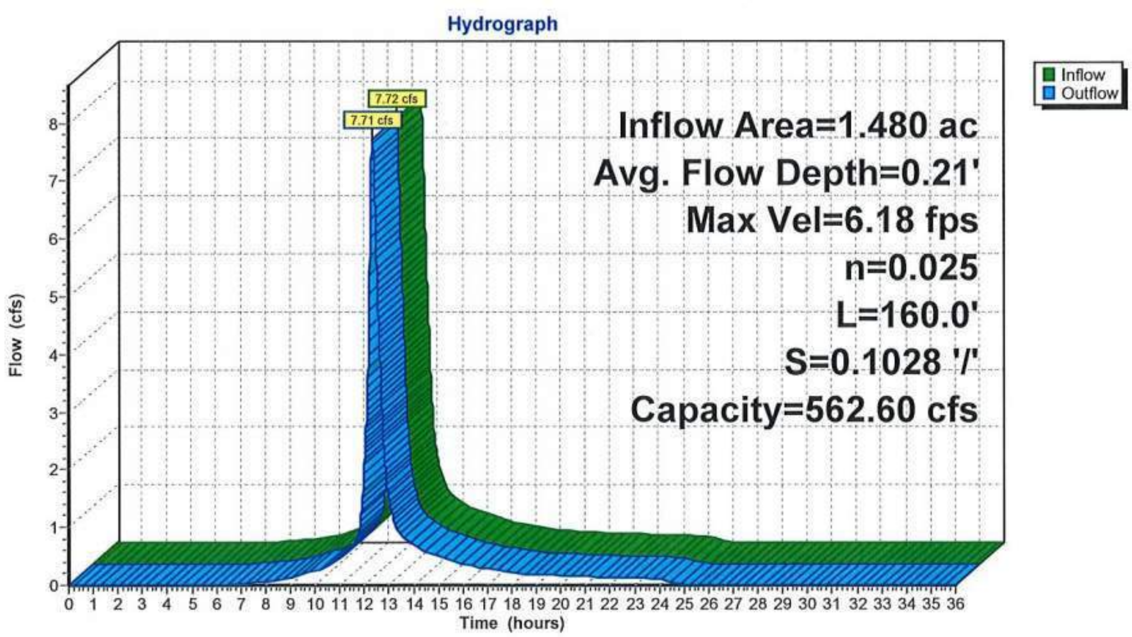
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.18 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.85 fps, Avg. Travel Time= 1.4 min

Peak Storage= 200 cf @ 12.32 hrs
Average Depth at Peak Storage= 0.21'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 562.60 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 160.0' Slope= 0.1028 '/'
Inlet Invert= 53.20', Outlet Invert= 36.75'

‡

Reach CC: Chute-Concrete Block Open Cell



Summary for Reach E: Chute-Concrete Block Open Cell

Inflow Area = 17.798 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 106.93 cfs @ 12.15 hrs, Volume= 9.140 af
Outflow = 106.72 cfs @ 12.16 hrs, Volume= 9.140 af, Atten= 0%, Lag= 0.7 min

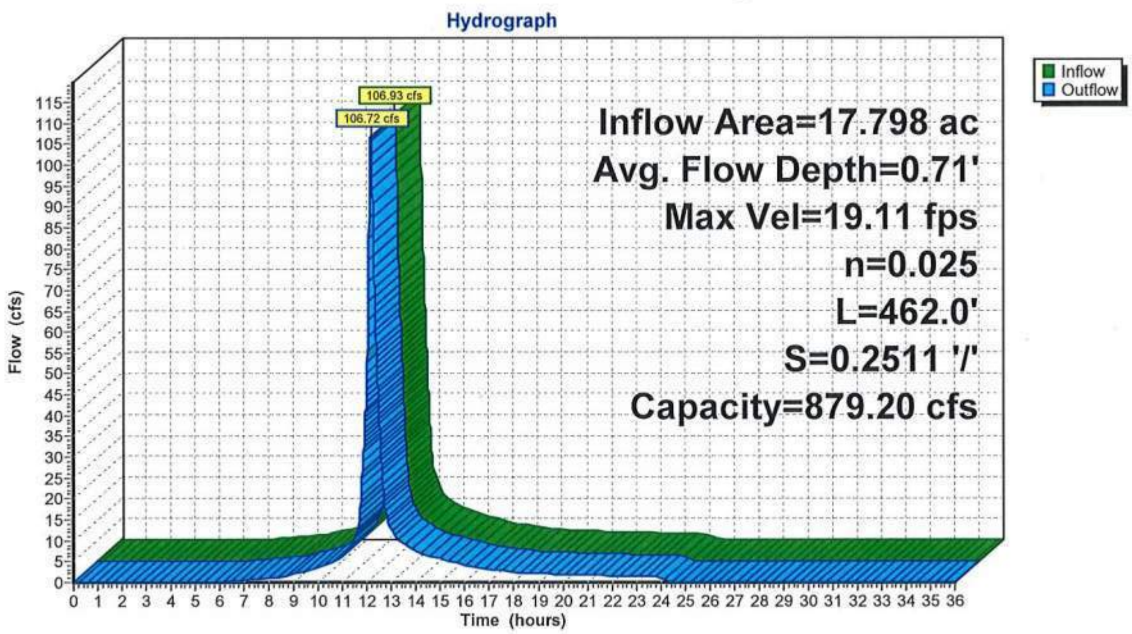
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.11 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.96 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,582 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 879.20 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 462.0' Slope= 0.2511 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'

‡

Reach E: Chute-Concrete Block Open Cell



Summary for Reach NE: Chute-Concrete Block Open Cell

Inflow Area =	15.287 ac,	0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event
Inflow =	91.93 cfs @	12.15 hrs, Volume=	7.851 af
Outflow =	91.74 cfs @	12.16 hrs, Volume=	7.851 af, Atten= 0%, Lag= 0.7 min

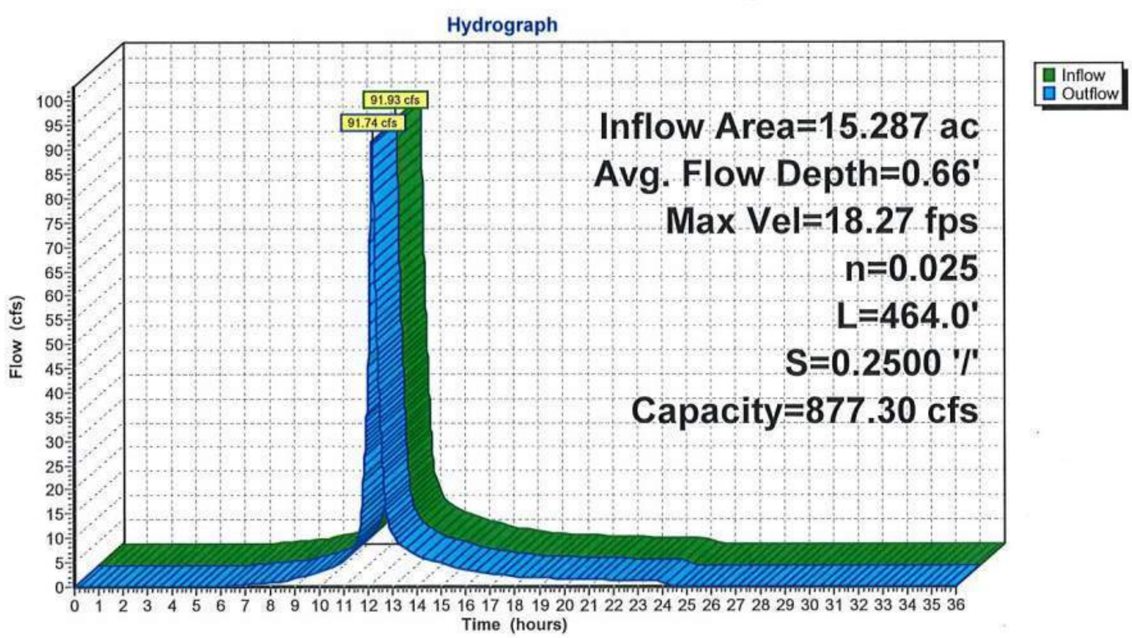
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 18.27 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.65 fps, Avg. Travel Time= 1.4 min

Peak Storage= 2,332 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 464.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'

‡

Reach NE: Chute-Concrete Block Open Cell



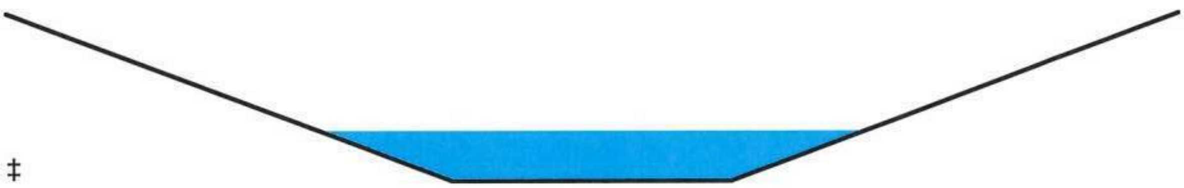
Summary for Reach NW: Chute-Concrete Block Open Cell

Inflow Area = 13.115 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 77.52 cfs @ 12.15 hrs, Volume= 6.735 af
Outflow = 77.39 cfs @ 12.16 hrs, Volume= 6.735 af, Atten= 0%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 17.38 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.36 fps, Avg. Travel Time= 1.4 min

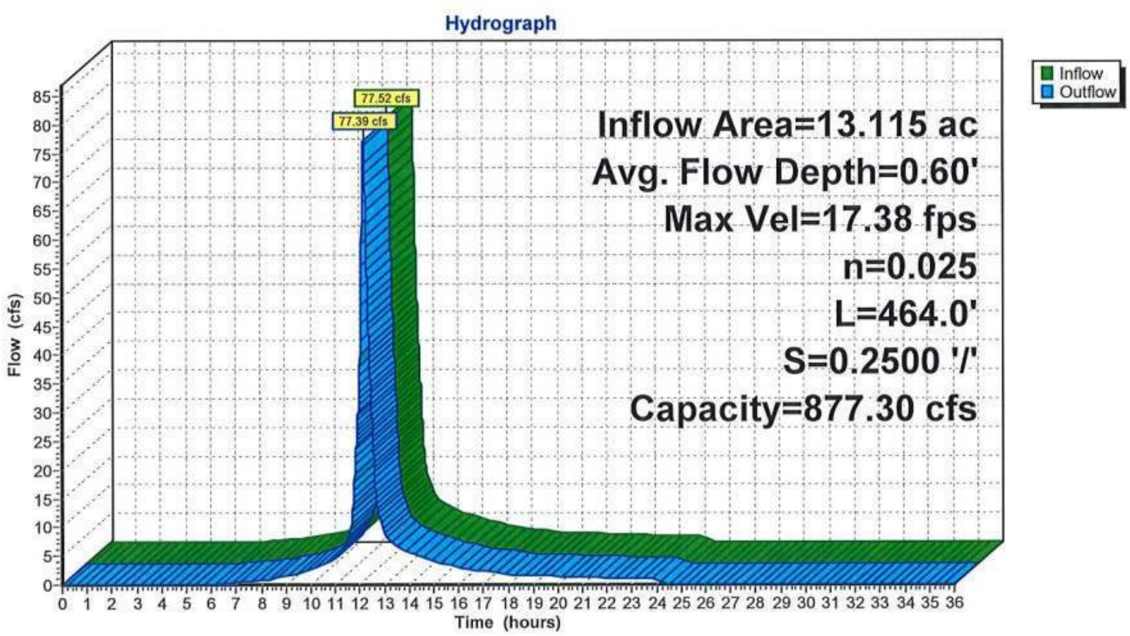
Peak Storage= 2,067 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.60'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 464.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'



‡

Reach NW: Chute-Concrete Block Open Cell



Summary for Reach OC: Existing Offsite Channel

Inflow Area = 42.338 ac, 0.00% Impervious, Inflow Depth > 6.18" for 25-Year event
Inflow = 33.70 cfs @ 12.91 hrs, Volume= 21.821 af
Outflow = 32.78 cfs @ 14.06 hrs, Volume= 21.722 af, Atten= 3%, Lag= 68.9 min

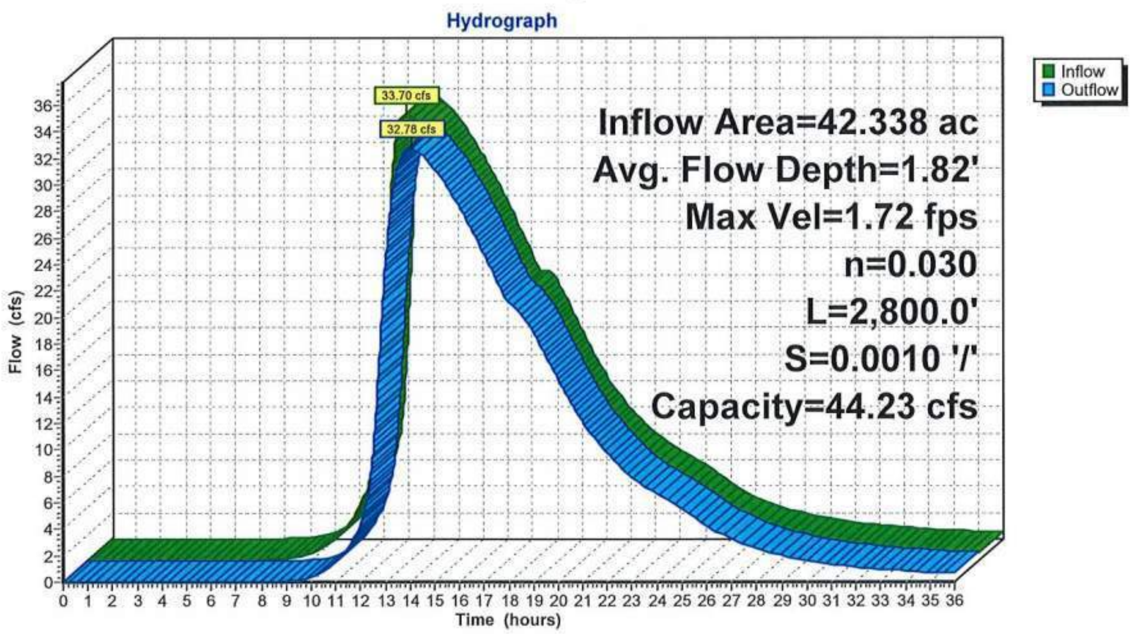
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.72 fps, Min. Travel Time= 27.1 min
Avg. Velocity = 0.84 fps, Avg. Travel Time= 55.4 min

Peak Storage= 53,292 cf @ 13.60 hrs
Average Depth at Peak Storage= 1.82'
Bank-Full Depth= 2.10' Flow Area= 23.7 sf, Capacity= 44.23 cfs

5.00' x 2.10' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 17.60'
Length= 2,800.0' Slope= 0.0010 '/'
Inlet Invert= 46.66', Outlet Invert= 43.86'

‡

Reach OC: Existing Offsite Channel



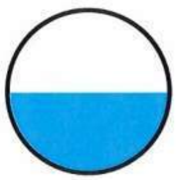
Summary for Reach P1: Culvert

Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 82.99 cfs @ 12.29 hrs, Volume= 7.851 af
Outflow = 82.96 cfs @ 12.29 hrs, Volume= 7.851 af, Atten= 0%, Lag= 0.1 min

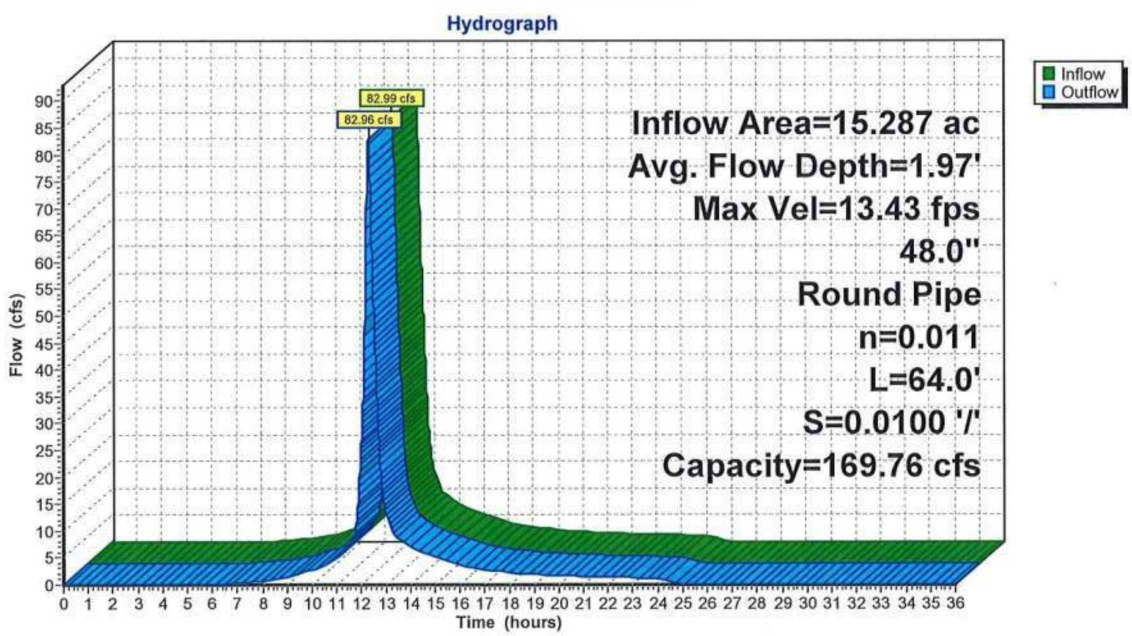
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.43 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.02 fps, Avg. Travel Time= 0.3 min

Peak Storage= 395 cf @ 12.29 hrs
Average Depth at Peak Storage= 1.97'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 169.76 cfs

48.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 64.0' Slope= 0.0100 '/'
Inlet Invert= 51.75', Outlet Invert= 51.11'



Reach P1: Culvert



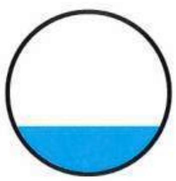
Summary for Reach P2: Culvert

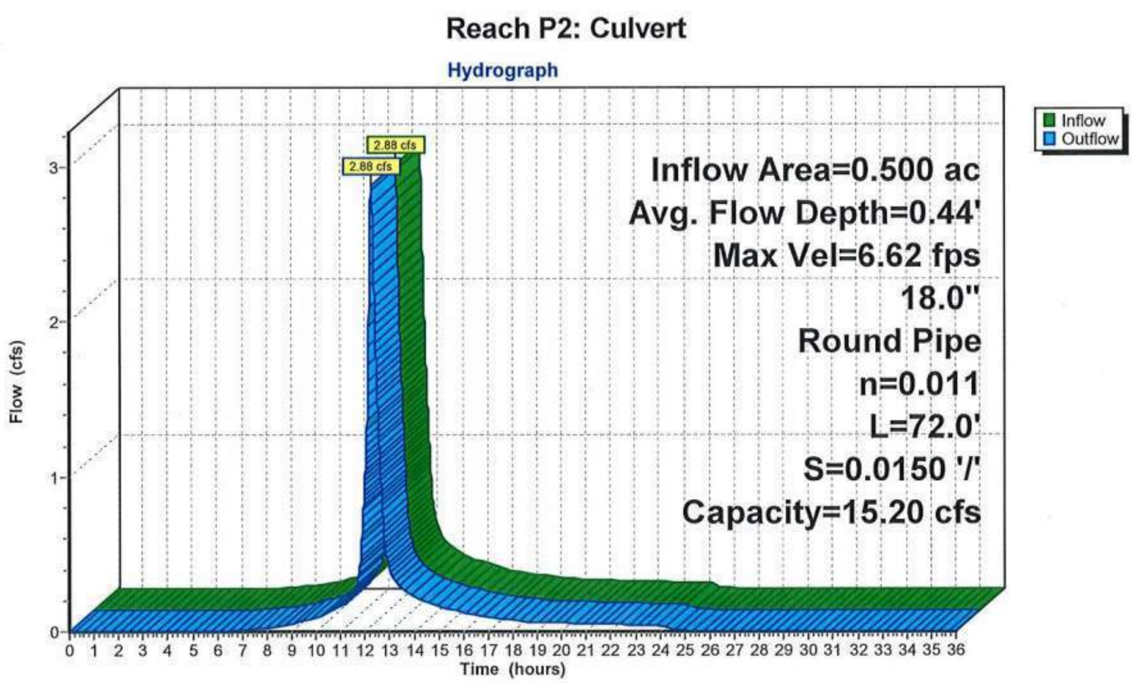
Inflow Area =	0.500 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event	
Inflow =	2.88 cfs @ 12.25 hrs, Volume=	0.257 af
Outflow =	2.88 cfs @ 12.25 hrs, Volume=	0.257 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.62 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.18 fps, Avg. Travel Time= 0.6 min

Peak Storage= 31 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.44'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 15.20 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 72.0' Slope= 0.0150 '/'
Inlet Invert= 54.39', Outlet Invert= 53.31'





Summary for Reach P2-1: Chute-Concrete Block Open Cell

Inflow Area =	0.500 ac, 0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event
Inflow =	2.88 cfs @ 12.25 hrs, Volume=	0.257 af
Outflow =	2.88 cfs @ 12.25 hrs, Volume=	0.257 af, Atten= 0%, Lag= 0.2 min

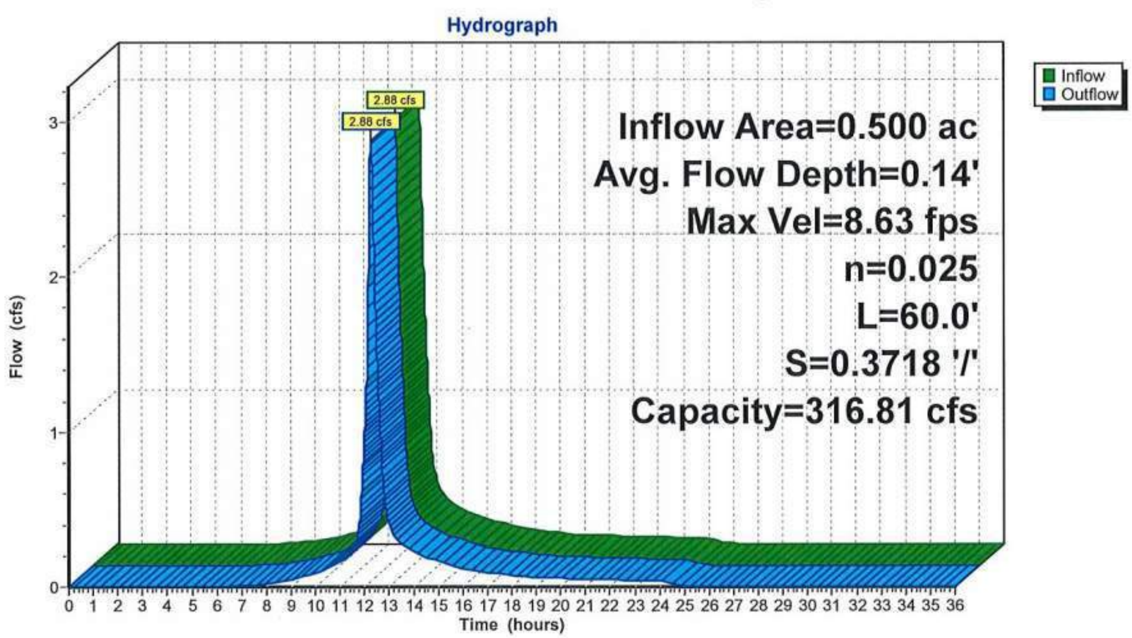
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.63 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.71 fps, Avg. Travel Time= 0.4 min

Peak Storage= 20 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.50' Flow Area= 9.8 sf, Capacity= 316.81 cfs

2.00' x 1.50' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 60.0' Slope= 0.3718 '/'
Inlet Invert= 53.31', Outlet Invert= 31.00'

‡

Reach P2-1: Chute-Concrete Block Open Cell



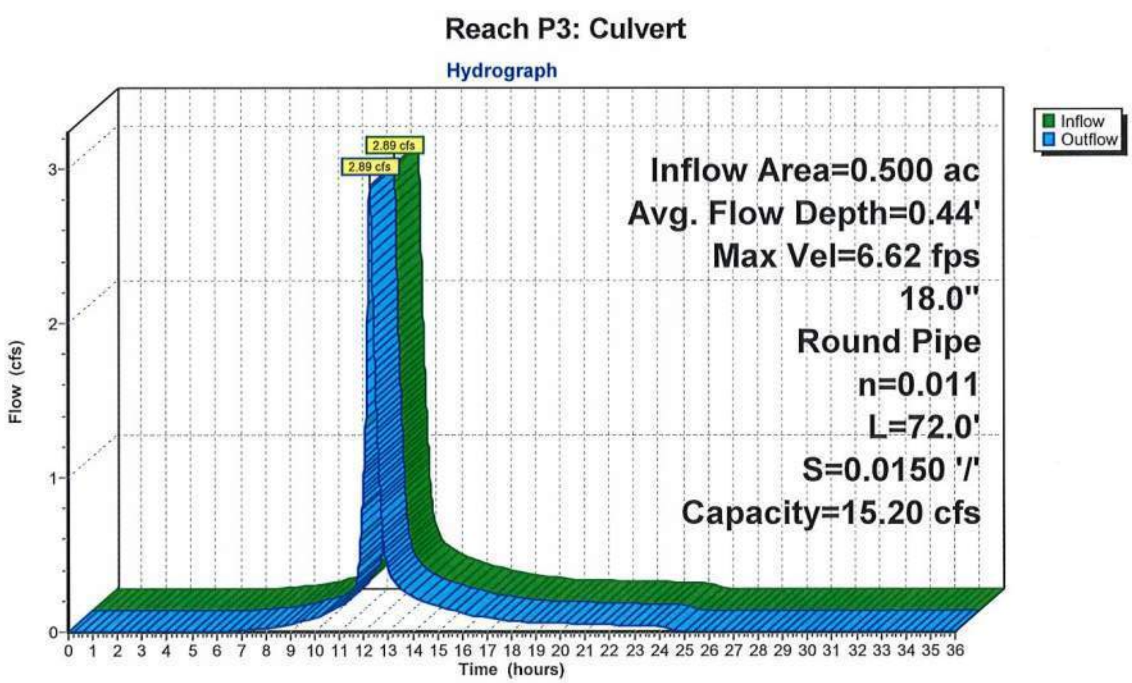
Summary for Reach P3: Culvert

Inflow Area = 0.500 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 2.89 cfs @ 12.24 hrs, Volume= 0.257 af
Outflow = 2.89 cfs @ 12.25 hrs, Volume= 0.257 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.62 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.18 fps, Avg. Travel Time= 0.6 min

Peak Storage= 31 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.44'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 15.20 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 72.0' Slope= 0.0150 '/'
Inlet Invert= 55.41', Outlet Invert= 54.33'



Post Development 25 Yr Drainage *Type III 24-hr 25-Year Rainfall=8.70"*
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Summary for Reach P3-1: Chute-Concrete Block Open Cell

Inflow Area =	0.500 ac,	0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event	
Inflow =	2.89 cfs @	12.25 hrs, Volume=	0.257 af	
Outflow =	2.89 cfs @	12.25 hrs, Volume=	0.257 af, Atten= 0%, Lag= 0.2 min	

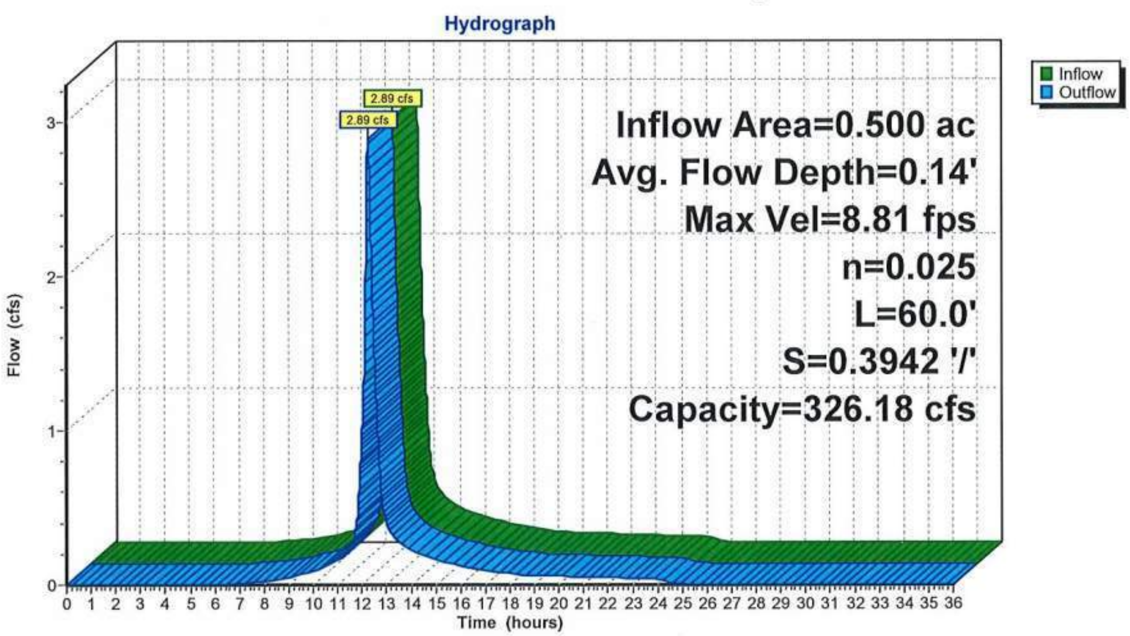
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.81 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.78 fps, Avg. Travel Time= 0.4 min

Peak Storage= 20 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.50' Flow Area= 9.8 sf, Capacity= 326.18 cfs

2.00' x 1.50' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 60.0' Slope= 0.3942 '/'
Inlet Invert= 54.65', Outlet Invert= 31.00'

‡

Reach P3-1: Chute-Concrete Block Open Cell



Summary for Reach S: Chute-Concrete Block Open Cell

Inflow Area = 17.361 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 107.94 cfs @ 12.14 hrs, Volume= 8.916 af
Outflow = 107.70 cfs @ 12.15 hrs, Volume= 8.916 af, Atten= 0%, Lag= 0.7 min

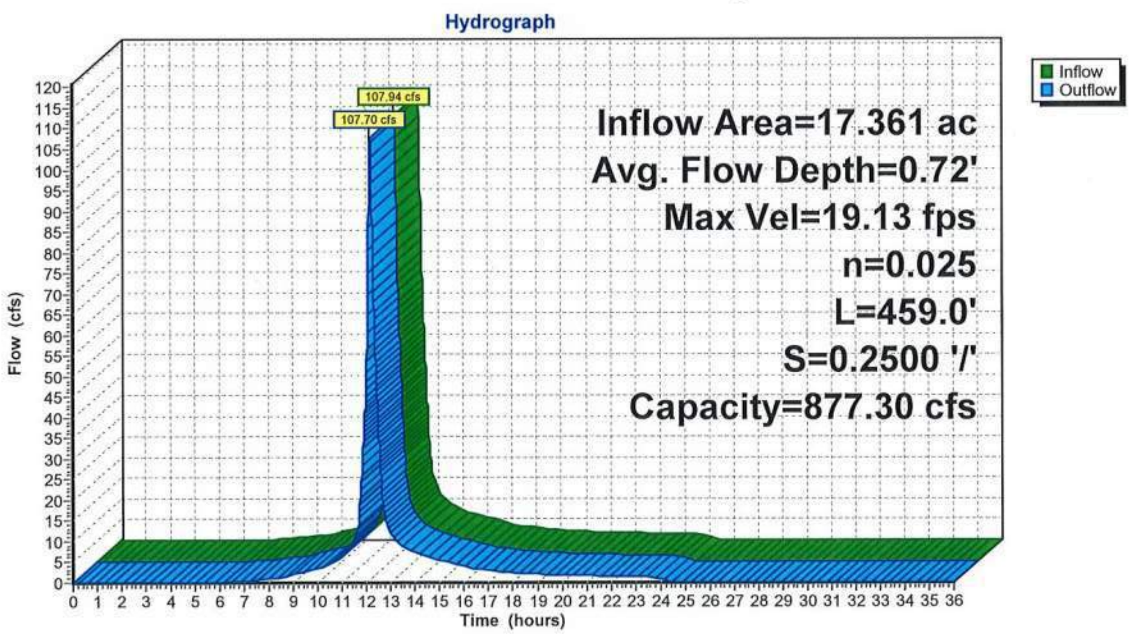
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.13 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.91 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,586 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 459.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 59.25'

‡

Reach S: Chute-Concrete Block Open Cell



Summary for Reach SE: Chute-Concrete Block Open Cell

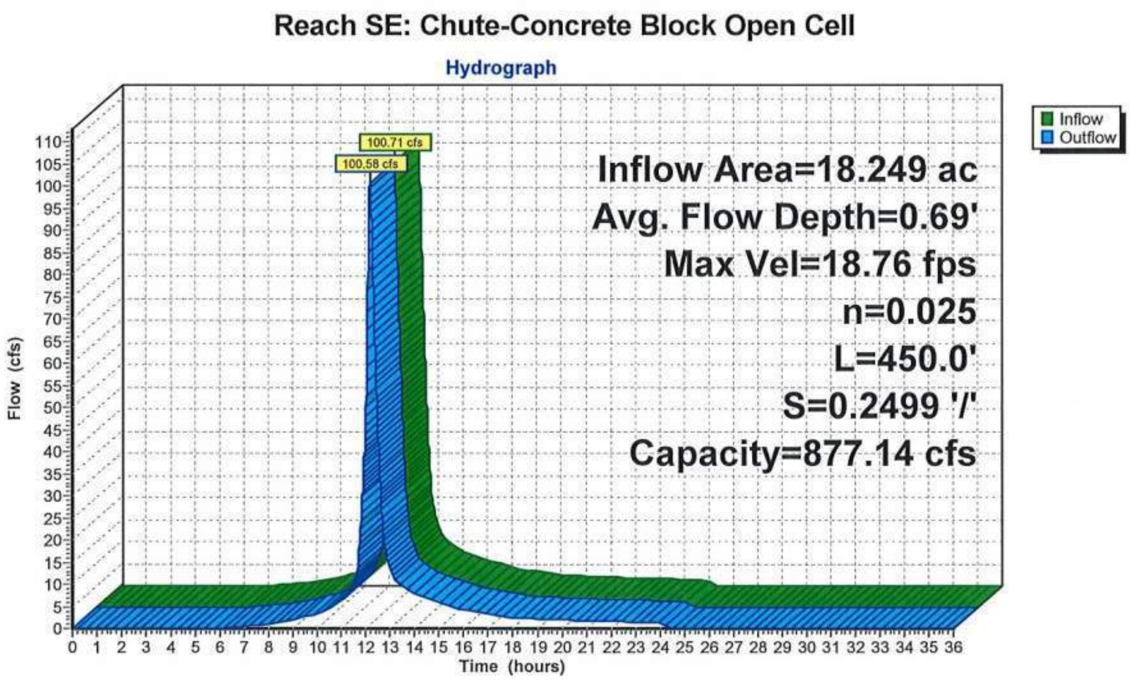
Inflow Area =	18.249 ac,	0.00% Impervious,	Inflow Depth = 6.16"	for 25-Year event	
Inflow =	100.71 cfs @	12.16 hrs,	Volume=	9.372 af	
Outflow =	100.58 cfs @	12.17 hrs,	Volume=	9.372 af,	Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 18.76 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.97 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,415 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.14 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 450.0' Slope= 0.2499 '/'
Inlet Invert= 174.00', Outlet Invert= 61.54'

‡



Summary for Reach SE1: Chute-Concrete Block Open Cell

Inflow Area = 18.249 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 100.58 cfs @ 12.17 hrs, Volume= 9.372 af
Outflow = 100.54 cfs @ 12.17 hrs, Volume= 9.372 af, Atten= 0%, Lag= 0.1 min

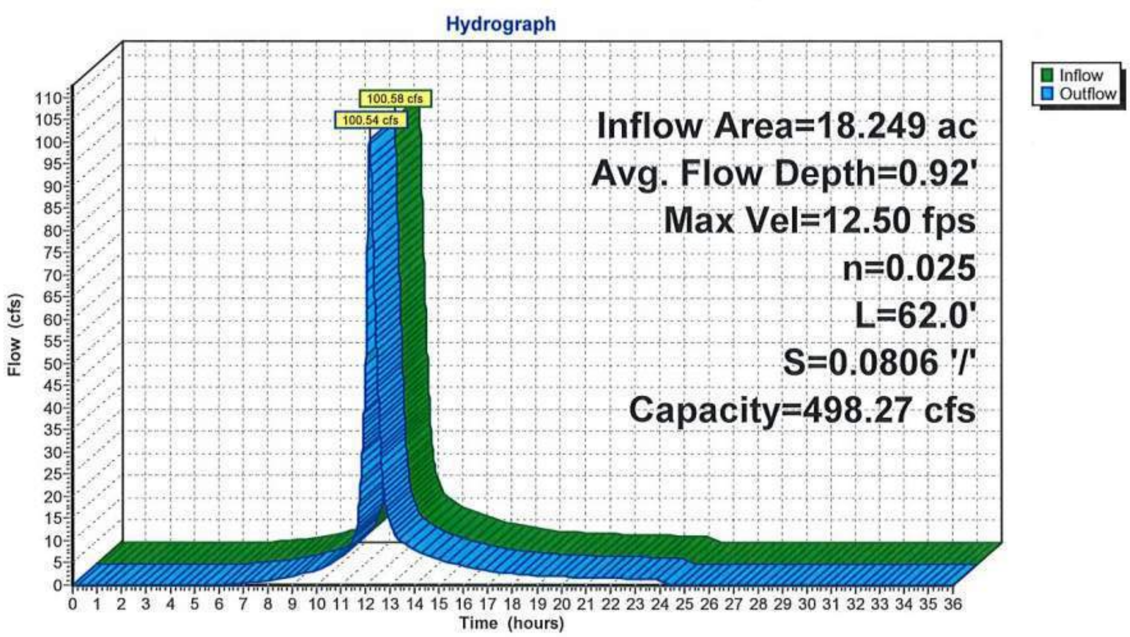
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.50 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.11 fps, Avg. Travel Time= 0.3 min

Peak Storage= 499 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.92'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 498.27 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 62.0' Slope= 0.0806 '/'
Inlet Invert= 61.54', Outlet Invert= 56.54'

‡

Reach SE1: Chute-Concrete Block Open Cell



Summary for Reach SW: Chute-Concrete Block Open Cell

Inflow Area =	15.434 ac,	0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event
Inflow =	95.96 cfs @	12.14 hrs, Volume=	7.926 af
Outflow =	95.76 cfs @	12.15 hrs, Volume=	7.926 af, Atten= 0%, Lag= 0.6 min

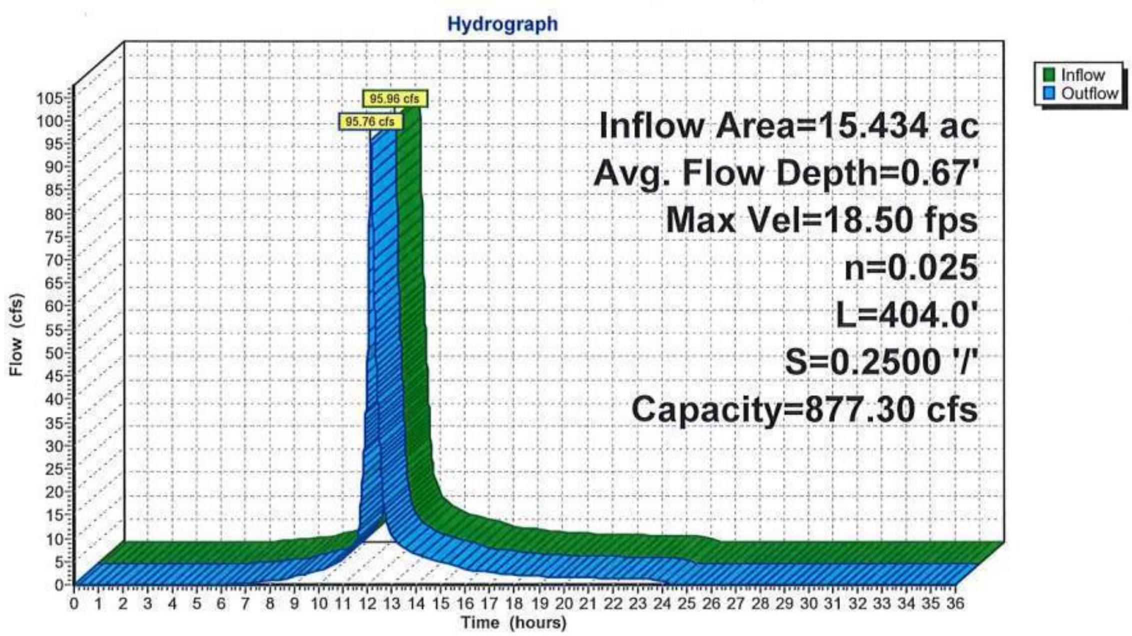
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 18.50 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.68 fps, Avg. Travel Time= 1.2 min

Peak Storage= 2,094 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.67'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 404.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 73.00'

‡

Reach SW: Chute-Concrete Block Open Cell



Summary for Reach SW-1: Chute-Concrete Block Open Cell

Inflow Area = 15.434 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 95.76 cfs @ 12.15 hrs, Volume= 7.926 af
Outflow = 95.59 cfs @ 12.16 hrs, Volume= 7.926 af, Atten= 0%, Lag= 0.5 min

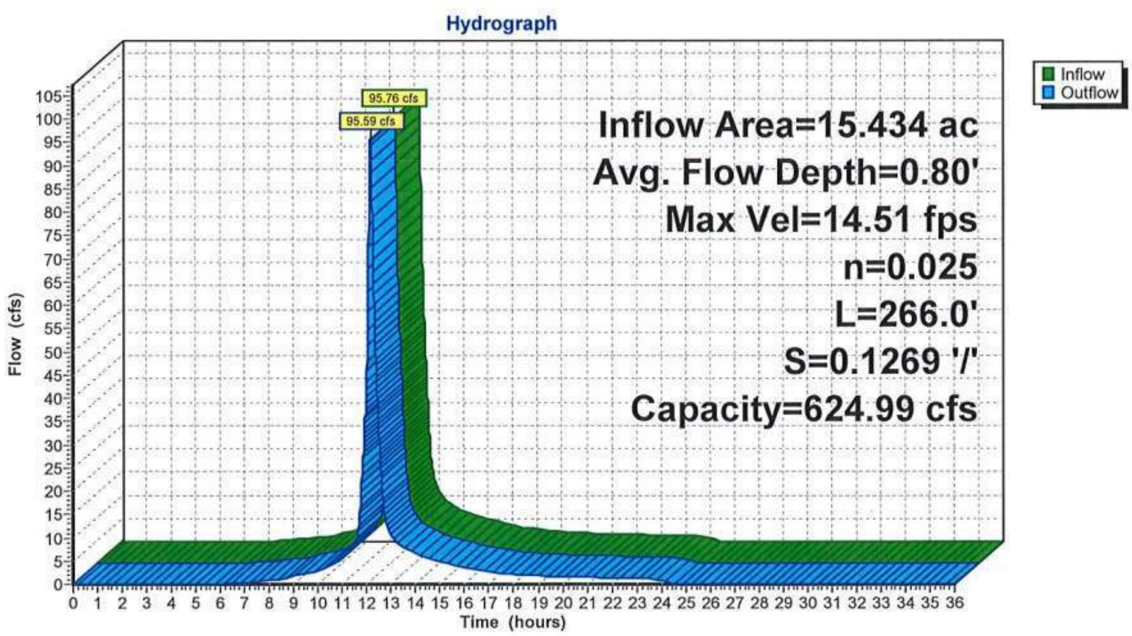
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 14.51 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.54 fps, Avg. Travel Time= 1.0 min

Peak Storage= 1,754 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.80'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 624.99 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 266.0' Slope= 0.1269 '/'
Inlet Invert= 70.50', Outlet Invert= 36.75'

‡

Reach SW-1: Chute-Concrete Block Open Cell



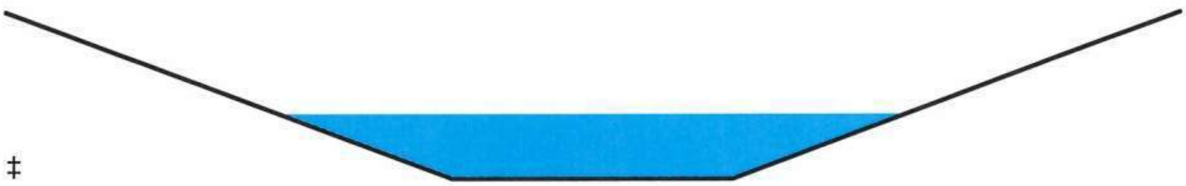
Summary for Reach W: Chute-Concrete Block Open Cell

Inflow Area = 22.383 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 127.46 cfs @ 12.15 hrs, Volume= 11.495 af
Outflow = 127.27 cfs @ 12.16 hrs, Volume= 11.495 af, Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.06 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.41 fps, Avg. Travel Time= 1.2 min

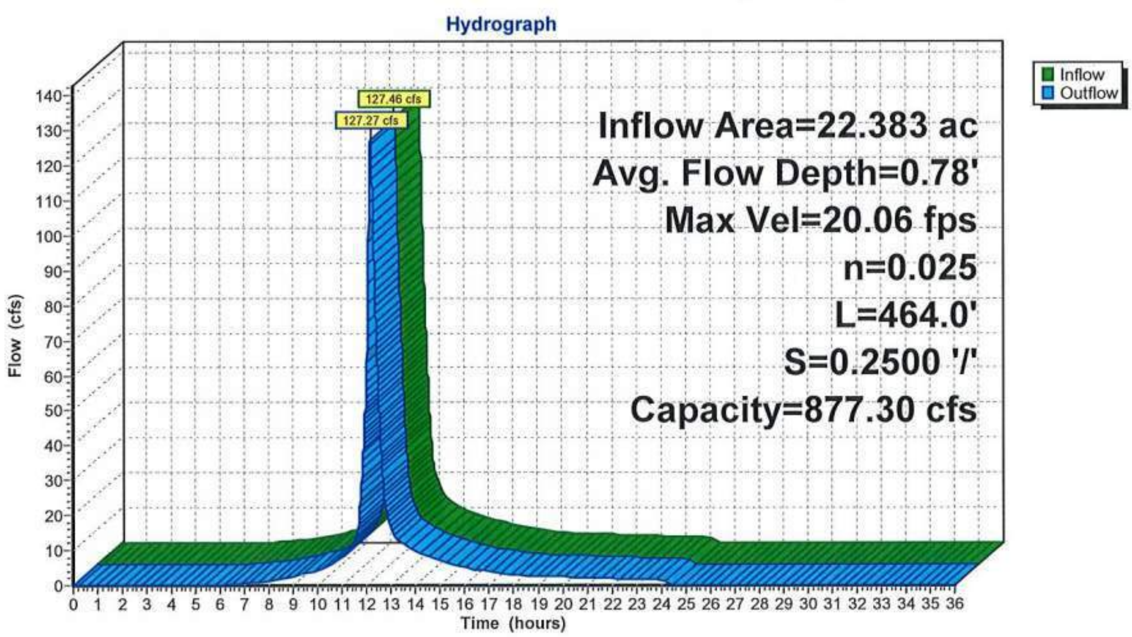
Peak Storage= 2,946 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.78'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 464.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'



‡

Reach W: Chute-Concrete Block Open Cell



Summary for Pond PA: Retention Pond A

No Discharge. Reshaping of Existing Pond A Bottom Required.

Inflow Area = 47.697 ac, 0.00% Impervious, Inflow Depth = 6.59" for 25-Year event
Inflow = 225.75 cfs @ 12.22 hrs, Volume= 26.201 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

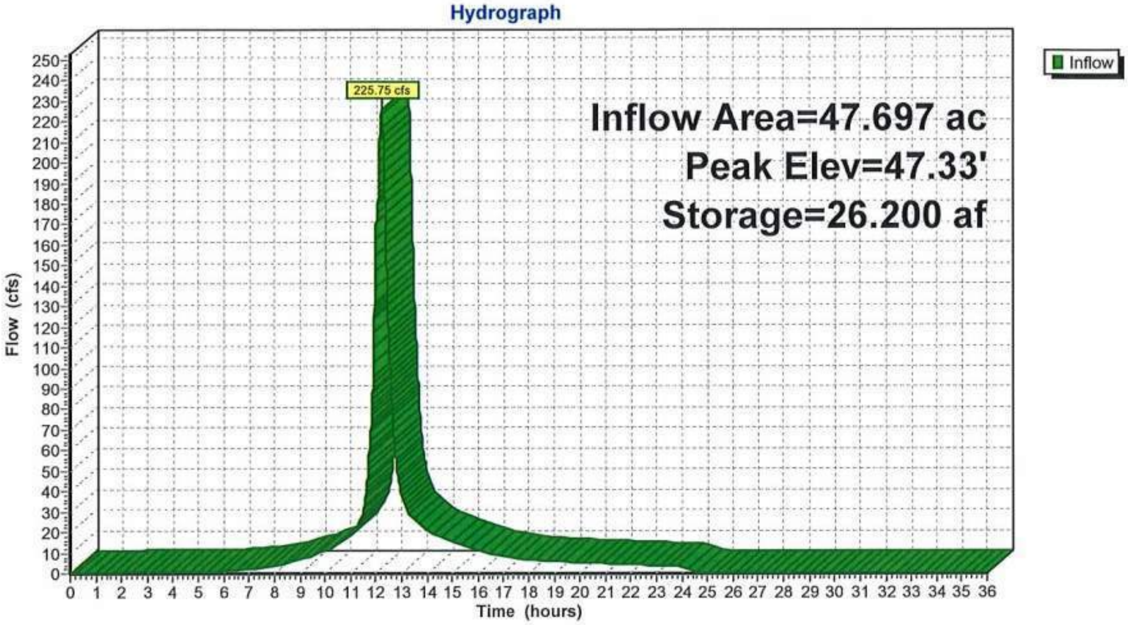
Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 47.33' @ 36.00 hrs Surf.Area= 4.028 ac Storage= 26.200 af

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	36.75'	82.379 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
36.75	1.340	1,049.8	0.000	0.000	1.340
37.00	1.380	1,064.9	0.340	0.340	1.399
38.00	1.540	1,125.4	1.459	1.799	1.642
39.00	1.720	1,171.5	1.629	3.428	1.837
40.00	1.890	1,216.8	1.804	5.233	2.037
41.00	2.120	1,292.5	2.004	7.237	2.385
42.00	2.360	1,370.6	2.239	9.476	2.766
43.00	2.620	1,447.9	2.489	11.964	3.166
44.00	2.900	1,537.3	2.759	14.723	3.654
45.00	3.210	1,623.3	3.054	17.777	4.152
46.00	3.550	1,699.4	3.379	21.156	4.616
47.00	3.910	1,769.6	3.729	24.884	5.062
48.00	4.270	1,832.8	4.089	28.973	5.480
49.00	4.640	1,894.6	4.454	33.426	5.903
50.00	5.020	1,956.1	4.829	38.255	6.338
51.00	5.450	2,024.3	5.234	43.489	6.836
52.00	5.860	2,075.6	5.654	49.143	7.223
53.00	6.180	2,125.3	6.019	55.162	7.608
54.00	6.490	2,167.2	6.334	61.496	7.940
55.00	6.800	2,209.1	6.644	68.141	8.279
56.00	7.120	2,250.9	6.959	75.100	8.623
57.00	7.440	2,292.6	7.279	82.379	8.973

Pond PA: Retention Pond A



Summary for Pond PB: Detention Pond B

Inflow Area = 42.338 ac, 0.00% Impervious, Inflow Depth = 6.40" for 25-Year event
Inflow = 235.89 cfs @ 12.16 hrs, Volume= 22.565 af
Outflow = 33.70 cfs @ 12.91 hrs, Volume= 21.821 af, Atten= 86%, Lag= 45.0 min
Primary = 33.70 cfs @ 12.91 hrs, Volume= 21.821 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 50.87' @ 12.91 hrs Surf.Area= 3.532 ac Storage= 11.562 af

Plug-Flow detention time= 244.2 min calculated for 21.821 af (97% of inflow)
Center-of-Mass det. time= 224.8 min (1,023.3 - 798.5)

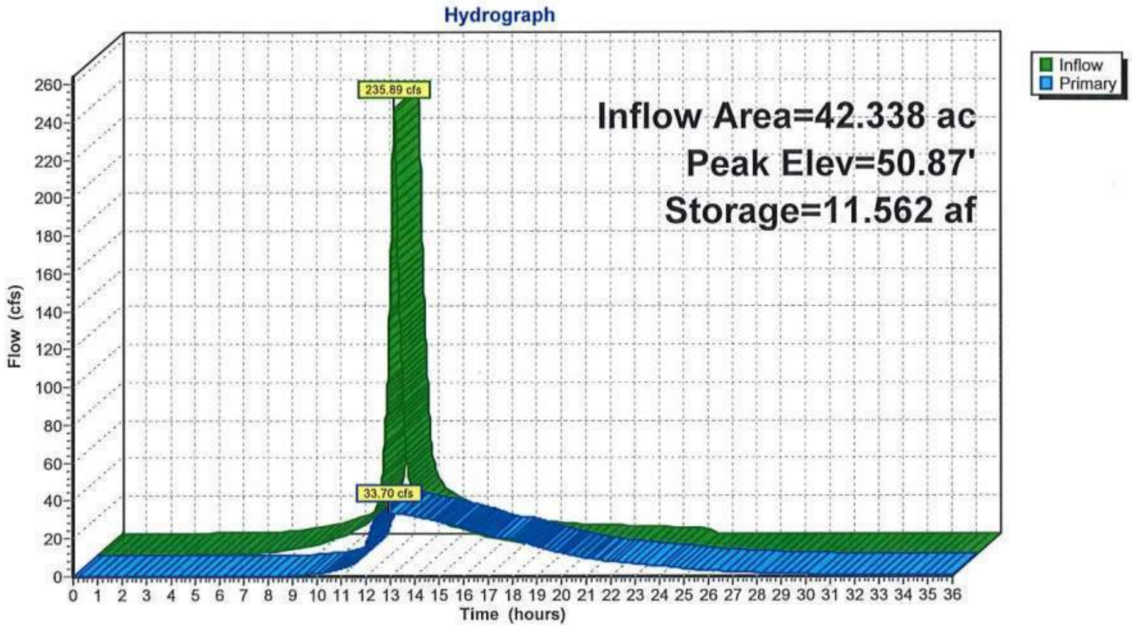
Volume	Invert	Avail.Storage	Storage Description
#1	47.00'	19.739 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
47.00	2.450	3,998.7	0.000	0.000	2.450
48.00	2.730	4,022.7	2.589	2.589	2.814
49.00	3.010	4,046.7	2.869	5.458	3.179
50.00	3.290	4,070.7	3.149	8.607	3.547
51.00	3.570	4,094.6	3.429	12.036	3.916
52.00	3.850	4,118.8	3.709	15.745	4.291
53.00	4.140	4,158.1	3.994	19.739	4.893

Device	Routing	Invert	Outlet Devices
#1	Primary	47.00'	**21.0" Round RCP_Round 21"** L= 128.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 47.00' / 46.75' S= 0.0020 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 2.41 sf
#2	Primary	47.00'	**21.0" Round RCP_Round 21"** L= 128.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 47.00' / 46.75' S= 0.0020 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 2.41 sf

Primary OutFlow Max=33.70 cfs @ 12.91 hrs HW=50.87' (Free Discharge)
1=RCP_Round 21" (Barrel Controls 16.85 cfs @ 7.00 fps)
2=RCP_Round 21" (Barrel Controls 16.85 cfs @ 7.00 fps)

Pond PB: Detention Pond B



Summary for Pond PC: Retention Pond C

No Discharge. Constructrion of Perimeter Berm to Elevation 48 ft. Required.

Inflow Area = 61.564 ac, 0.00% Impervious, Inflow Depth = 6.37" for 25-Year event
Inflow = 313.19 cfs @ 12.23 hrs, Volume= 32.676 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

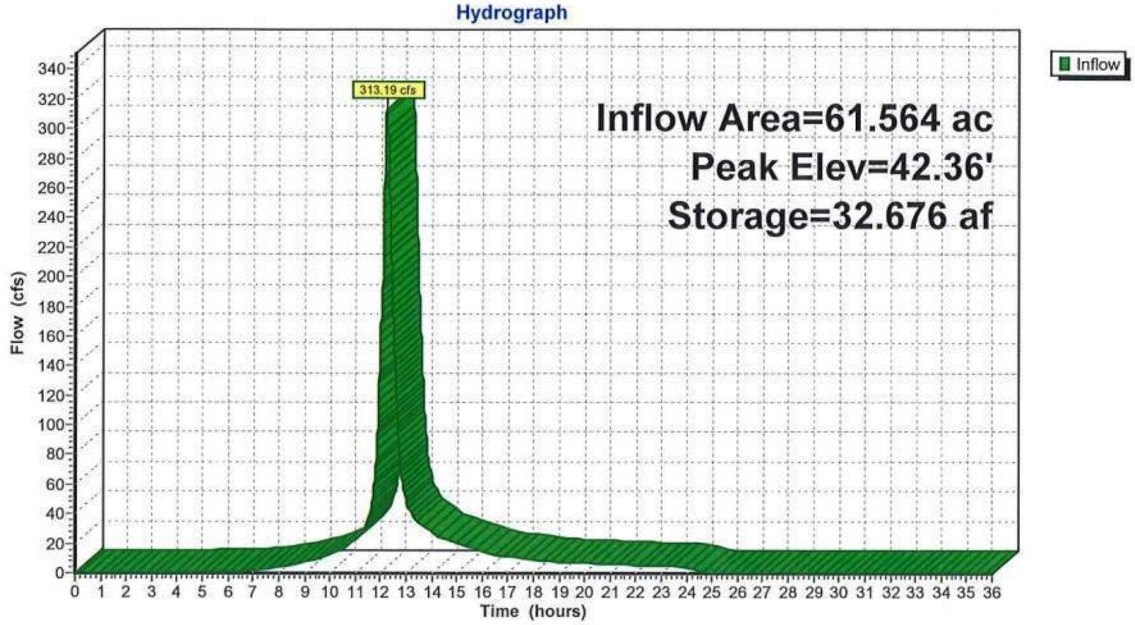
Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 42.36' @ 36.00 hrs Surf.Area= 3.718 ac Storage= 32.676 af

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	31.00'	56.115 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
31.00	2.060	2,014.1	0.000	0.000	2.060
32.00	2.200	2,032.9	2.130	2.130	2.207
33.00	2.340	2,051.7	2.270	4.399	2.354
34.00	2.480	2,070.5	2.410	6.809	2.504
35.00	2.630	2,089.2	2.555	9.364	2.654
36.00	2.770	2,108.0	2.700	12.063	2.806
37.00	2.920	2,126.8	2.845	14.908	2.959
38.00	3.060	2,145.6	2.990	17.898	3.114
39.00	3.210	2,164.4	3.135	21.032	3.270
40.00	3.360	2,183.2	3.285	24.317	3.427
41.00	3.510	2,201.9	3.435	27.752	3.585
42.00	3.660	2,220.7	3.585	31.337	3.745
43.00	3.820	2,239.5	3.740	35.076	3.907
44.00	3.970	2,258.3	3.895	38.971	4.070
45.00	4.130	2,277.1	4.050	43.021	4.234
46.00	4.290	2,295.9	4.210	47.230	4.400
47.00	4.440	2,314.6	4.365	51.595	4.566
48.00	4.600	2,333.4	4.520	56.115	4.734

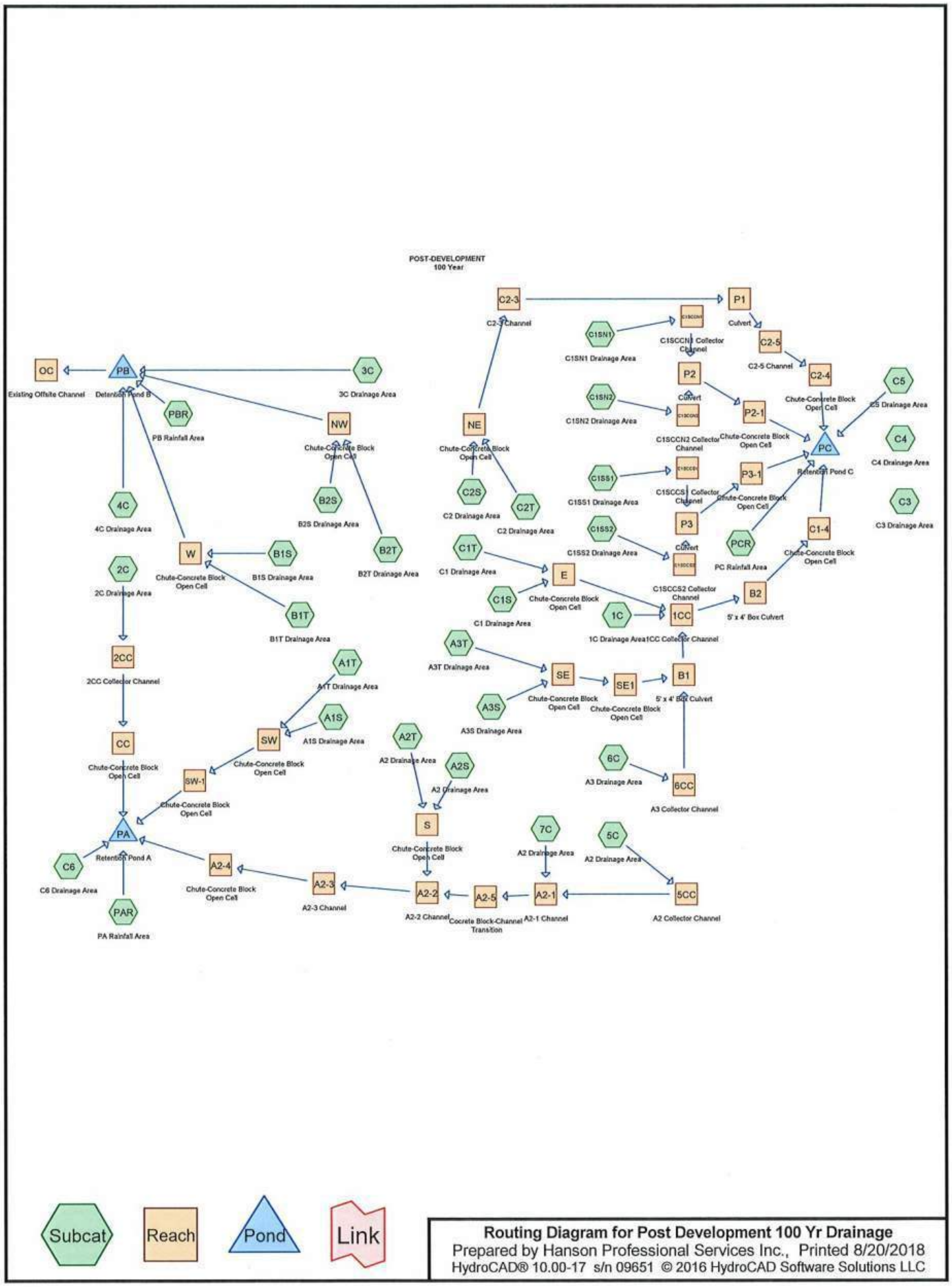
Pond PC: Retention Pond C



APPENDIX 6B.5

HYDROCAD MODEL POST DEVELOPMENT-100 YEAR

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.


POST-DEVELOPMENT
100 Year
Subcat
Reach
Pond
Link
Routing Diagram for Post Development 100 Yr Drainage
Prepared by Hanson Professional Services Inc., Printed 8/20/2018
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
128.657	79	50-75% Grass cover, Fair, HSG C (1C, 2C, 3C, 4C, 5C, 6C, 7C, A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1SN1, C1SN2, C1SS1, C1SS2, C1T, C2S, C2T)
19.672	86	<50% Grass cover, Poor, HSG C (C3, C4, C5, C6)
16.270	98	Water Surface, 0% imp, HSG C (PAR, PBR, PCR)
164.599	**82**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
164.599	HSG C	1C, 2C, 3C, 4C, 5C, 6C, 7C, A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1SN1, C1SN2, C1SS1, C1SS2, C1T, C2S, C2T, C3, C4, C5, C6, PAR, PBR, PCR
0.000	HSG D	
0.000	Other	
164.599		**TOTAL AREA**

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	128.657	0.000	0.000	128.657	50-75% Grass cover, Fair	1C, 2C, 3C, 4C, 5C, 6C, 7C, A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1SN1, C1SN2, C1SS1, C1SS2, C1T, C2S, C2T
0.000	0.000	19.672	0.000	0.000	19.672	<50% Grass cover, Poor	C3, C4, C5, C6
0.000	0.000	16.270	0.000	0.000	16.270	Water Surface, 0% imp	PAR, PBR, PCR
0.000	**0.000**	**164.599**	**0.000**	**0.000**	**164.599**	**TOTAL AREA**	

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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	B1	56.54	53.89	464.0	0.0057	0.013	60.0	48.0	0.0
2	B2	53.45	49.80	200.0	0.0182	0.013	60.0	48.0	0.0
3	P1	51.75	51.11	64.0	0.0100	0.011	48.0	0.0	0.0
4	P2	54.39	53.31	72.0	0.0150	0.011	18.0	0.0	0.0
5	P3	55.41	54.33	72.0	0.0150	0.011	18.0	0.0	0.0
6	PB	47.00	46.75	128.0	0.0020	0.013	21.0	0.0	0.0
7	PB	47.00	46.75	128.0	0.0020	0.013	21.0	0.0	0.0

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1C: 1C Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=8.77 cfs 0.736 af

Subcatchment 2C: 2C Drainage Area Runoff Area=1.480 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=12.98 cfs 1.089 af

Subcatchment 3C: 3C Drainage Area Runoff Area=1.640 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=14.38 cfs 1.207 af

Subcatchment 4C: 4C Drainage Area Runoff Area=0.910 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=7.98 cfs 0.670 af

Subcatchment 5C: A2 Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=8.77 cfs 0.736 af

Subcatchment 6C: A3 Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=8.77 cfs 0.736 af

Subcatchment 7C: A2 Drainage Area Runoff Area=1.000 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=8.77 cfs 0.736 af

Subcatchment A1S: A1S Drainage Area Runoff Area=8.009 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=70.23 cfs 5.892 af

Subcatchment A1T: A1T Drainage Area Runoff Area=7.425 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=65.11 cfs 5.463 af

Subcatchment A2S: A2 Drainage Area Runoff Area=12.241 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=107.35 cfs 9.006 af

Subcatchment A2T: A2 Drainage Area Runoff Area=5.120 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=44.90 cfs 3.767 af

Subcatchment A3S: A3S Drainage Area Runoff Area=10.760 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=94.36 cfs 7.916 af

Subcatchment A3T: A3T Drainage Area Runoff Area=7.489 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=1,050' Tc=16.7 min CN=79 Runoff=54.75 cfs 5.510 af

Subcatchment B1S: B1S Drainage Area Runoff Area=14.884 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=130.52 cfs 10.951 af

Subcatchment B1T: B1T Drainage Area Runoff Area=7.499 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=950' Tc=16.0 min CN=79 Runoff=55.80 cfs 5.517 af

Subcatchment B2S: B2S Drainage Area Runoff Area=8.806 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=77.22 cfs 6.479 af

Subcatchment B2T: B2T Drainage Area Runoff Area=4.309 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=850' Tc=13.7 min CN=79 Runoff=33.95 cfs 3.170 af

Subcatchment C1S: C1 Drainage Area Runoff Area=11.506 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=100.90 cfs 8.465 af

Subcatchment C1SN1: C1SN1 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=2.19 cfs 0.184 af

Subcatchment C1SN2: C1SN2 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=2.19 cfs 0.184 af

Subcatchment C1SS1: C1SS1 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=2.19 cfs 0.184 af

Subcatchment C1SS2: C1SS2 Drainage Area Runoff Area=0.250 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=2.19 cfs 0.184 af

Subcatchment C1T: C1 Drainage Area Runoff Area=6.292 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=800' Tc=12.5 min CN=79 Runoff=51.20 cfs 4.629 af

Subcatchment C2S: C2 Drainage Area Runoff Area=10.038 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=88.03 cfs 7.385 af

Subcatchment C2T: C2 Drainage Area Runoff Area=5.249 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=800' Tc=12.5 min CN=79 Runoff=42.72 cfs 3.862 af

Subcatchment C3: C3 Drainage Area Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=9.75"
Tc=10.0 min CN=86 Runoff=32.84 cfs 2.845 af

Subcatchment C4: C4 Drainage Area Runoff Area=9.500 ac 0.00% Impervious Runoff Depth=9.75"
Tc=10.0 min CN=86 Runoff=89.15 cfs 7.722 af

Subcatchment C5: C5 Drainage Area Runoff Area=2.690 ac 0.00% Impervious Runoff Depth=9.75"
Tc=10.0 min CN=86 Runoff=25.24 cfs 2.186 af

Subcatchment C6: C6 Drainage Area Runoff Area=3.982 ac 0.00% Impervious Runoff Depth=9.75"
Tc=10.0 min CN=86 Runoff=37.37 cfs 3.237 af

Subcatchment PAR: PA Rainfall Area Runoff Area=7.440 ac 0.00% Impervious Runoff Depth=11.26"
Tc=0.0 min CN=98 Runoff=102.59 cfs 6.980 af

Subcatchment PBR: PB Rainfall Area Runoff Area=4.290 ac 0.00% Impervious Runoff Depth=11.26"
Tc=0.0 min CN=98 Runoff=59.15 cfs 4.025 af

Subcatchment PCR: PC Rainfall Area Runoff Area=4.540 ac 0.00% Impervious Runoff Depth=11.26"
Tc=0.0 min CN=98 Runoff=62.60 cfs 4.260 af

Reach 1CC: 1CC Collector Channel Avg. Flow Depth=5.24' Max Vel=4.25 fps Inflow=301.75 cfs 27.992 af
n=0.030 L=222.0' S=0.0020 '/' Capacity=2,157.50 cfs Outflow=300.25 cfs 27.992 af

Post Development 100 Yr Drainage *Type III 24-hr 100-Year Rainfall=11.50"*
Prepared by Hanson Professional Services Inc. Printed 8/20/2018
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Reach 2CC: 2CC Collector Channel Avg. Flow Depth=1.46' Max Vel=1.74 fps Inflow=12.98 cfs 1.089 af
n=0.030 L=650.0' S=0.0020 '/' Capacity=46.53 cfs Outflow=11.11 cfs 1.089 af

Reach 5CC: A2 Collector Channel Avg. Flow Depth=1.15' Max Vel=1.50 fps Inflow=8.77 cfs 0.736 af
n=0.030 L=595.0' S=0.0015 '/' Capacity=68.72 cfs Outflow=7.45 cfs 0.736 af

Reach 6CC: A3 Collector Channel Avg. Flow Depth=0.92' Max Vel=2.17 fps Inflow=8.77 cfs 0.736 af
n=0.030 L=740.0' S=0.0040 '/' Capacity=50.02 cfs Outflow=7.67 cfs 0.736 af

Reach A2-1: A2-1 Channel Avg. Flow Depth=1.48' Max Vel=1.73 fps Inflow=12.75 cfs 1.471 af
n=0.030 L=250.5' S=0.0015 '/' Capacity=83.47 cfs Outflow=12.71 cfs 1.471 af

Reach A2-2: A2-2 Channel Avg. Flow Depth=3.02' Max Vel=4.09 fps Inflow=162.11 cfs 14.244 af
n=0.025 L=257.0' S=0.0020 '/' Capacity=338.68 cfs Outflow=160.83 cfs 14.244 af

Reach A2-3: A2-3 Channel Avg. Flow Depth=3.09' Max Vel=3.52 fps Inflow=160.83 cfs 14.244 af
n=0.030 L=582.0' S=0.0020 '/' Capacity=532.10 cfs Outflow=154.07 cfs 14.244 af

Reach A2-4: Chute-Concrete Block Avg. Flow Depth=0.91' Max Vel=12.45 fps Inflow=154.07 cfs 14.244 af
n=0.025 L=250.0' S=0.0697 '/' Capacity=692.98 cfs Outflow=153.86 cfs 14.244 af

Reach A2-5: Cocrete Block-Channel Avg. Flow Depth=0.37' Max Vel=12.58 fps Inflow=12.71 cfs 1.471 af
n=0.025 L=5.6' S=0.2482 '/' Capacity=903.50 cfs Outflow=12.71 cfs 1.471 af

Reach B1: 5' x 4' Box Culvert Avg. Flow Depth=2.81' Max Vel=10.42 fps Inflow=146.99 cfs 14.162 af
60.0" x 48.0" Box Pipe n=0.013 L=464.0' S=0.0057 '/' Capacity=185.34 cfs Outflow=146.52 cfs 14.162 af

Reach B2: 5' x 4' Box Culvert Avg. Flow Depth=3.12' Max Vel=19.22 fps Inflow=300.25 cfs 27.992 af
60.0" x 48.0" Box Pipe n=0.013 L=200.0' S=0.0182 '/' Capacity=331.32 cfs Outflow=300.01 cfs 27.992 af

Reach C1-4: Chute-Concrete Block Avg. Flow Depth=1.21' Max Vel=25.32 fps Inflow=300.01 cfs 27.992 af
n=0.025 L=76.0' S=0.2474 '/' Capacity=872.67 cfs Outflow=299.94 cfs 27.992 af

Reach C1SCCN1: C1SCCN1 Collector Avg. Flow Depth=0.40' Max Vel=1.34 fps Inflow=2.19 cfs 0.184 af
n=0.030 L=285.0' S=0.0033 '/' Capacity=24.47 cfs Outflow=2.06 cfs 0.184 af

Reach C1SCCN2: C1SCCN2 Collector Avg. Flow Depth=0.40' Max Vel=1.33 fps Inflow=2.19 cfs 0.184 af
n=0.030 L=287.5' S=0.0033 '/' Capacity=24.36 cfs Outflow=2.06 cfs 0.184 af

Reach C1SCCS1: C1SCCS1 Collector Avg. Flow Depth=0.41' Max Vel=1.33 fps Inflow=2.19 cfs 0.184 af
n=0.030 L=280.0' S=0.0033 '/' Capacity=24.30 cfs Outflow=2.06 cfs 0.184 af

Reach C1SCCS2: C1SCCS2 Collector Avg. Flow Depth=0.41' Max Vel=1.33 fps Inflow=2.19 cfs 0.184 af
n=0.030 L=280.0' S=0.0033 '/' Capacity=24.30 cfs Outflow=2.06 cfs 0.184 af

Reach C2-3: C2-3 Channel Avg. Flow Depth=3.32' Max Vel=3.35 fps Inflow=129.45 cfs 11.247 af
n=0.030 L=882.0' S=0.0020 '/' Capacity=178.76 cfs Outflow=118.51 cfs 11.247 af

Reach C2-4: Chute-Concrete Block Avg. Flow Depth=0.70' Max Vel=21.63 fps Inflow=118.38 cfs 11.247 af
n=0.025 L=52.0' S=0.3269 '/' Capacity=1,003.23 cfs Outflow=118.36 cfs 11.247 af

Reach C2-5: C2-5 Channel Avg. Flow Depth=1.29' Max Vel=9.05 fps Inflow=118.48 cfs 11.247 af
n=0.025 L=106.0' S=0.0293 '/' Capacity=492.25 cfs Outflow=118.38 cfs 11.247 af

Reach CC: Chute-Concrete Block Avg. Flow Depth=0.26' Max Vel=6.99 fps Inflow=11.11 cfs 1.089 af
n=0.025 L=160.0' S=0.1028 '/' Capacity=562.60 cfs Outflow=11.10 cfs 1.089 af

Reach E: Chute-Concrete Block Avg. Flow Depth=0.85' Max Vel=21.08 fps Inflow=150.87 cfs 13.094 af
n=0.025 L=462.0' S=0.2511 '/' Capacity=879.20 cfs Outflow=150.58 cfs 13.094 af

Reach NE: Chute-Concrete Block Avg. Flow Depth=0.79' Max Vel=20.16 fps Inflow=129.70 cfs 11.247 af
n=0.025 L=464.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=129.45 cfs 11.247 af

Reach NW: Chute-Concrete Block Avg. Flow Depth=0.72' Max Vel=19.21 fps Inflow=109.40 cfs 9.649 af
n=0.025 L=464.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=109.21 cfs 9.649 af

Reach OC: Existing Offsite Channel Avg. Flow Depth=2.04' Max Vel=1.83 fps Inflow=42.26 cfs 31.217 af
n=0.030 L=2,800.0' S=0.0010 '/' Capacity=44.23 cfs Outflow=41.59 cfs 31.108 af

Reach P1: Culvert Avg. Flow Depth=2.46' Max Vel=14.61 fps Inflow=118.51 cfs 11.247 af
48.0" Round Pipe n=0.011 L=64.0' S=0.0100 '/' Capacity=169.76 cfs Outflow=118.48 cfs 11.247 af

Reach P2: Culvert Avg. Flow Depth=0.53' Max Vel=7.31 fps Inflow=4.12 cfs 0.368 af
18.0" Round Pipe n=0.011 L=72.0' S=0.0150 '/' Capacity=15.20 cfs Outflow=4.11 cfs 0.368 af

Reach P2-1: Chute-Concrete Block Avg. Flow Depth=0.17' Max Vel=9.69 fps Inflow=4.11 cfs 0.368 af
n=0.025 L=60.0' S=0.3718 '/' Capacity=316.81 cfs Outflow=4.11 cfs 0.368 af

Reach P3: Culvert Avg. Flow Depth=0.53' Max Vel=7.31 fps Inflow=4.12 cfs 0.368 af
18.0" Round Pipe n=0.011 L=72.0' S=0.0150 '/' Capacity=15.20 cfs Outflow=4.12 cfs 0.368 af

Reach P3-1: Chute-Concrete Block Avg. Flow Depth=0.17' Max Vel=9.89 fps Inflow=4.12 cfs 0.368 af
n=0.025 L=60.0' S=0.3942 '/' Capacity=326.18 cfs Outflow=4.12 cfs 0.368 af

Reach S: Chute-Concrete Block Avg. Flow Depth=0.86' Max Vel=21.09 fps Inflow=152.24 cfs 12.773 af
n=0.025 L=459.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=151.93 cfs 12.773 af

Reach SE: Chute-Concrete Block Avg. Flow Depth=0.83' Max Vel=20.70 fps Inflow=142.28 cfs 13.426 af
n=0.025 L=450.0' S=0.2499 '/' Capacity=877.14 cfs Outflow=142.07 cfs 13.426 af

Reach SE1: Chute-Concrete Block Avg. Flow Depth=1.10' Max Vel=13.74 fps Inflow=142.07 cfs 13.426 af
n=0.025 L=62.0' S=0.0806 '/' Capacity=498.27 cfs Outflow=142.01 cfs 13.426 af

Reach SW: Chute-Concrete Block Avg. Flow Depth=0.81' Max Vel=20.41 fps Inflow=135.35 cfs 11.355 af
n=0.025 L=404.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=135.10 cfs 11.355 af

Reach SW-1: Chute-Concrete Block Avg. Flow Depth=0.96' Max Vel=15.98 fps Inflow=135.10 cfs 11.355 af
n=0.025 L=266.0' S=0.1269 '/' Capacity=624.99 cfs Outflow=134.87 cfs 11.355 af

Reach W: Chute-Concrete Block Avg. Flow Depth=0.93' Max Vel=22.10 fps Inflow=179.96 cfs 16.468 af
n=0.025 L=464.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=179.70 cfs 16.468 af

Pond PA: Retention Pond A Peak Elev=49.73' Storage=36.905 af Inflow=324.39 cfs 36.905 af
Outflow=0.00 cfs 0.000 af

Pond PB: Detention Pond B Peak Elev=52.22' Storage=16.607 af Inflow=331.73 cfs 32.018 af
Outflow=42.26 cfs 31.217 af

Pond PC: Retention Pond C Peak Elev=45.81' Storage=46.421 af Inflow=446.58 cfs 46.421 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 164.599 ac Runoff Volume = 125.910 af Average Runoff Depth = 9.18"
100.00% Pervious = 164.599 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1C: 1C Drainage Area

Use Conservative Value of Tc=10 min

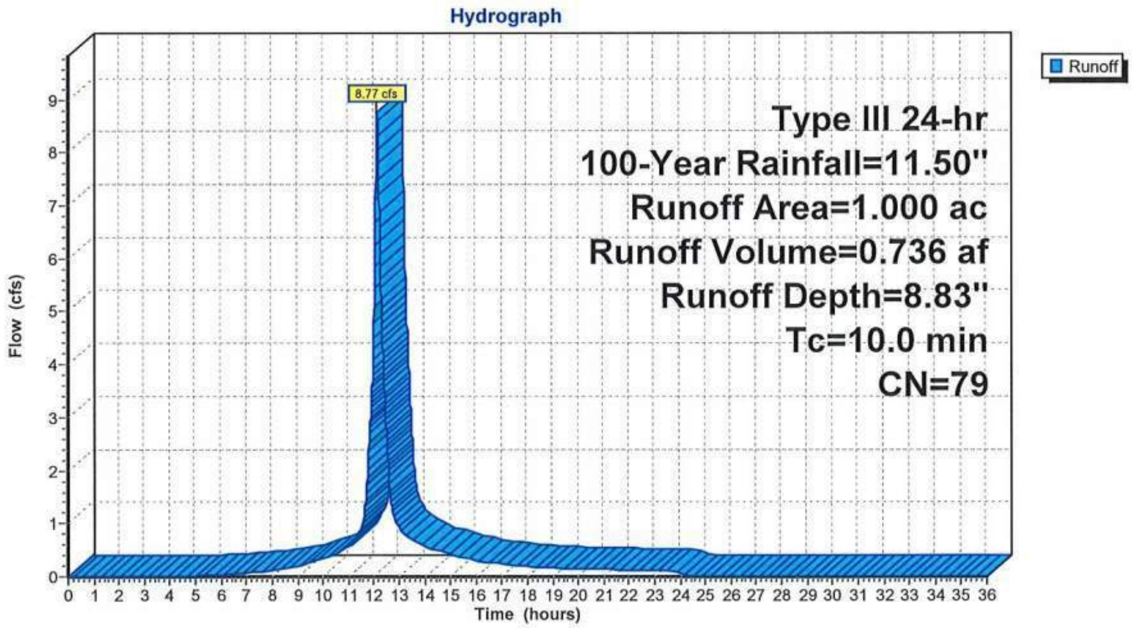
Runoff = 8.77 cfs @ 12.14 hrs, Volume= 0.736 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 1C: 1C Drainage Area



Summary for Subcatchment 2C: 2C Drainage Area

Use Conservative Value of Tc=10 min

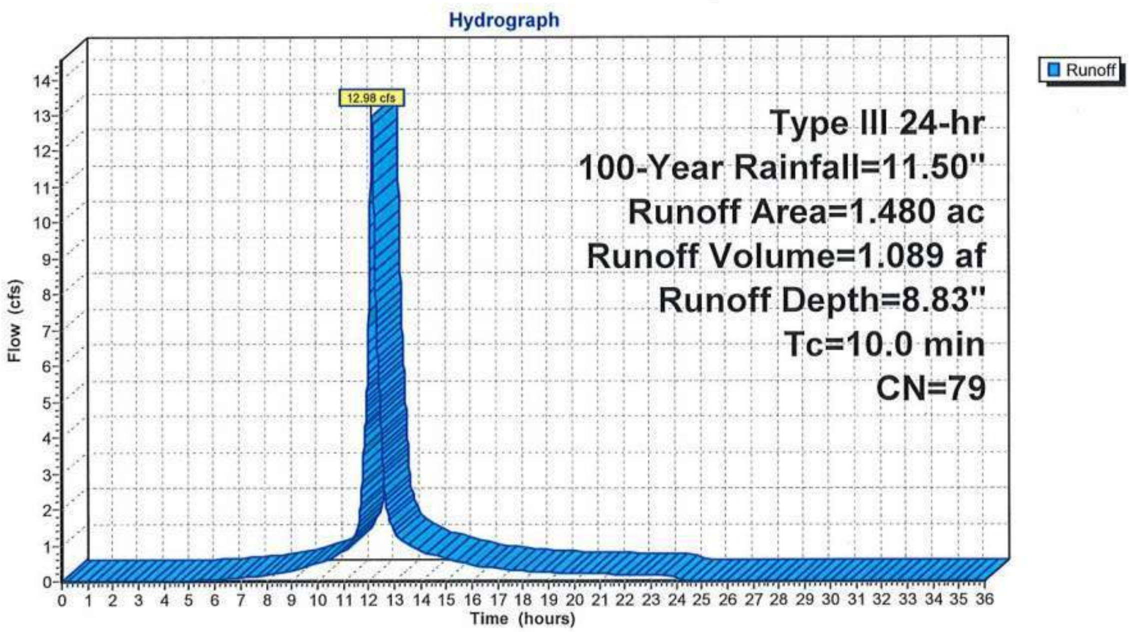
Runoff = 12.98 cfs @ 12.14 hrs, Volume= 1.089 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
1.480	79	50-75% Grass cover, Fair, HSG C
1.480		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 2C: 2C Drainage Area



Summary for Subcatchment 3C: 3C Drainage Area

Use Conservative Value of Tc=10 min

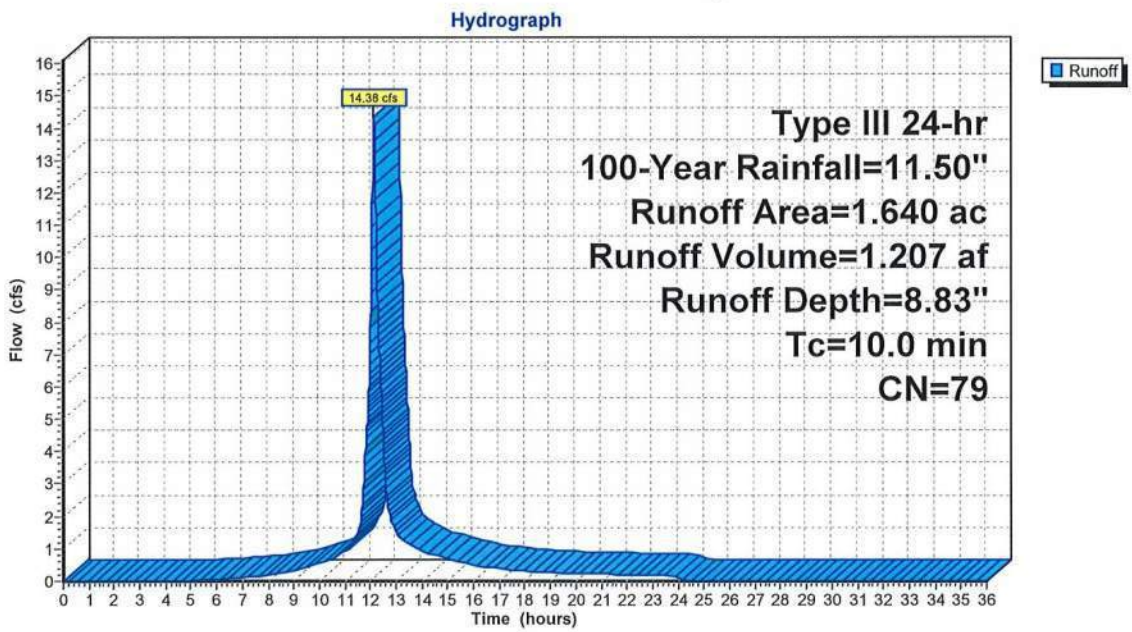
Runoff = 14.38 cfs @ 12.14 hrs, Volume= 1.207 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
1.640	79	50-75% Grass cover, Fair, HSG C
1.640		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Surface Drainage to Pond B**

Subcatchment 3C: 3C Drainage Area



Summary for Subcatchment 4C: 4C Drainage Area

Use Conservative Value of Tc=10 min

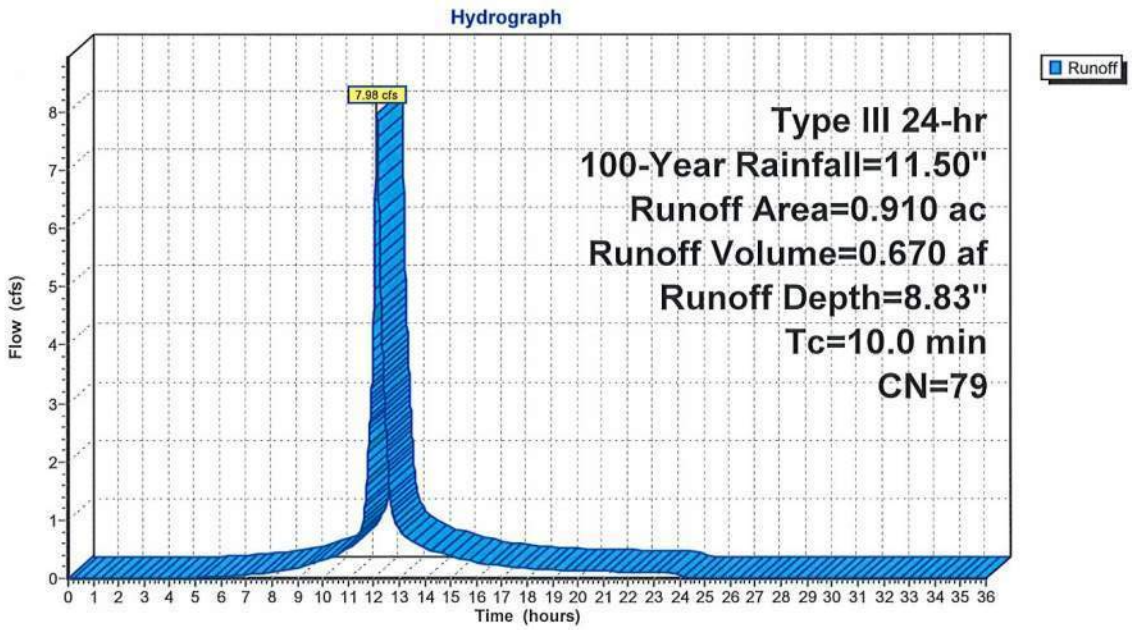
Runoff = 7.98 cfs @ 12.14 hrs, Volume= 0.670 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
0.910	79	50-75% Grass cover, Fair, HSG C
0.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Surface Drainage to Pond B**

Subcatchment 4C: 4C Drainage Area



Summary for Subcatchment 5C: A2 Drainage Area

Use Conservative Value of Tc=10 min

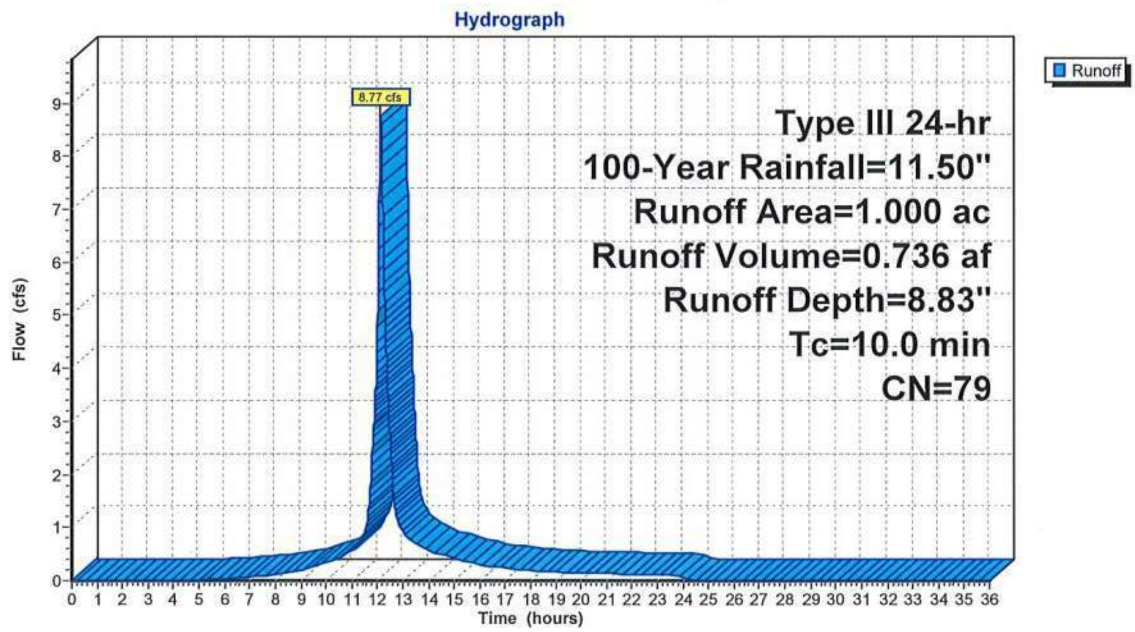
Runoff = 8.77 cfs @ 12.14 hrs, Volume= 0.736 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 5C: A2 Drainage Area



Summary for Subcatchment 6C: A3 Drainage Area

Use Conservative Value of Tc=10 min

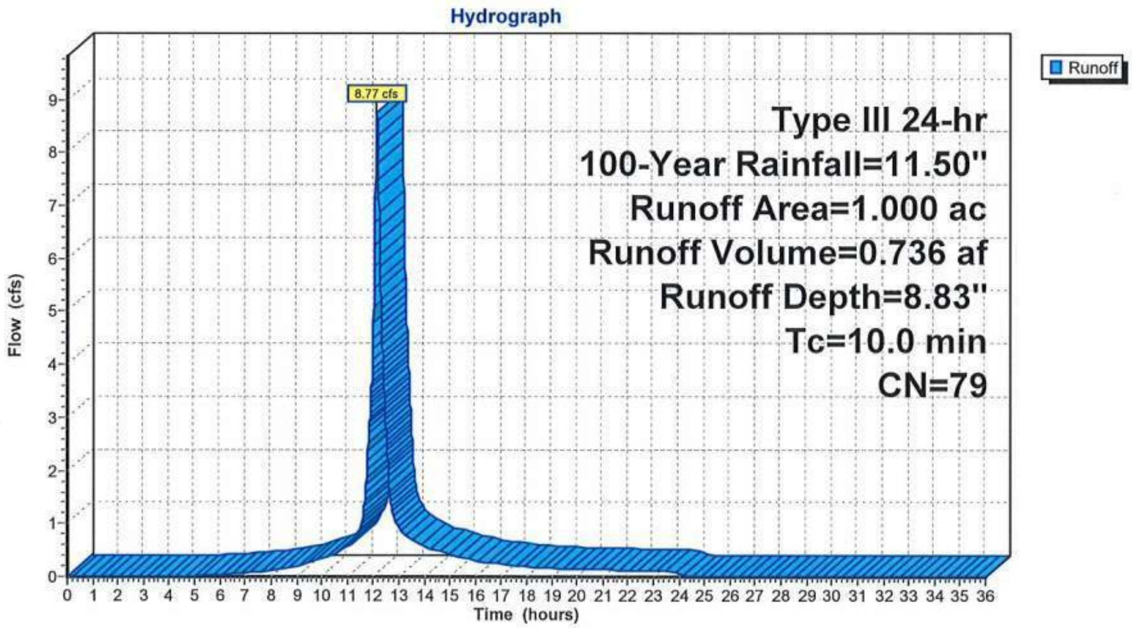
Runoff = 8.77 cfs @ 12.14 hrs, Volume= 0.736 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 6C: A3 Drainage Area



Summary for Subcatchment 7C: A2 Drainage Area

Use Conservative Value of Tc=10 min

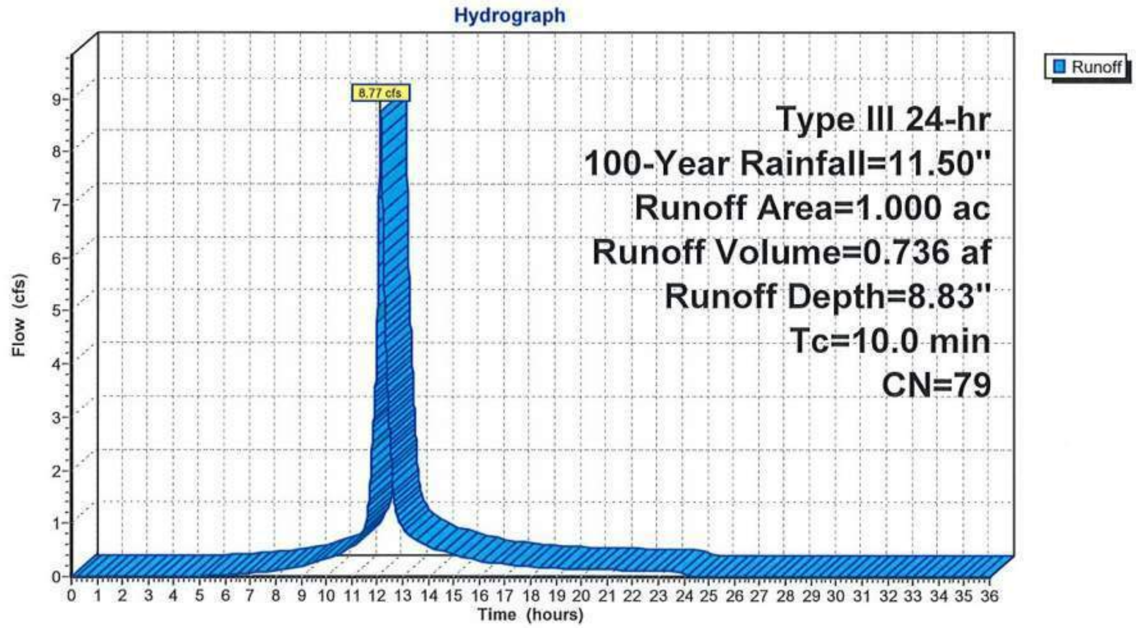
Runoff = 8.77 cfs @ 12.14 hrs, Volume= 0.736 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
1.000	79	50-75% Grass cover, Fair, HSG C
1.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment 7C: A2 Drainage Area



Summary for Subcatchment A1S: A1S Drainage Area

Use Conservative Value of Tc=10 min.

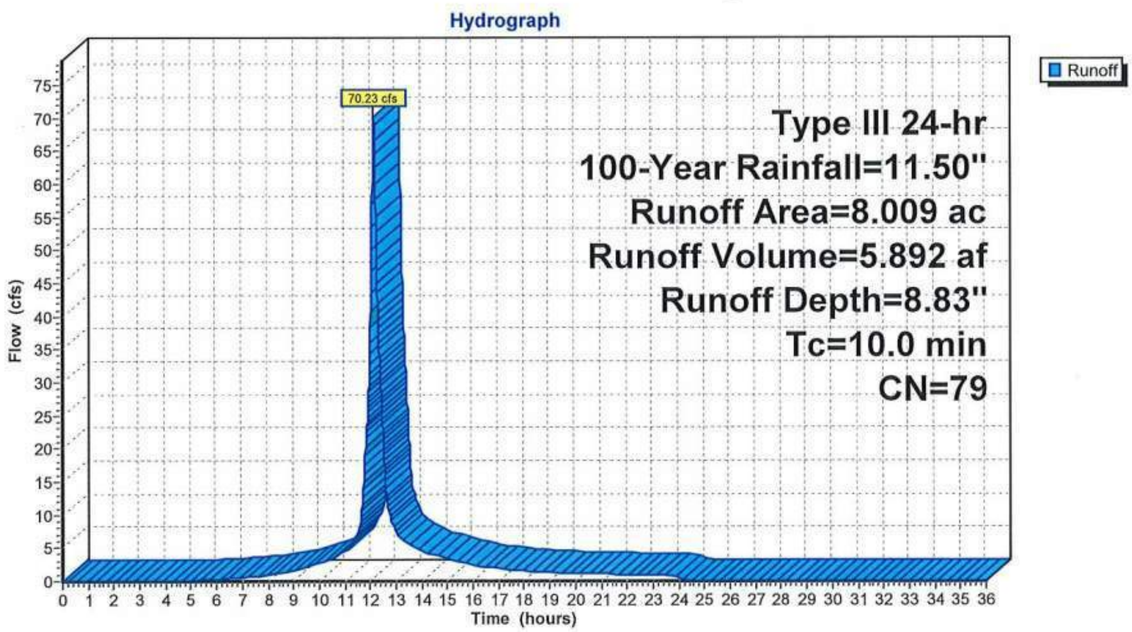
Runoff = 70.23 cfs @ 12.14 hrs, Volume= 5.892 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
8.009	79	50-75% Grass cover, Fair, HSG C
8.009		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1S-Chute Flow Evaluation**

Subcatchment A1S: A1S Drainage Area



Summary for Subcatchment A1T: A1T Drainage Area

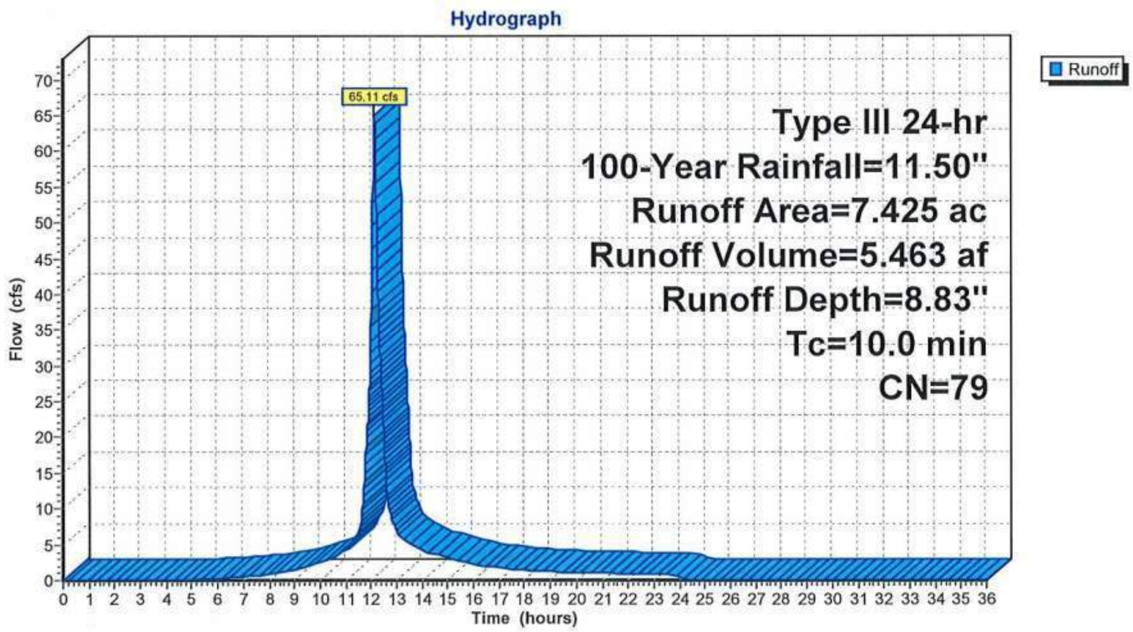
Runoff = 65.11 cfs @ 12.14 hrs, Volume= 5.463 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
7.425	79	50-75% Grass cover, Fair, HSG C
7.425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1T-Chute Flow Evaluation**

Subcatchment A1T: A1T Drainage Area



Summary for Subcatchment A2S: A2 Drainage Area

Use Conservative Value of Tc=10 min.

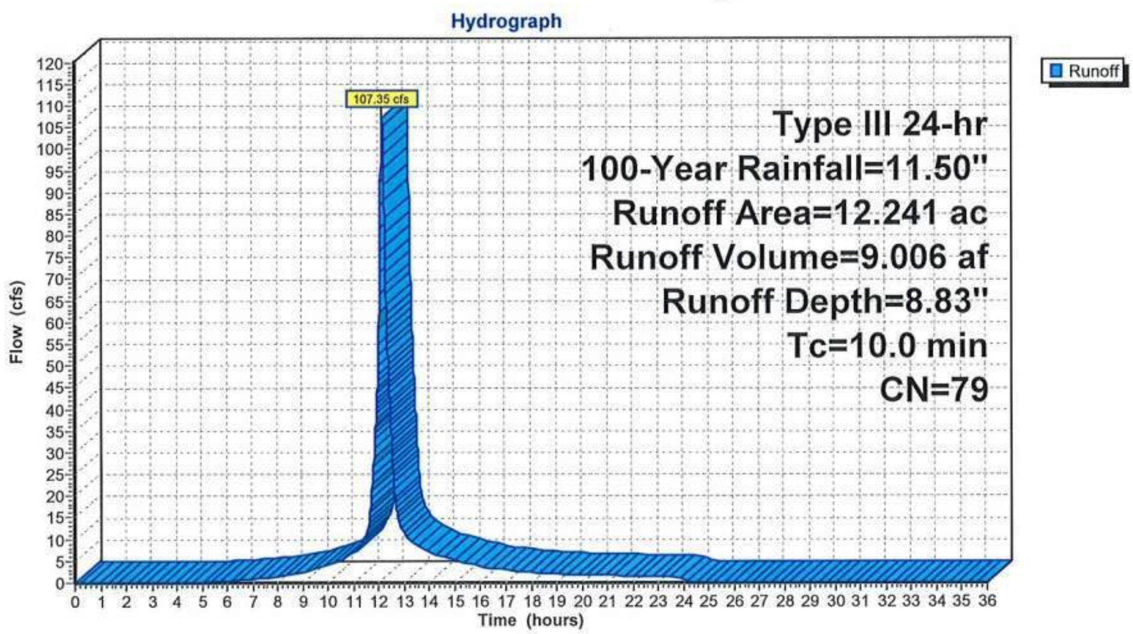
Runoff = 107.35 cfs @ 12.14 hrs, Volume= 9.006 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
12.241	79	50-75% Grass cover, Fair, HSG C
12.241		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A2 Drainage Area**

Subcatchment A2S: A2 Drainage Area



Summary for Subcatchment A2T: A2 Drainage Area

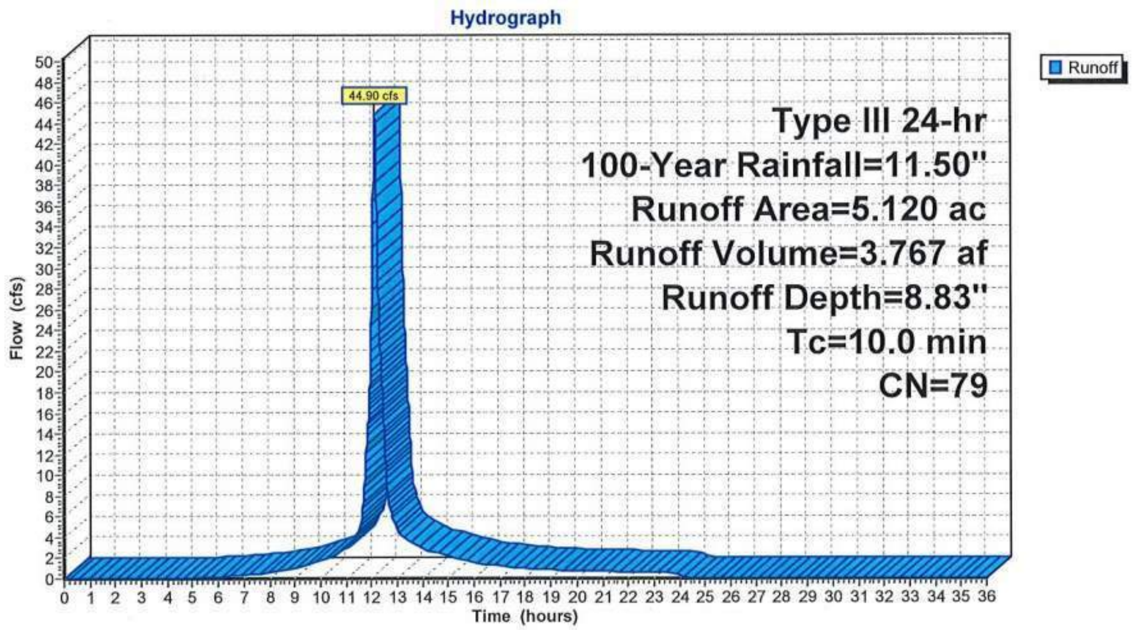
Runoff = 44.90 cfs @ 12.14 hrs, Volume= 3.767 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
5.120	79	50-75% Grass cover, Fair, HSG C
5.120		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A2 Drainage Area**

Subcatchment A2T: A2 Drainage Area



Summary for Subcatchment A3S: A3S Drainage Area

Use Conservative Value of Tc=10 min.

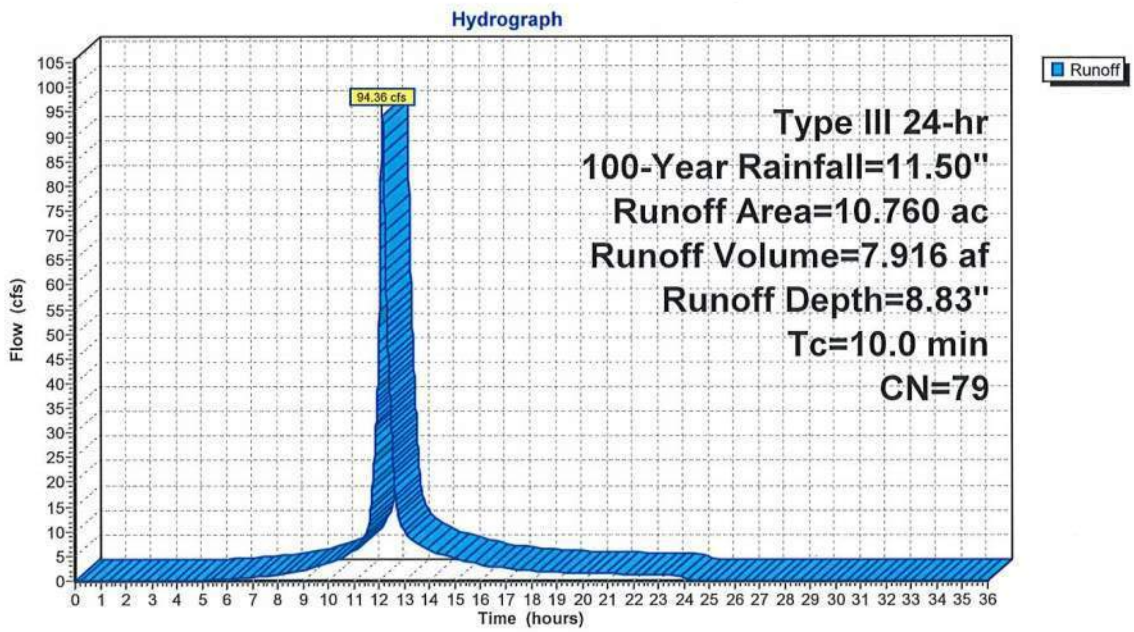
Runoff = 94.36 cfs @ 12.14 hrs, Volume= 7.916 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
10.760	79	50-75% Grass cover, Fair, HSG C
10.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A3S-Chute Flow Evaluation**

Subcatchment A3S: A3S Drainage Area



Summary for Subcatchment A3T: A3T Drainage Area

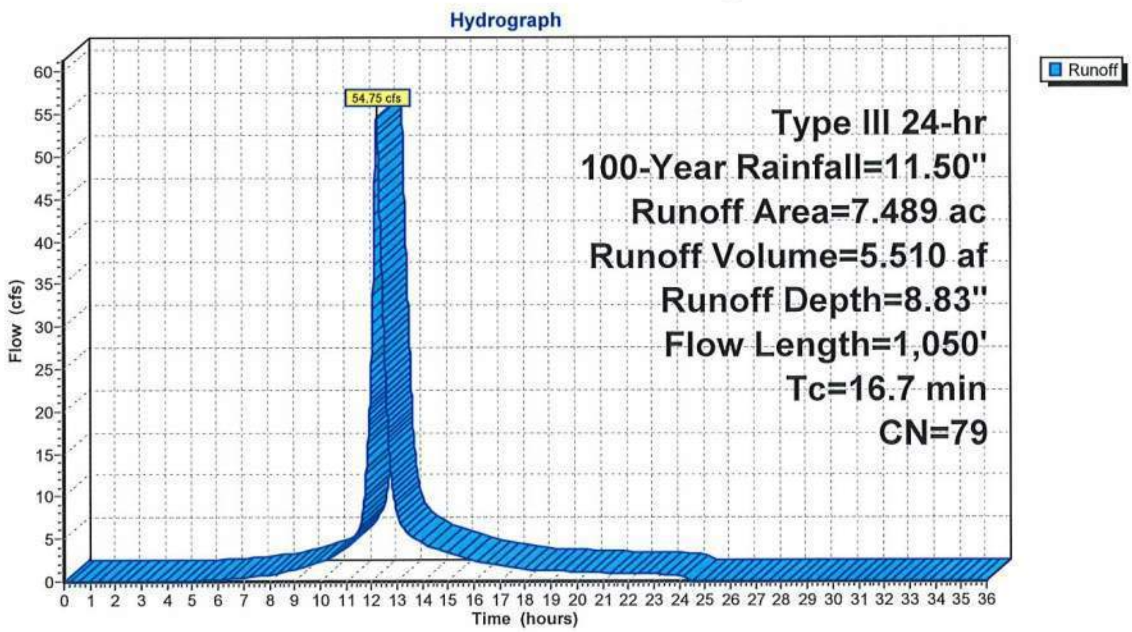
Runoff = 54.75 cfs @ 12.22 hrs, Volume= 5.510 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
7.489	79	50-75% Grass cover, Fair, HSG C
7.489		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	750		1.30		**Direct Entry, A3T-Chute Flow Evaluation**
7.1	300		0.70		**Direct Entry,**
16.7	1,050	Total			

Subcatchment A3T: A3T Drainage Area



Summary for Subcatchment B1S: B1S Drainage Area

Use Conservative Value of Tc= 10 min.

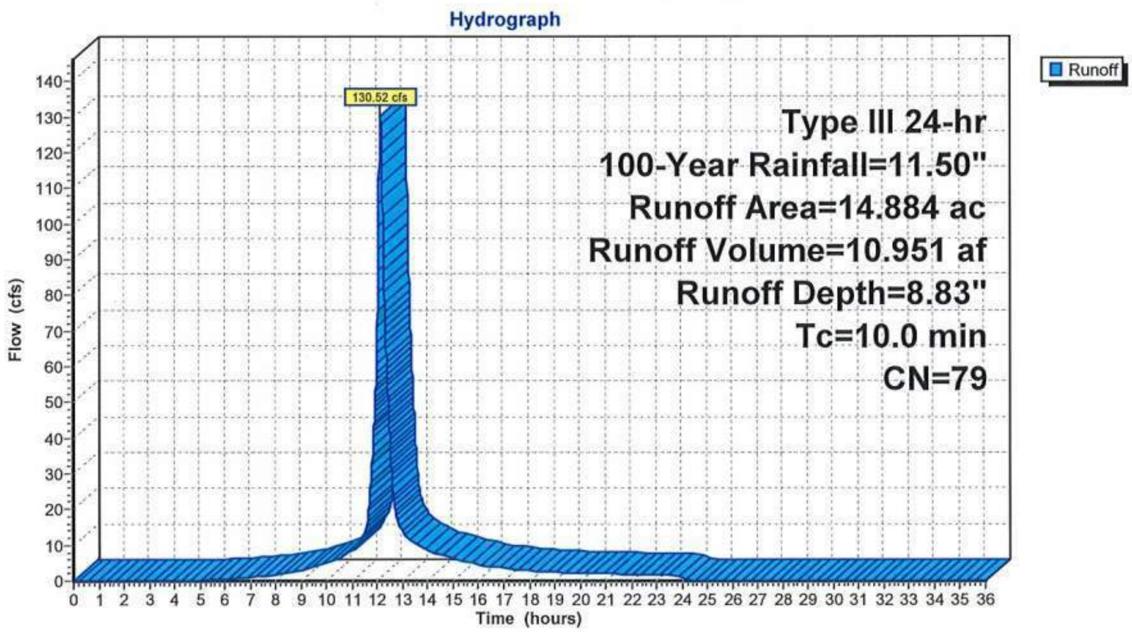
Runoff = 130.52 cfs @ 12.14 hrs, Volume= 10.951 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
14.884	79	50-75% Grass cover, Fair, HSG C
14.884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S-Chute Flow Evaluation**

Subcatchment B1S: B1S Drainage Area



Summary for Subcatchment B1T: B1T Drainage Area

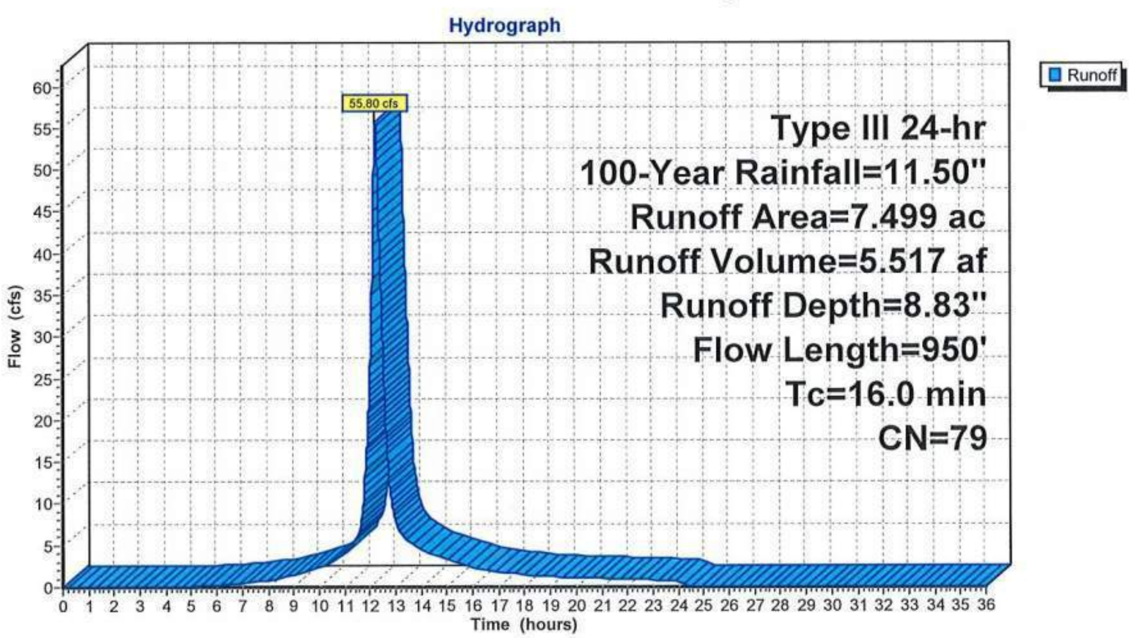
Runoff = 55.80 cfs @ 12.21 hrs, Volume= 5.517 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
7.499	79	50-75% Grass cover, Fair, HSG C
7.499		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T-Chute Flow Evaluation**
8.3	350		0.70		**Direct Entry,**
16.0	950	Total			

Subcatchment B1T: B1T Drainage Area



Summary for Subcatchment B2S: B2S Drainage Area

Use Conservative Value of Tc=10 min.

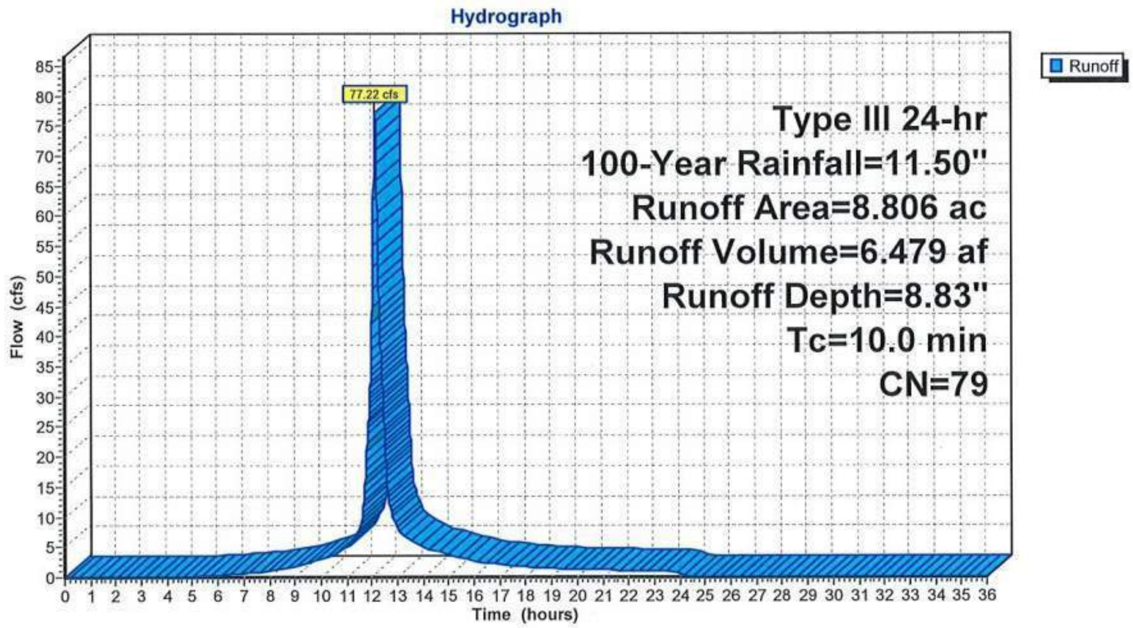
Runoff = 77.22 cfs @ 12.14 hrs, Volume= 6.479 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
8.806	79	50-75% Grass cover, Fair, HSG C
8.806		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B2S-Chute Flow Evaluation**

Subcatchment B2S: B2S Drainage Area



Summary for Subcatchment B2T: B2T Drainage Area

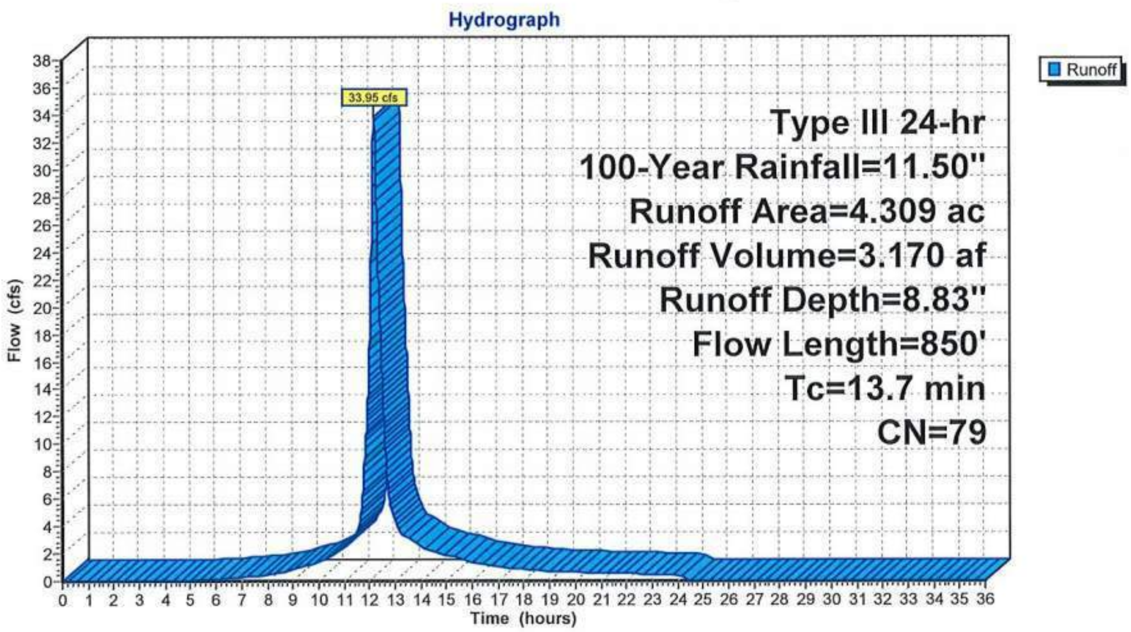
Runoff = 33.95 cfs @ 12.18 hrs, Volume= 3.170 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
4.309	79	50-75% Grass cover, Fair, HSG C
4.309		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B2T-Chute Flow Evaluation**
6.0	250		0.70		**Direct Entry,**
13.7	850	Total			

Subcatchment B2T: B2T Drainage Area



Summary for Subcatchment C1S: C1 Drainage Area

Use Conservative Value of Tc=10 min.

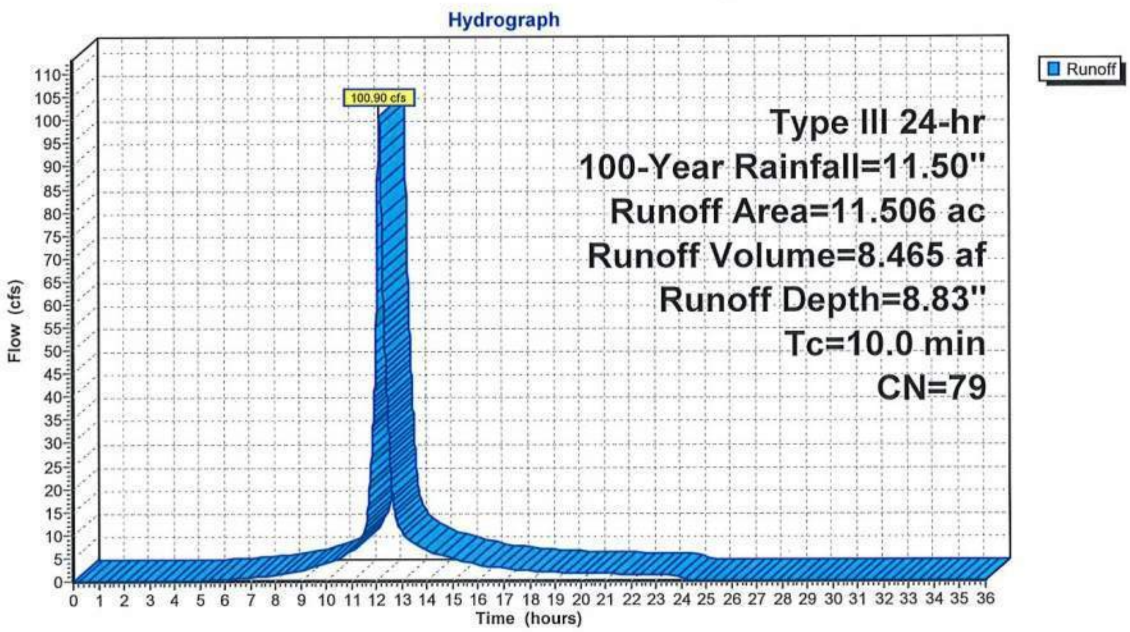
Runoff = 100.90 cfs @ 12.14 hrs, Volume= 8.465 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
11.506	79	50-75% Grass cover, Fair, HSG C
11.506		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C1 Drainage Area**

Subcatchment C1S: C1 Drainage Area



Summary for Subcatchment C1SN1: C1SN1 Drainage Area

Use Conservative Value of Tc=10 min

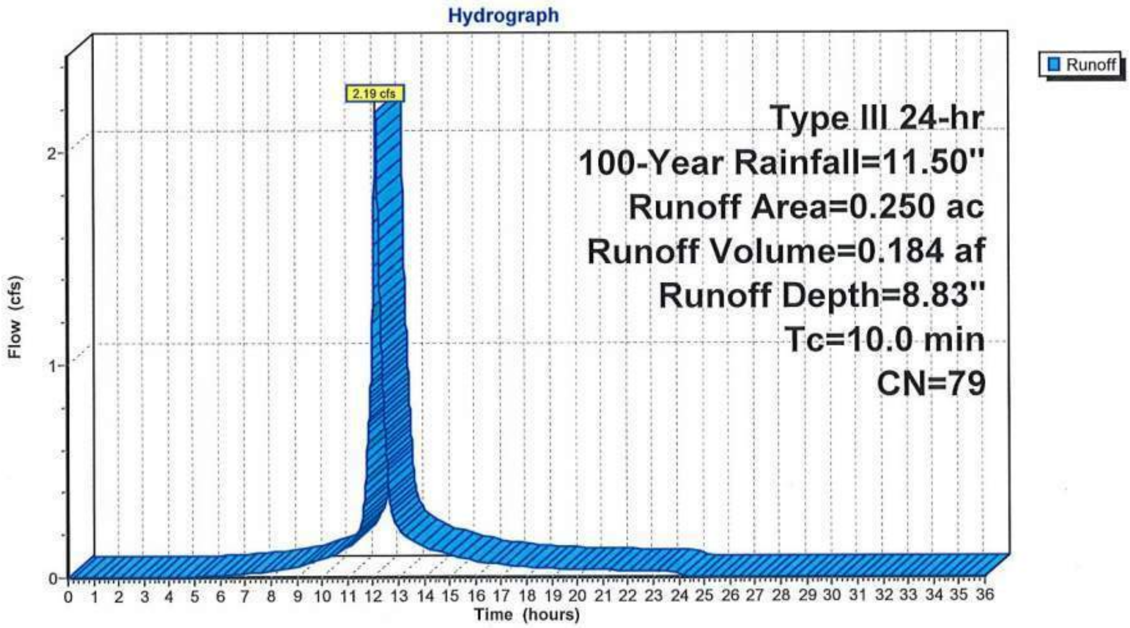
Runoff = 2.19 cfs @ 12.14 hrs, Volume= 0.184 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SN1: C1SN1 Drainage Area



Summary for Subcatchment C1SN2: C1SN2 Drainage Area

Use Conservative Value of Tc=10 min

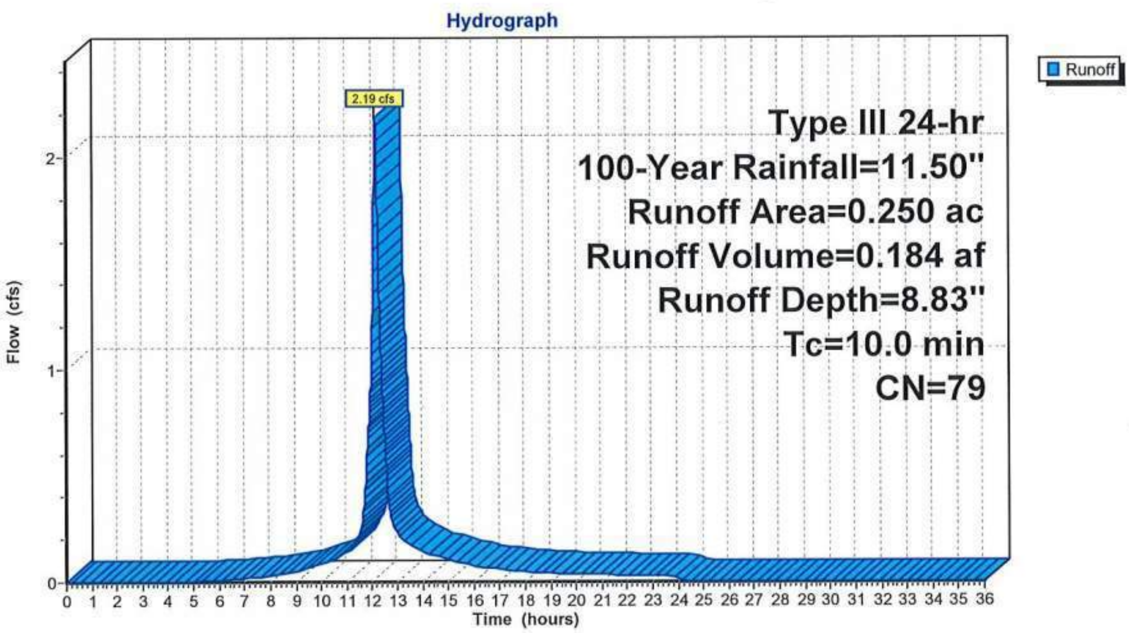
Runoff = 2.19 cfs @ 12.14 hrs, Volume= 0.184 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SN2: C1SN2 Drainage Area



Summary for Subcatchment C1SS1: C1SS1 Drainage Area

Use Conservative Value of Tc=10 min

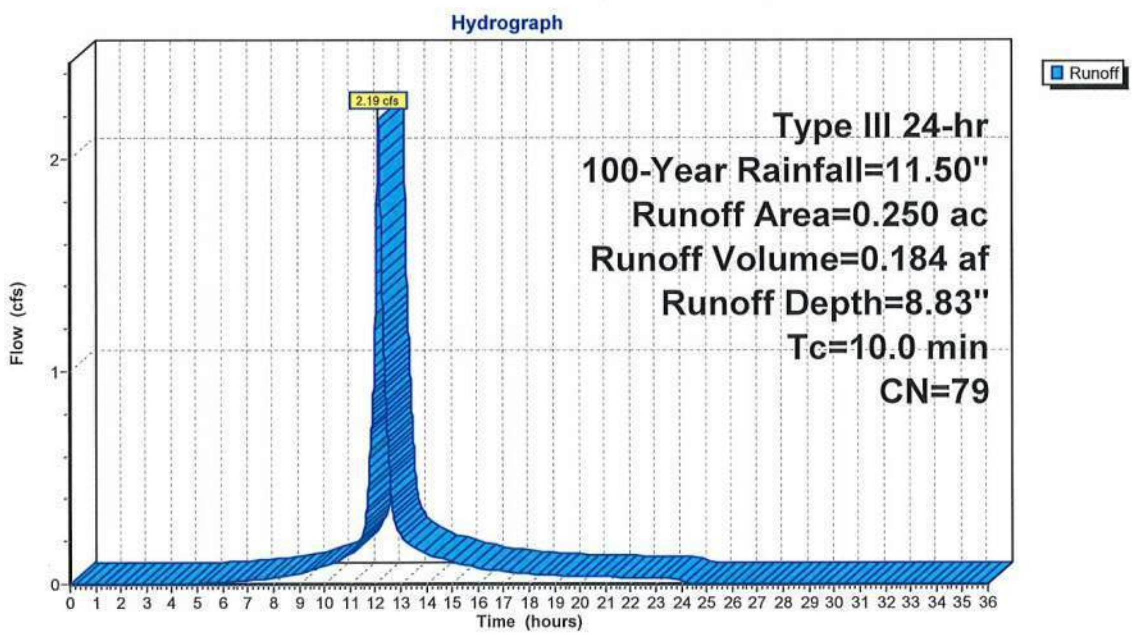
Runoff = 2.19 cfs @ 12.14 hrs, Volume= 0.184 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SS1: C1SS1 Drainage Area



Summary for Subcatchment C1SS2: C1SS2 Drainage Area

Use Conservative Value of Tc=10 min

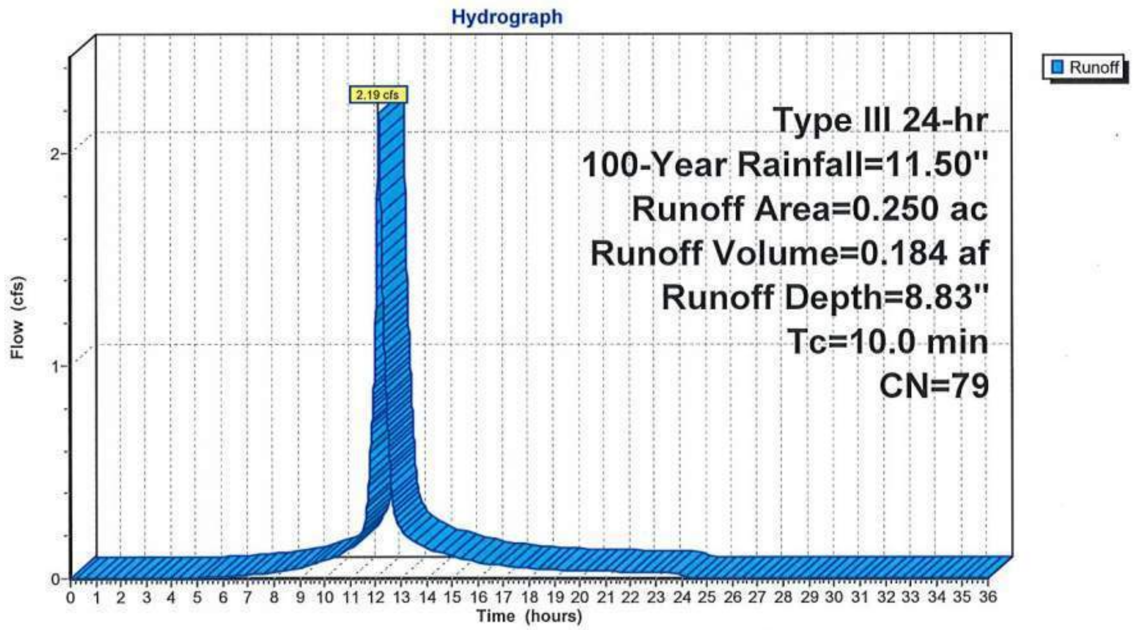
Runoff = 2.19 cfs @ 12.14 hrs, Volume= 0.184 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
0.250	79	50-75% Grass cover, Fair, HSG C
0.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Drainage Area at Bottom of Slope**

Subcatchment C1SS2: C1SS2 Drainage Area



Summary for Subcatchment C1T: C1 Drainage Area

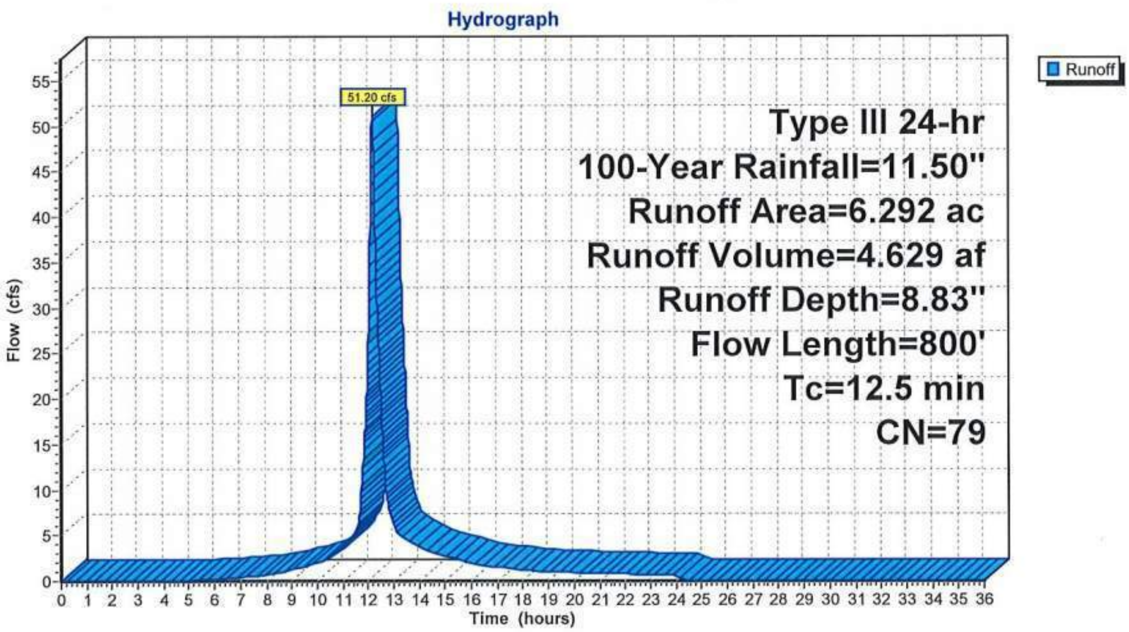
Runoff = 51.20 cfs @ 12.17 hrs, Volume= 4.629 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
6.292	79	50-75% Grass cover, Fair, HSG C
6.292		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C1 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C1T: C1 Drainage Area



Summary for Subcatchment C2S: C2 Drainage Area

Use Conservative Value of Tc=10 min.

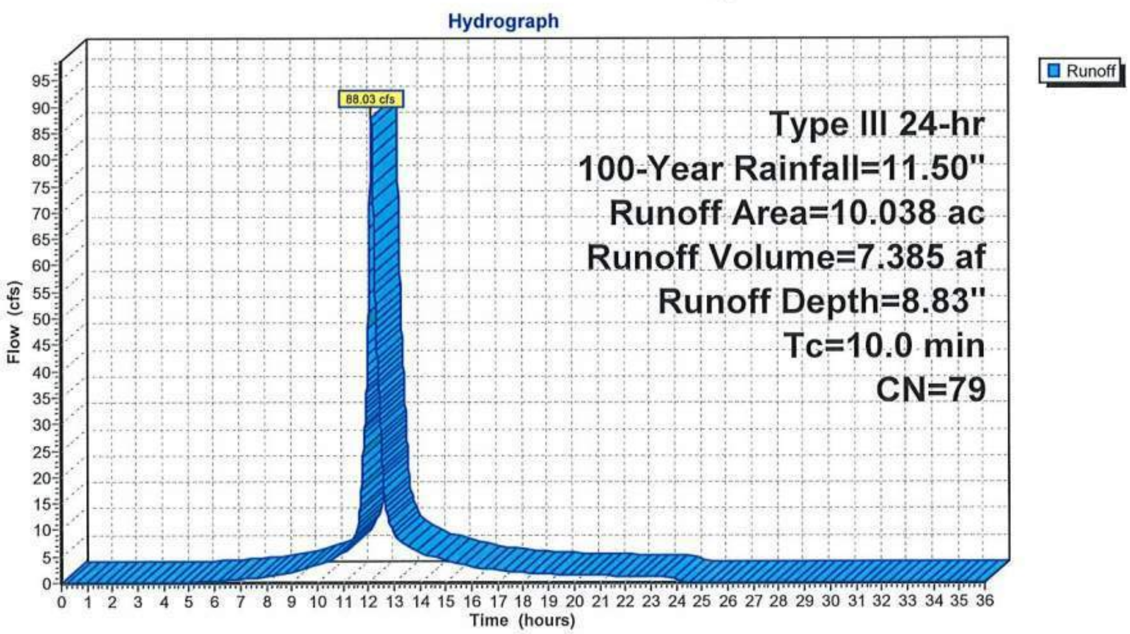
Runoff = 88.03 cfs @ 12.14 hrs, Volume= 7.385 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
10.038	79	50-75% Grass cover, Fair, HSG C
10.038		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C2 Drainage Area**

Subcatchment C2S: C2 Drainage Area



Summary for Subcatchment C2T: C2 Drainage Area

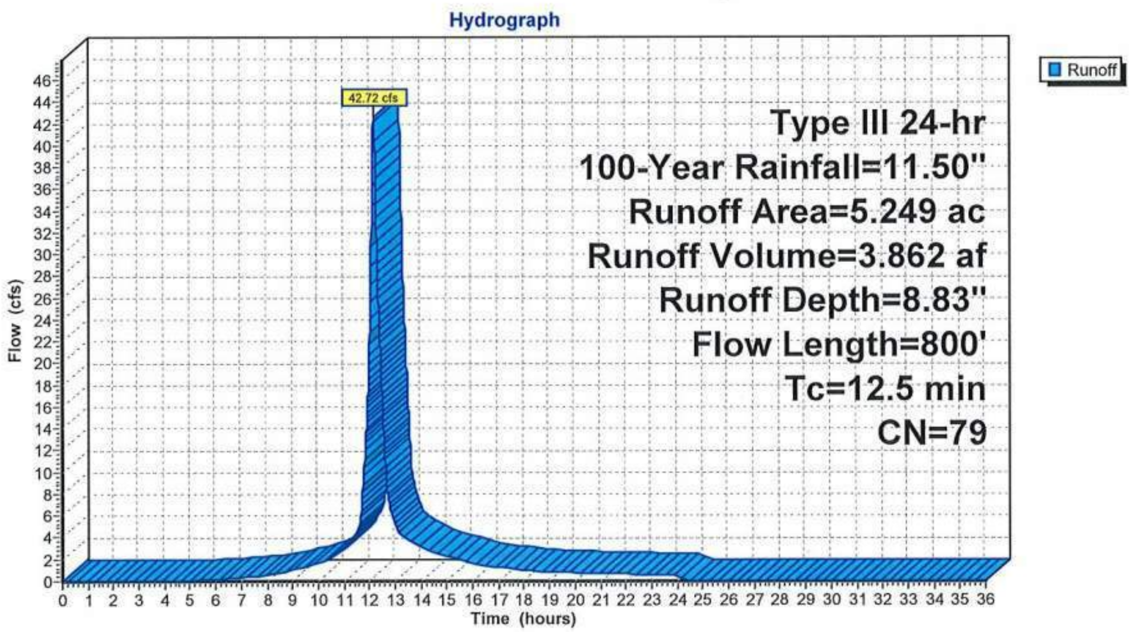
Runoff = 42.72 cfs @ 12.17 hrs, Volume= 3.862 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
5.249	79	50-75% Grass cover, Fair, HSG C
5.249		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C2 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C2T: C2 Drainage Area



Summary for Subcatchment C3: C3 Drainage Area

Existing Drainage Area Surface Drains to the North, Into Existing Low-Lying Excavated Pit C4 Drainage Area.

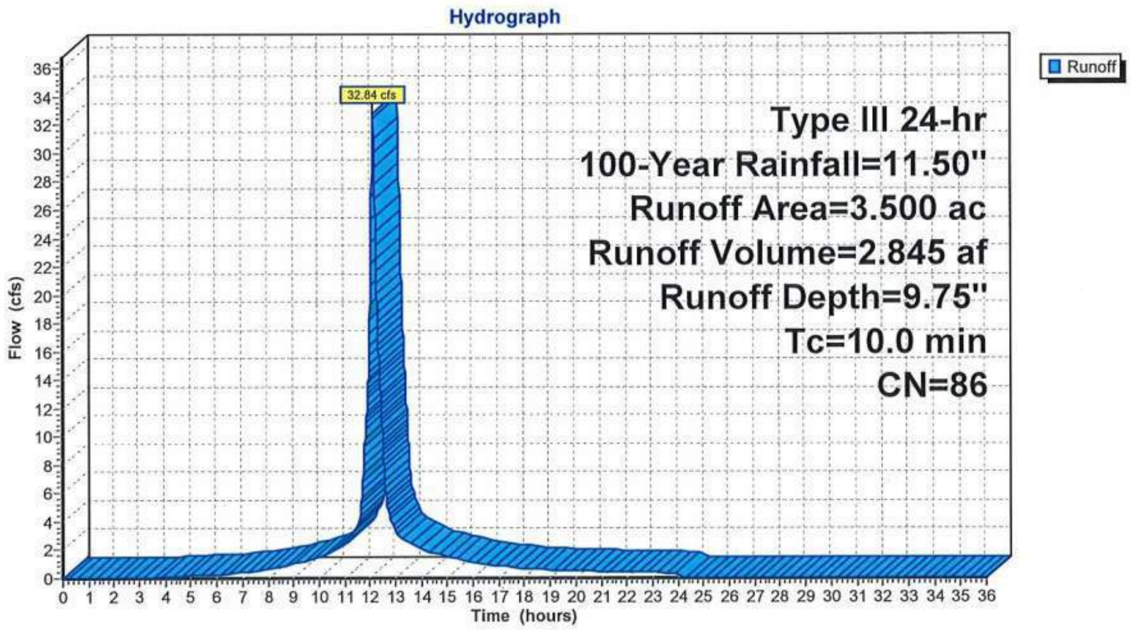
Runoff = 32.84 cfs @ 12.13 hrs, Volume= 2.845 af, Depth= 9.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
3.500	86	<50% Grass cover, Poor, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C3 Drainage Area**

Subcatchment C3: C3 Drainage Area



Summary for Subcatchment C4: C4 Drainage Area

Existing Low-Lying Excavated Pit Area. Infiltration and Evaporation Occur Here.

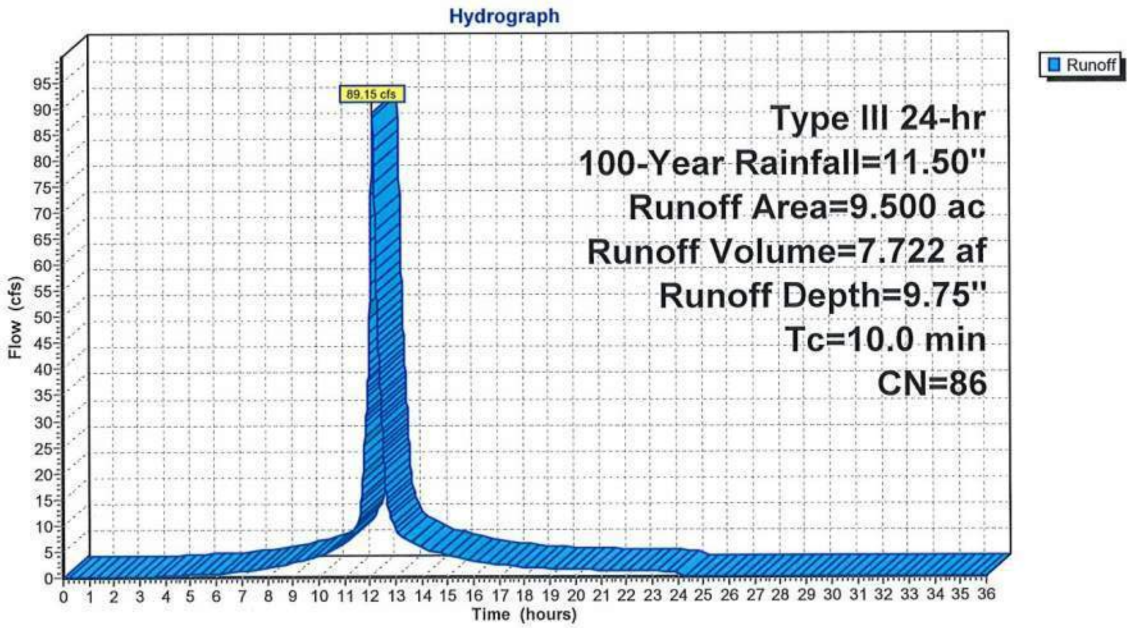
Runoff = 89.15 cfs @ 12.13 hrs, Volume= 7.722 af, Depth= 9.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
9.500	86	<50% Grass cover, Poor, HSG C
9.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C4 Drainage Area**

Subcatchment C4: C4 Drainage Area



Summary for Subcatchment C5: C5 Drainage Area

Side Slope Drainage Area that Flows Into Pond C.

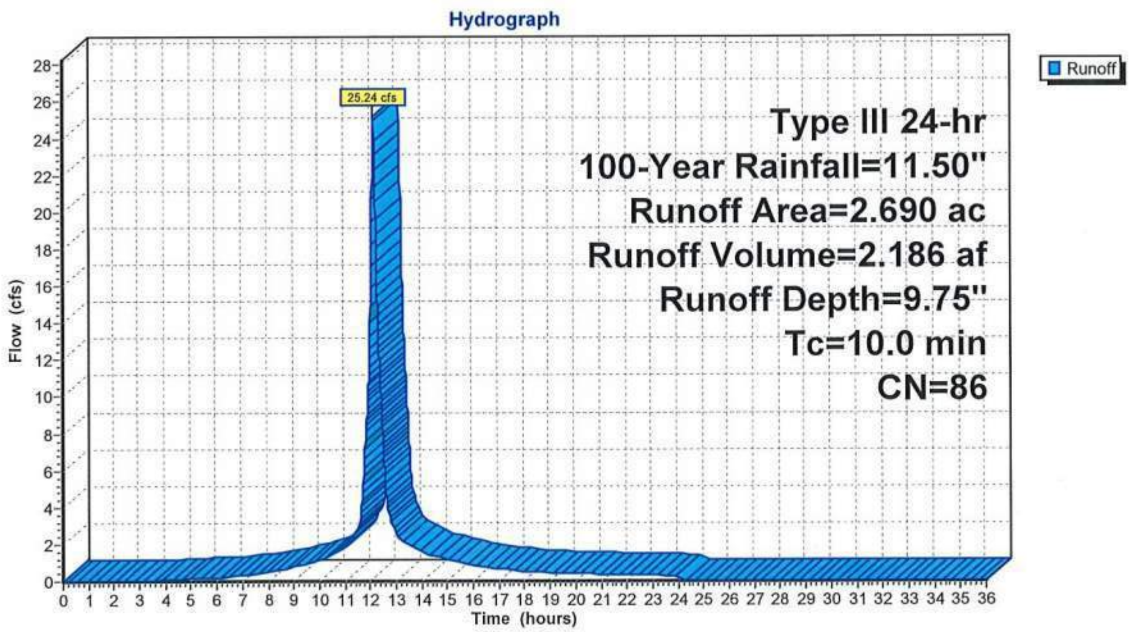
Runoff = 25.24 cfs @ 12.13 hrs, Volume= 2.186 af, Depth= 9.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
2.690	86	<50% Grass cover, Poor, HSG C
2.690		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry, C5 Drainage Area

Subcatchment C5: C5 Drainage Area



Summary for Subcatchment C6: C6 Drainage Area

Surrounding Drainage Area that Flows Into Pond A.

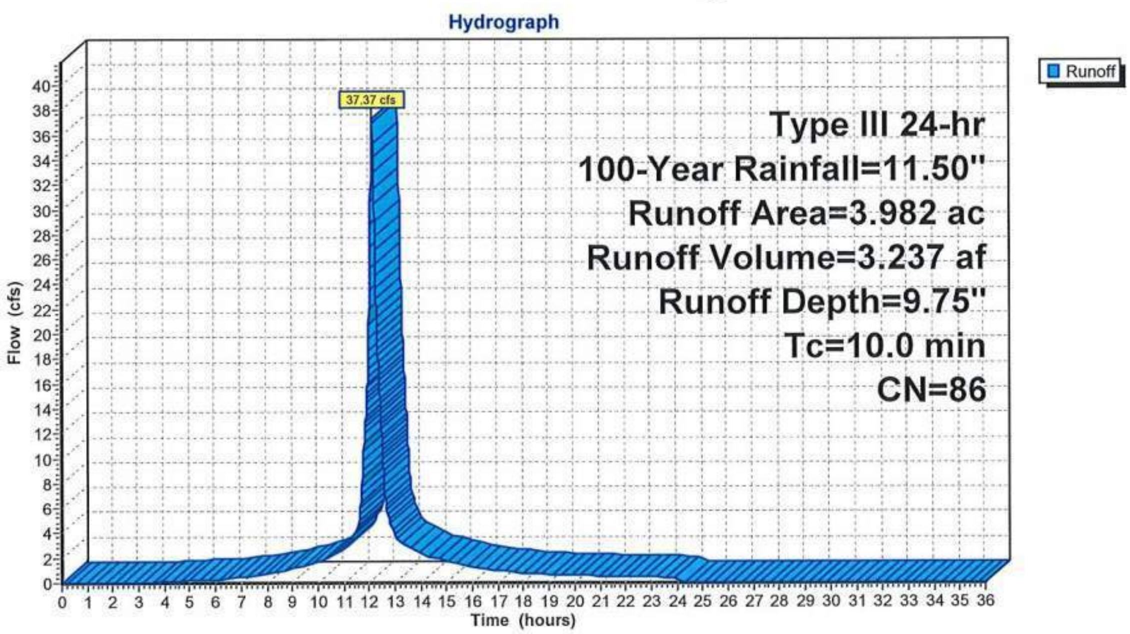
Runoff = 37.37 cfs @ 12.13 hrs, Volume= 3.237 af, Depth= 9.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
3.982	86	<50% Grass cover, Poor, HSG C
3.982		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C6 Drainage Area**

Subcatchment C6: C6 Drainage Area



Summary for Subcatchment PAR: PA Rainfall Area

Use Conservative Value of Tc=10 min

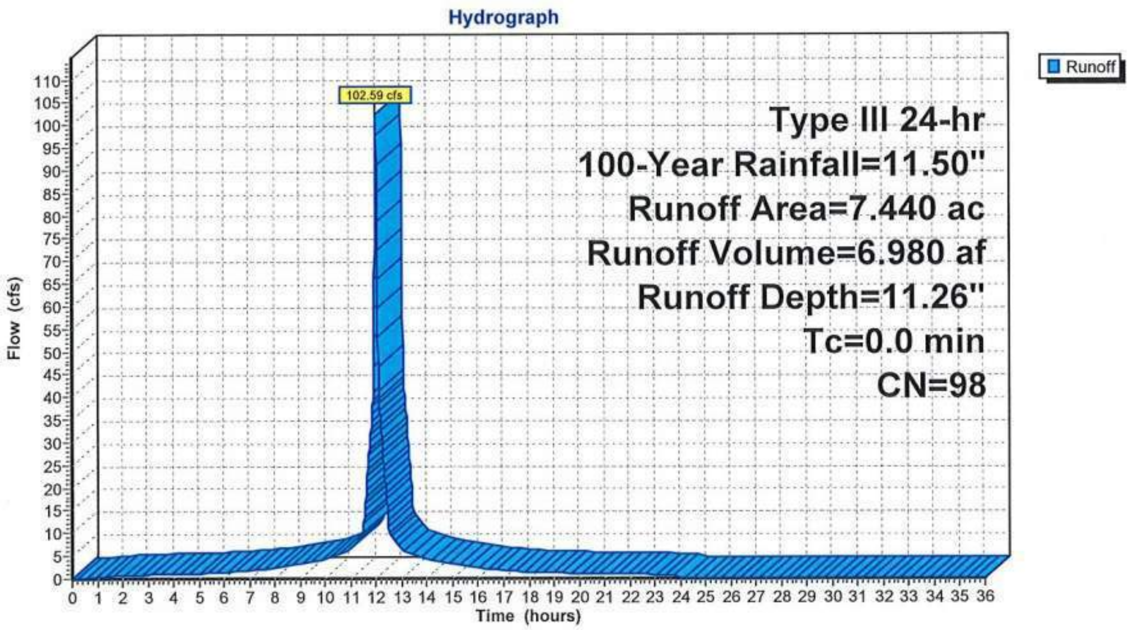
Runoff = 102.59 cfs @ 12.00 hrs, Volume= 6.980 af, Depth=11.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
7.440	98	Water Surface, 0% imp, HSG C
7.440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Rainfall at Pond A**

Subcatchment PAR: PA Rainfall Area



Summary for Subcatchment PBR: PB Rainfall Area

Use Conservative Value of Tc=10 min

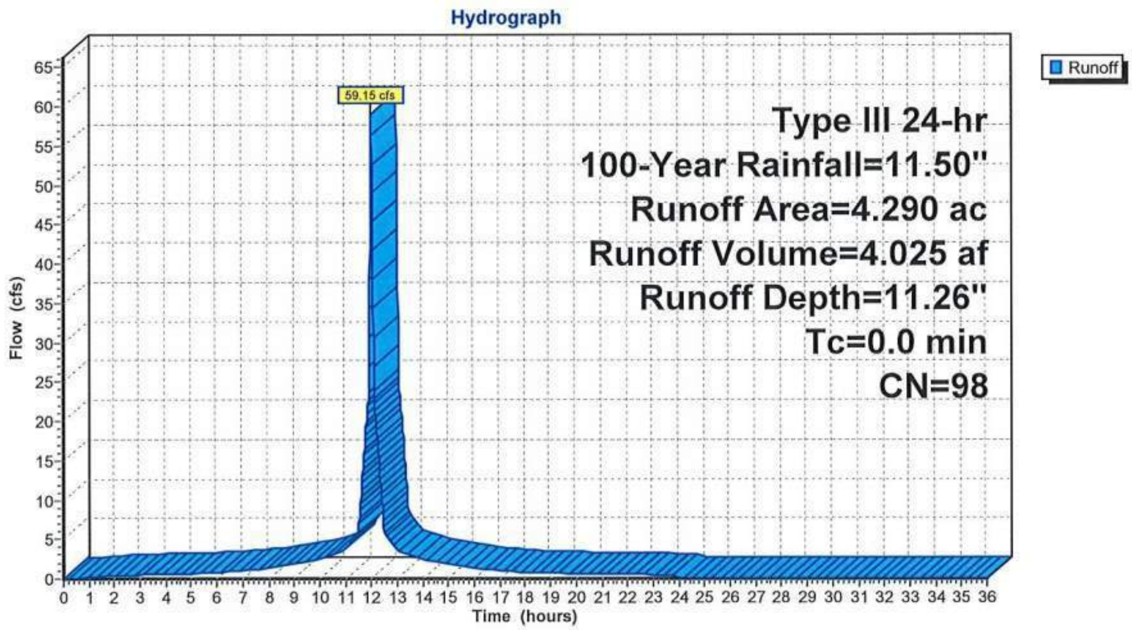
Runoff = 59.15 cfs @ 12.00 hrs, Volume= 4.025 af, Depth=11.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
4.290	98	Water Surface, 0% imp, HSG C
4.290		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Rainfall at Pond B**

Subcatchment PBR: PB Rainfall Area



Summary for Subcatchment PCR: PC Rainfall Area

Use Conservative Value of Tc=10 min

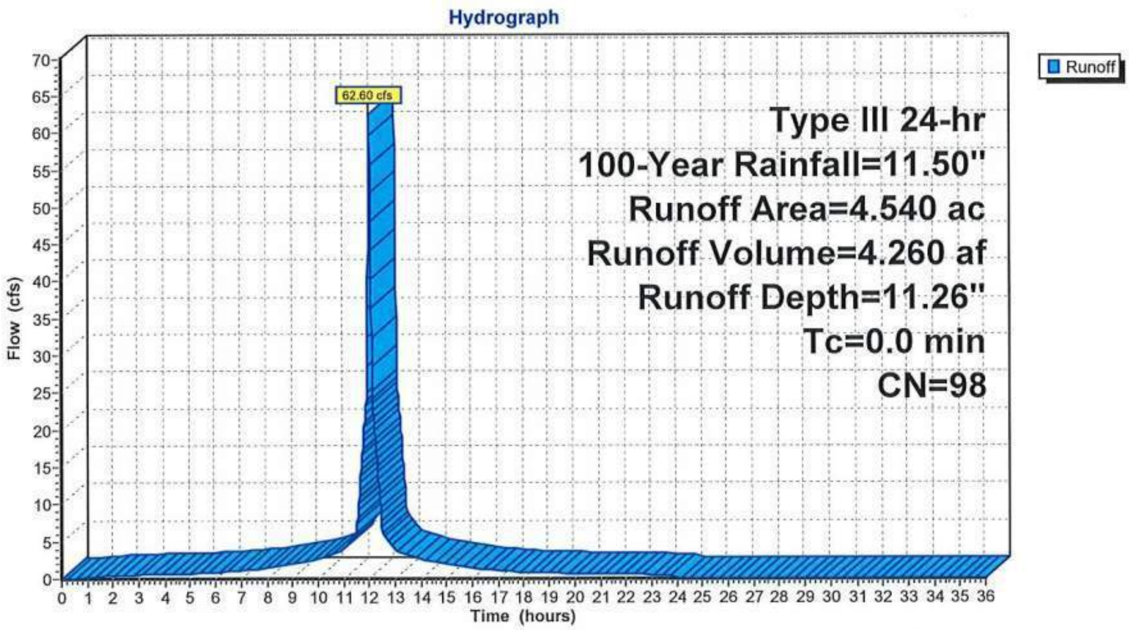
Runoff = 62.60 cfs @ 12.00 hrs, Volume= 4.260 af, Depth=11.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
4.540	98	Water Surface, 0% imp, HSG C
4.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Rainfall at Pond C**

Subcatchment PCR: PC Rainfall Area



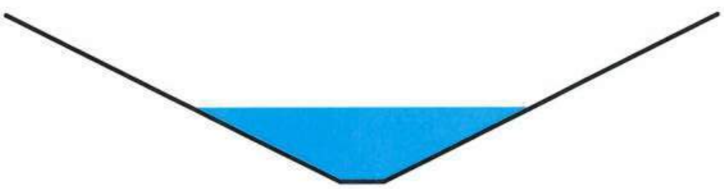
Summary for Reach 1CC: 1CC Collector Channel

Inflow Area = 38.047 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 301.75 cfs @ 12.17 hrs, Volume= 27.992 af
Outflow = 300.25 cfs @ 12.20 hrs, Volume= 27.992 af, Atten= 0%, Lag= 1.6 min

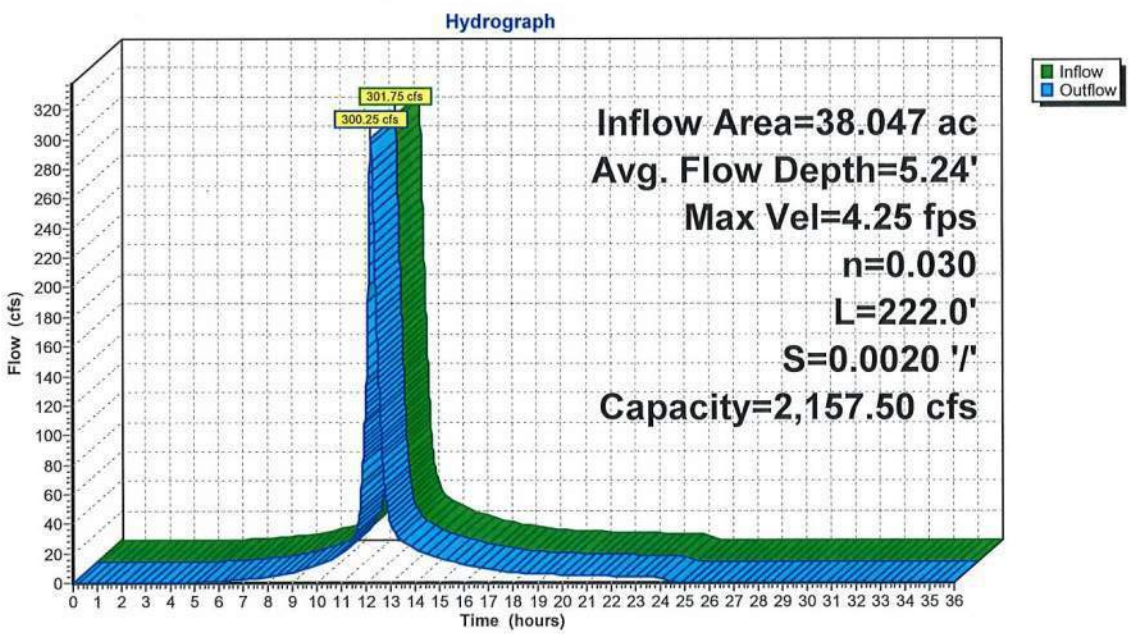
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.25 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.43 fps, Avg. Travel Time= 2.6 min

Peak Storage= 15,702 cf @ 12.18 hrs
Average Depth at Peak Storage= 5.24'
Bank-Full Depth= 11.73' Flow Area= 310.4 sf, Capacity= 2,157.50 cfs

3.00' x 11.73' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 49.92'
Length= 222.0' Slope= 0.0020 '/'
Inlet Invert= 53.89', Outlet Invert= 53.45'



Reach 1CC: 1CC Collector Channel



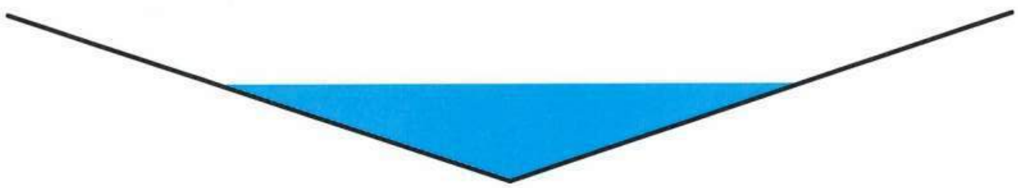
Summary for Reach 2CC: 2CC Collector Channel

Inflow Area = 1.480 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 12.98 cfs @ 12.14 hrs, Volume= 1.089 af
Outflow = 11.11 cfs @ 12.30 hrs, Volume= 1.089 af, Atten= 14%, Lag= 10.1 min

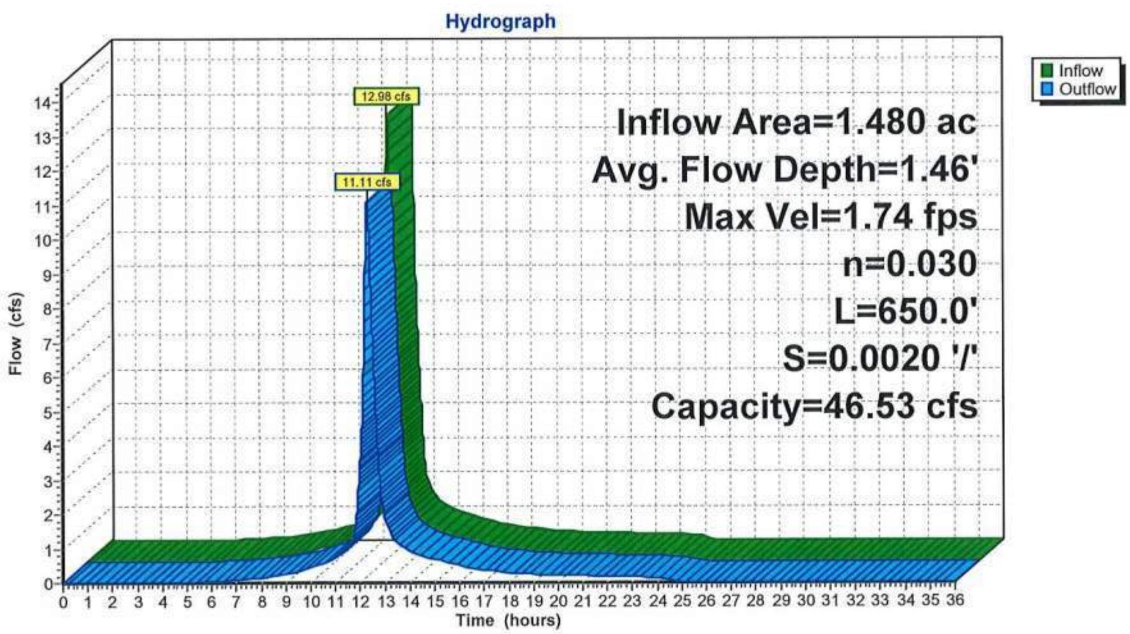
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.74 fps, Min. Travel Time= 6.2 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 19.4 min

Peak Storage= 4,166 cf @ 12.20 hrs
Average Depth at Peak Storage= 1.46'
Bank-Full Depth= 2.50' Flow Area= 18.8 sf, Capacity= 46.53 cfs

0.00' x 2.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 15.00'
Length= 650.0' Slope= 0.0020 '/'
Inlet Invert= 54.50', Outlet Invert= 53.20'



Reach 2CC: 2CC Collector Channel



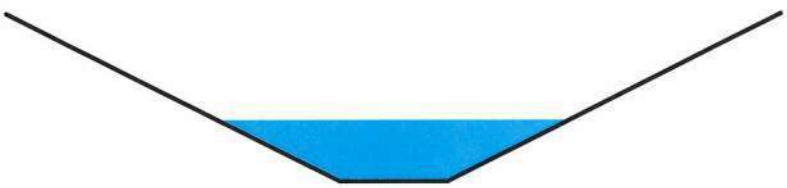
Summary for Reach 5CC: A2 Collector Channel

Inflow Area =	1.000 ac,	0.00% Impervious, Inflow Depth = 8.83"	for 100-Year event
Inflow =	8.77 cfs @	12.14 hrs, Volume=	0.736 af
Outflow =	7.45 cfs @	12.31 hrs, Volume=	0.736 af, Atten= 15%, Lag= 10.5 min

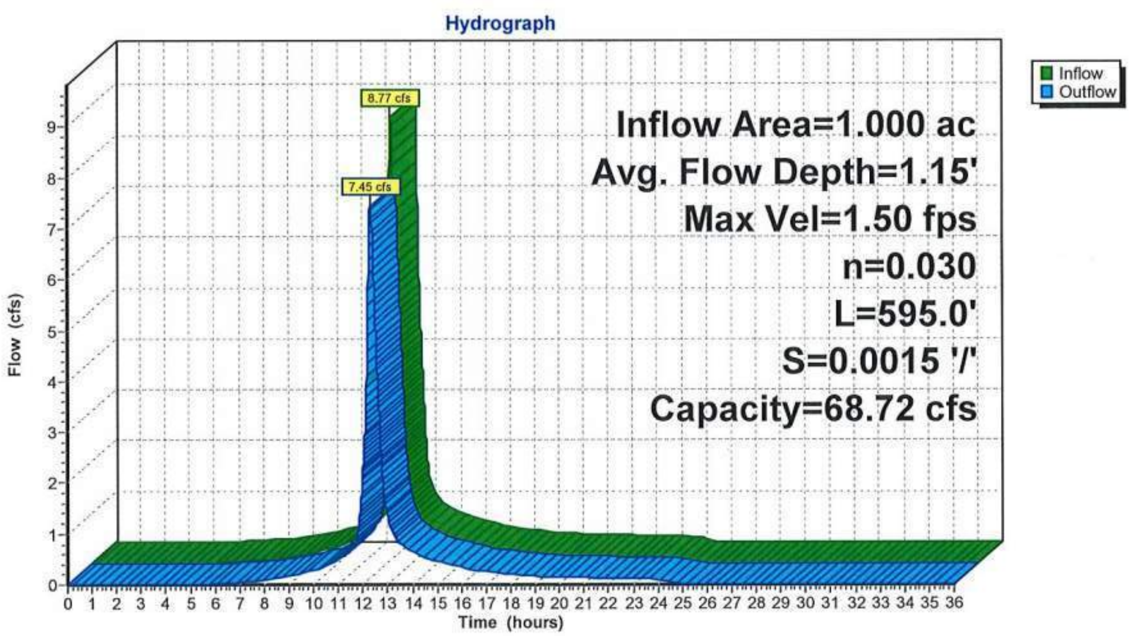
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.50 fps, Min. Travel Time= 6.6 min
Avg. Velocity = 0.46 fps, Avg. Travel Time= 21.6 min

Peak Storage= 2,954 cf @ 12.20 hrs
Average Depth at Peak Storage= 1.15'
Bank-Full Depth= 3.14' Flow Area= 26.0 sf, Capacity= 68.72 cfs

2.00' x 3.14' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 14.56'
Length= 595.0' Slope= 0.0015 '/'
Inlet Invert= 58.50', Outlet Invert= 57.61'



Reach 5CC: A2 Collector Channel



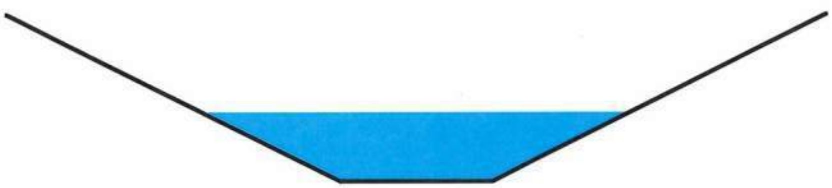
Summary for Reach 6CC: A3 Collector Channel

Inflow Area = 1.000 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 8.77 cfs @ 12.14 hrs, Volume= 0.736 af
Outflow = 7.67 cfs @ 12.29 hrs, Volume= 0.736 af, Atten= 13%, Lag= 9.2 min

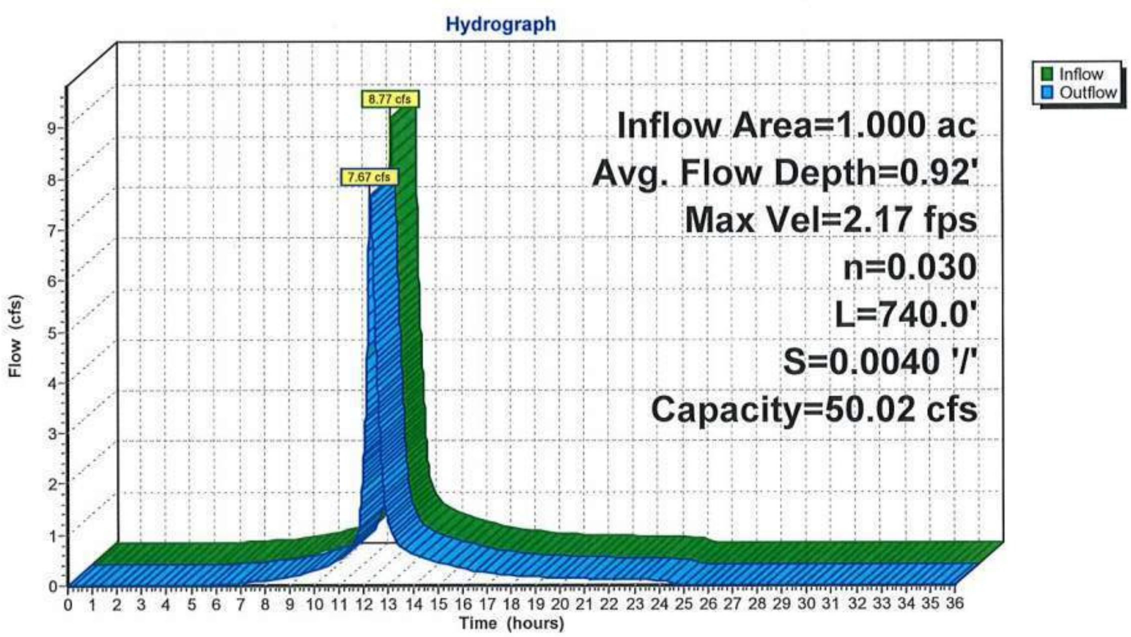
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.17 fps, Min. Travel Time= 5.7 min
Avg. Velocity = 0.64 fps, Avg. Travel Time= 19.2 min

Peak Storage= 2,614 cf @ 12.19 hrs
Average Depth at Peak Storage= 0.92'
Bank-Full Depth= 2.21' Flow Area= 14.2 sf, Capacity= 50.02 cfs

2.00' x 2.21' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 10.84'
Length= 740.0' Slope= 0.0040 '/'
Inlet Invert= 59.50', Outlet Invert= 56.54'



Reach 6CC: A3 Collector Channel



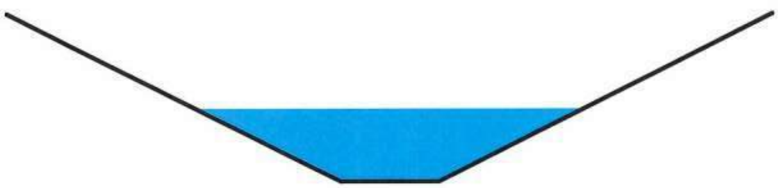
Summary for Reach A2-1: A2-1 Channel

Inflow Area = 2.000 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 12.75 cfs @ 12.25 hrs, Volume= 1.471 af
Outflow = 12.71 cfs @ 12.31 hrs, Volume= 1.471 af, Atten= 0%, Lag= 3.5 min

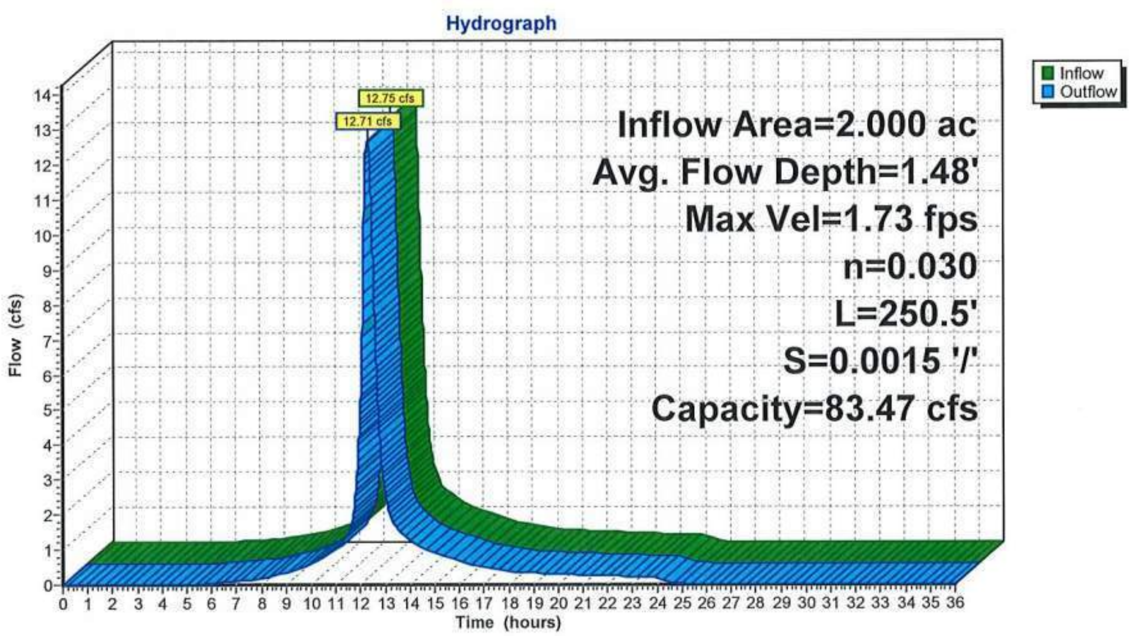
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.73 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 7.5 min

Peak Storage= 1,837 cf @ 12.27 hrs
Average Depth at Peak Storage= 1.48'
Bank-Full Depth= 3.40' Flow Area= 29.9 sf, Capacity= 83.47 cfs

2.00' x 3.40' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 15.60'
Length= 250.5' Slope= 0.0015 '/'
Inlet Invert= 57.61', Outlet Invert= 57.23'



Reach A2-1: A2-1 Channel



Summary for Reach A2-2: A2-2 Channel

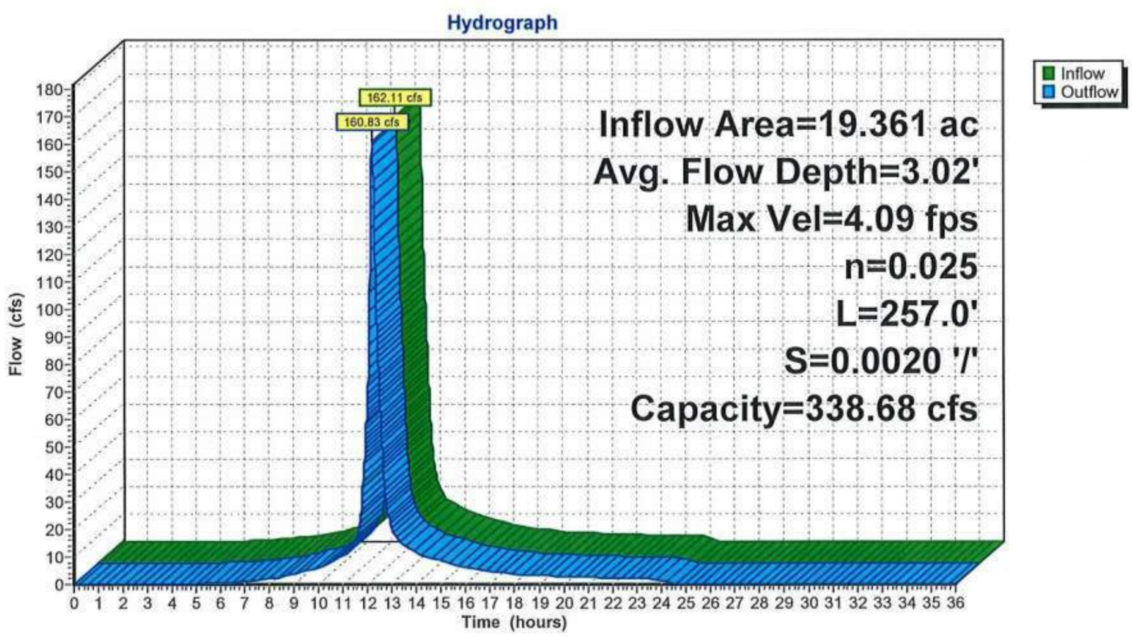
Inflow Area = 19.361 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 162.11 cfs @ 12.15 hrs, Volume= 14.244 af
Outflow = 160.83 cfs @ 12.18 hrs, Volume= 14.244 af, Atten= 1%, Lag= 1.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.09 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 3.9 min

Peak Storage= 10,114 cf @ 12.16 hrs
Average Depth at Peak Storage= 3.02'
Bank-Full Depth= 4.34' Flow Area= 68.1 sf, Capacity= 338.68 cfs

7.00' x 4.34' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 2.0 '/' Top Width= 24.36'
Length= 257.0' Slope= 0.0020 '/'
Inlet Invert= 55.84', Outlet Invert= 55.33'

Reach A2-2: A2-2 Channel



Summary for Reach A2-3: A2-3 Channel

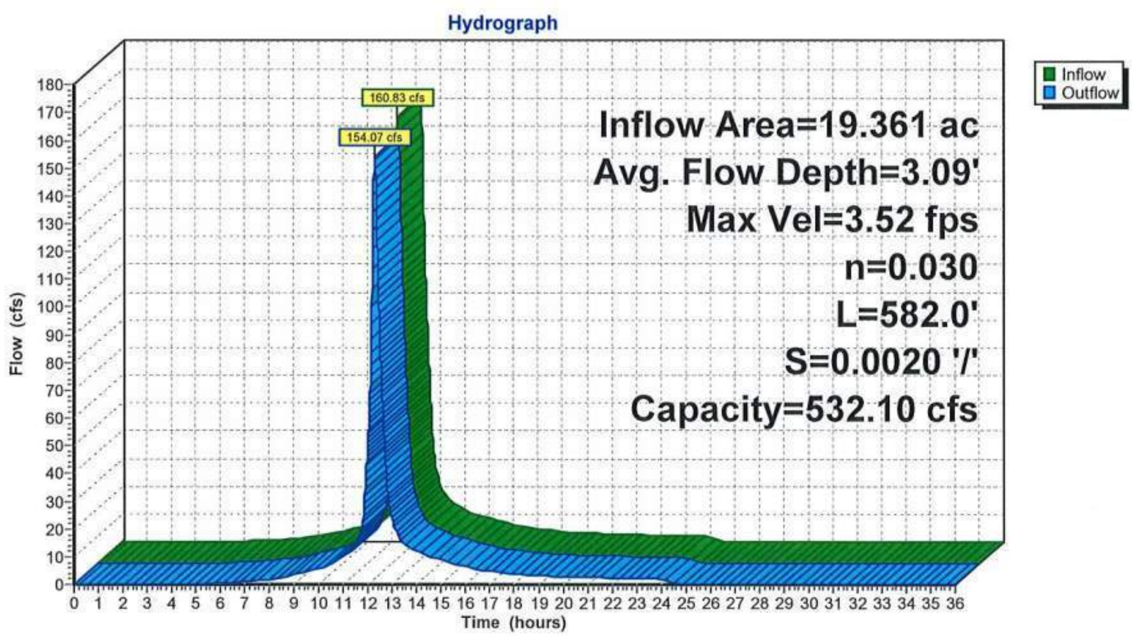
Inflow Area = 19.361 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 160.83 cfs @ 12.18 hrs, Volume= 14.244 af
Outflow = 154.07 cfs @ 12.26 hrs, Volume= 14.244 af, Atten= 4%, Lag= 4.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.52 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.95 fps, Avg. Travel Time= 10.2 min

Peak Storage= 25,497 cf @ 12.21 hrs
Average Depth at Peak Storage= 3.09'
Bank-Full Depth= 5.65' Flow Area= 109.0 sf, Capacity= 532.10 cfs

8.00' x 5.65' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 30.60'
Length= 582.0' Slope= 0.0020 '/'
Inlet Invert= 55.33', Outlet Invert= 54.17'

Reach A2-3: A2-3 Channel



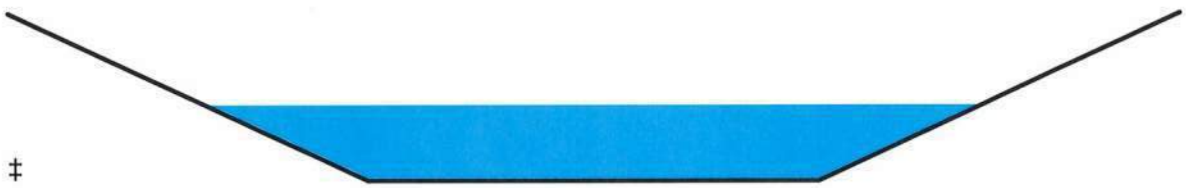
Summary for Reach A2-4: Chute-Concrete Block Open Cell

Inflow Area = 19.361 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 154.07 cfs @ 12.26 hrs, Volume= 14.244 af
Outflow = 153.86 cfs @ 12.27 hrs, Volume= 14.244 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.45 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.12 fps, Avg. Travel Time= 1.3 min

Peak Storage= 3,091 cf @ 12.26 hrs
Average Depth at Peak Storage= 0.91'
Bank-Full Depth= 2.00' Flow Area= 36.0 sf, Capacity= 692.98 cfs

10.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 26.00'
Length= 250.0' Slope= 0.0697 '/'
Inlet Invert= 54.17', Outlet Invert= 36.75'



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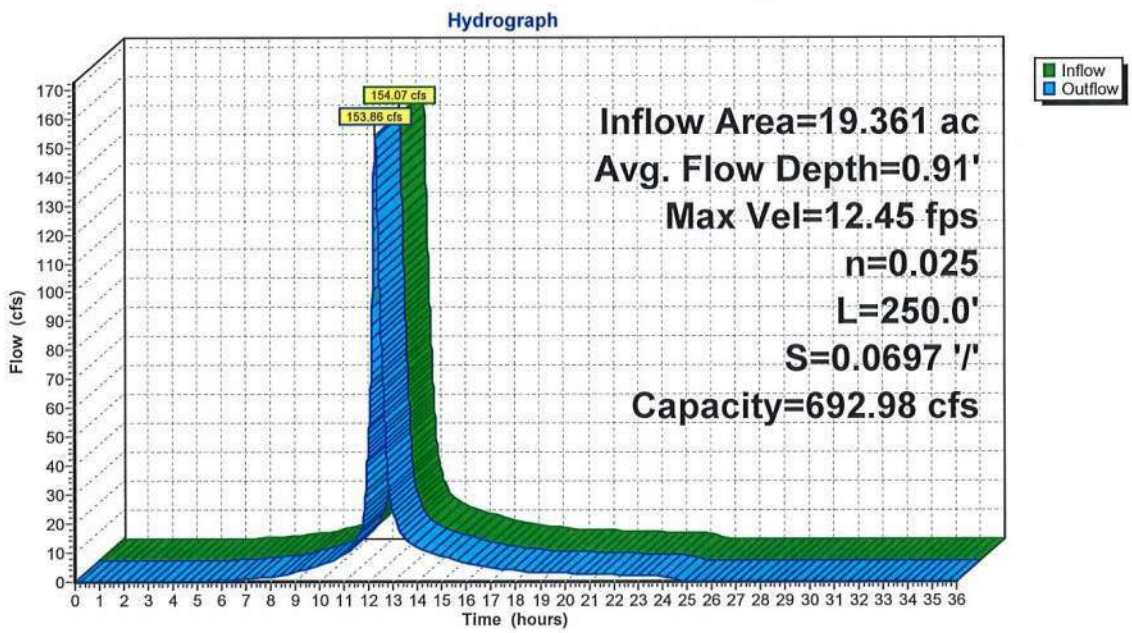
Reach A2-4: Chute-Concrete Block Open Cell



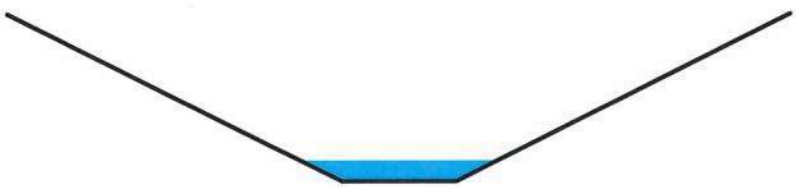
Summary for Reach A2-5: Cocrete Block-Channel Transition

Inflow Area = 2.000 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 12.71 cfs @ 12.31 hrs, Volume= 1.471 af
Outflow = 12.71 cfs @ 12.31 hrs, Volume= 1.471 af, Atten= 0%, Lag= 0.0 min

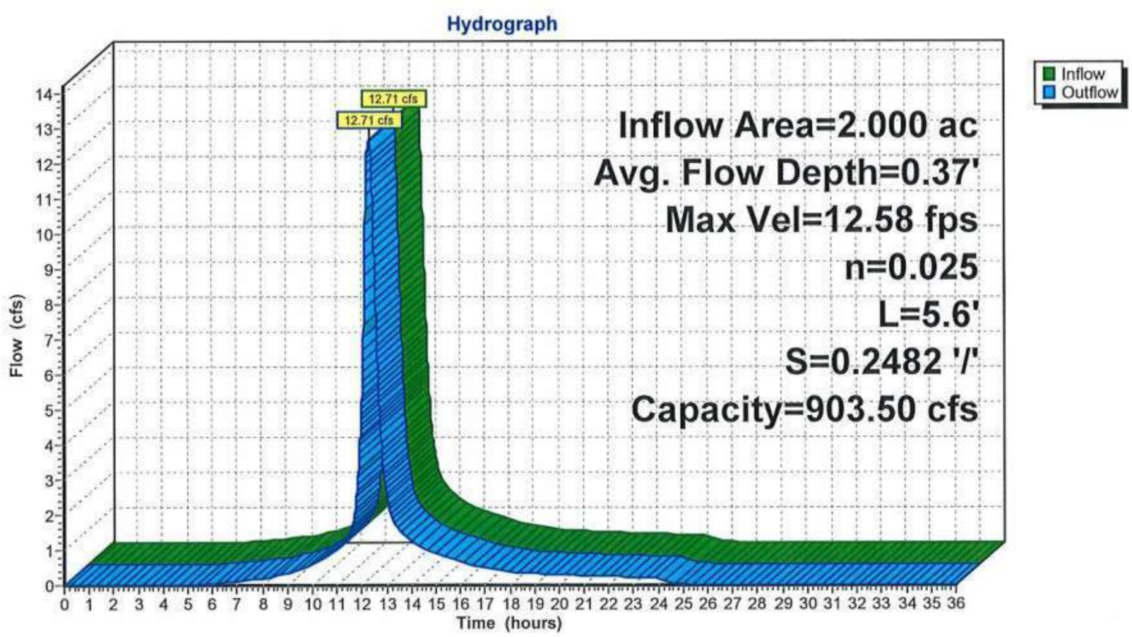
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.58 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 4.06 fps, Avg. Travel Time= 0.0 min

Peak Storage= 6 cf @ 12.31 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 2.93' Flow Area= 23.0 sf, Capacity= 903.50 cfs

2.00' x 2.93' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 2.0 '/' Top Width= 13.72'
Length= 5.6' Slope= 0.2482 '/'
Inlet Invert= 57.23', Outlet Invert= 55.84'



Reach A2-5: Cocrete Block-Channel Transition



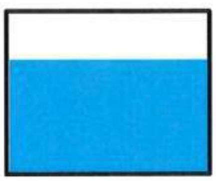
Summary for Reach B1: 5' x 4' Box Culvert

Inflow Area = 19.249 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 146.99 cfs @ 12.17 hrs, Volume= 14.162 af
Outflow = 146.52 cfs @ 12.19 hrs, Volume= 14.162 af, Atten= 0%, Lag= 1.3 min

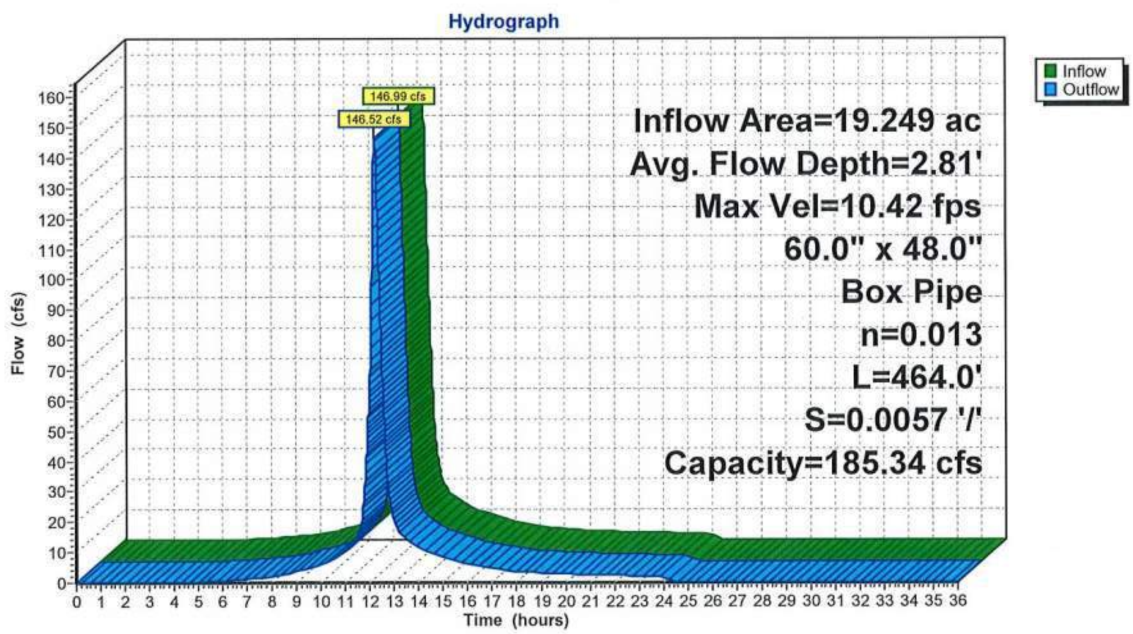
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.42 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 2.94 fps, Avg. Travel Time= 2.6 min

Peak Storage= 6,530 cf @ 12.18 hrs
Average Depth at Peak Storage= 2.81'
Bank-Full Depth= 4.00' Flow Area= 20.0 sf, Capacity= 185.34 cfs

60.0" W x 48.0" H Box Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 464.0' Slope= 0.0057 '/'
Inlet Invert= 56.54', Outlet Invert= 53.89'



Reach B1: 5' x 4' Box Culvert



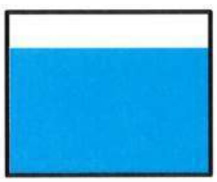
Summary for Reach B2: 5' x 4' Box Culvert

Inflow Area = 38.047 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 300.25 cfs @ 12.20 hrs, Volume= 27.992 af
Outflow = 300.01 cfs @ 12.20 hrs, Volume= 27.992 af, Atten= 0%, Lag= 0.3 min

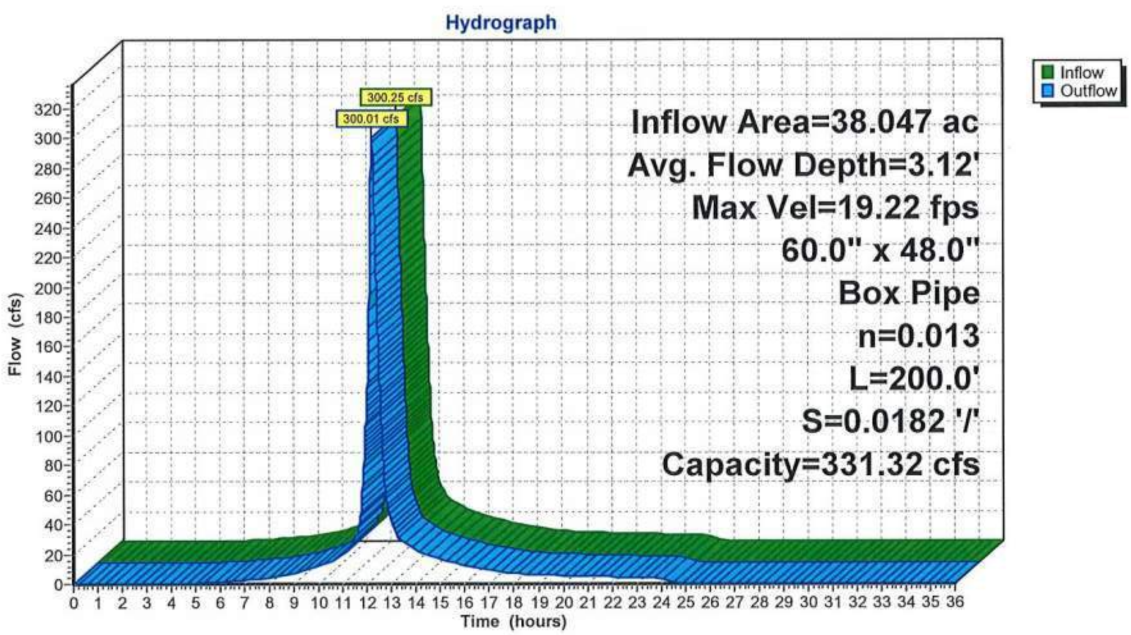
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.22 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.48 fps, Avg. Travel Time= 0.6 min

Peak Storage= 3,124 cf @ 12.20 hrs
Average Depth at Peak Storage= 3.12'
Bank-Full Depth= 4.00' Flow Area= 20.0 sf, Capacity= 331.32 cfs

60.0" W x 48.0" H Box Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 200.0' Slope= 0.0182 '/'
Inlet Invert= 53.45', Outlet Invert= 49.80'



Reach B2: 5' x 4' Box Culvert



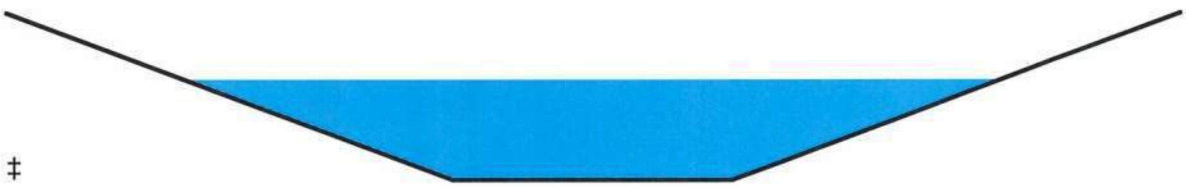
Summary for Reach C1-4: Chute-Concrete Block Open Cell

Inflow Area = 38.047 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 300.01 cfs @ 12.20 hrs, Volume= 27.992 af
Outflow = 299.94 cfs @ 12.20 hrs, Volume= 27.992 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 25.32 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 7.50 fps, Avg. Travel Time= 0.2 min

Peak Storage= 900 cf @ 12.20 hrs
Average Depth at Peak Storage= 1.21'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 872.67 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 76.0' Slope= 0.2474 '/'
Inlet Invert= 49.80', Outlet Invert= 31.00'



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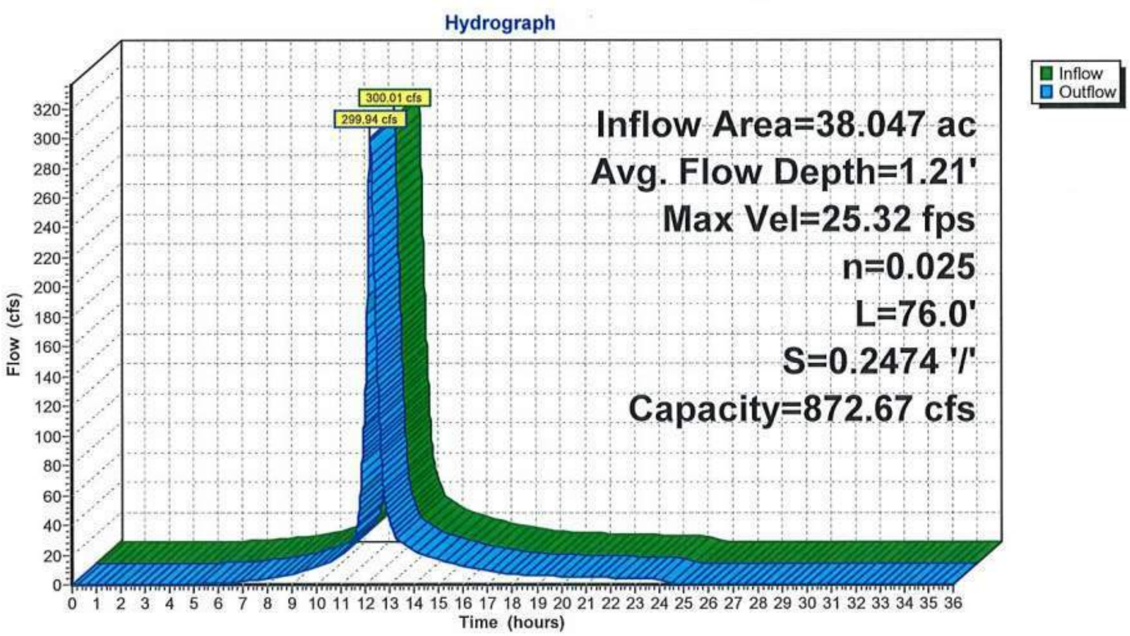
Reach C1-4: Chute-Concrete Block Open Cell



Summary for Reach C1SCCN1: C1SCCN1 Collector Channel

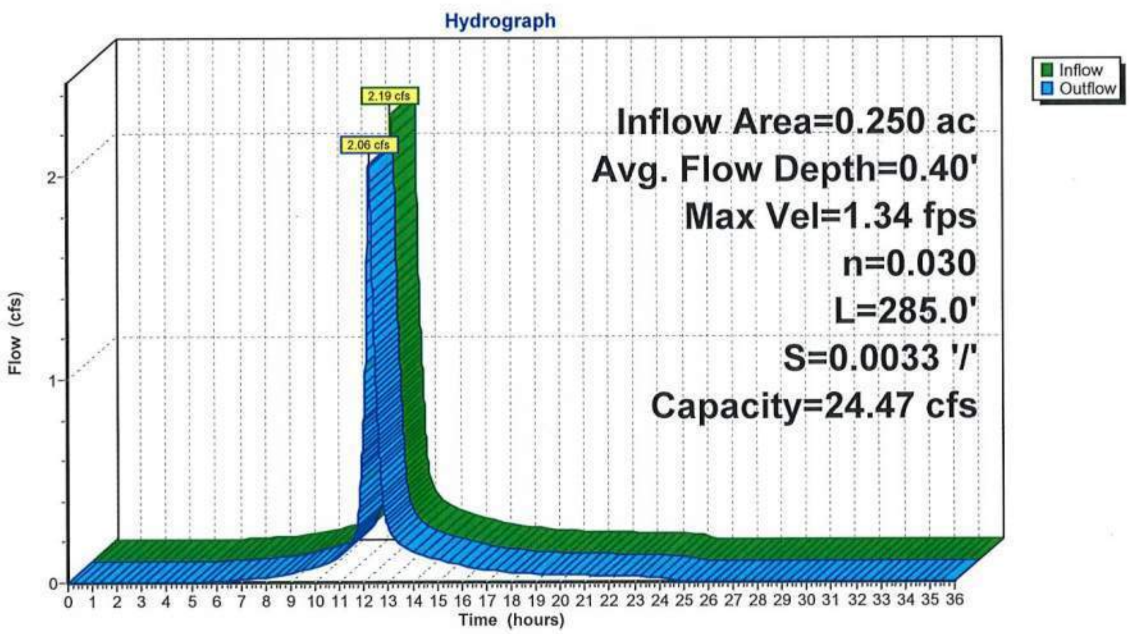
Inflow Area = 0.250 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 2.19 cfs @ 12.14 hrs, Volume= 0.184 af
Outflow = 2.06 cfs @ 12.23 hrs, Volume= 0.184 af, Atten= 6%, Lag= 5.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.34 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 13.0 min

Peak Storage= 439 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.47 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 285.0' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.55'

Reach C1SCCN1: C1SCCN1 Collector Channel



Summary for Reach C1SCCN2: C1SCCN2 Collector Channel

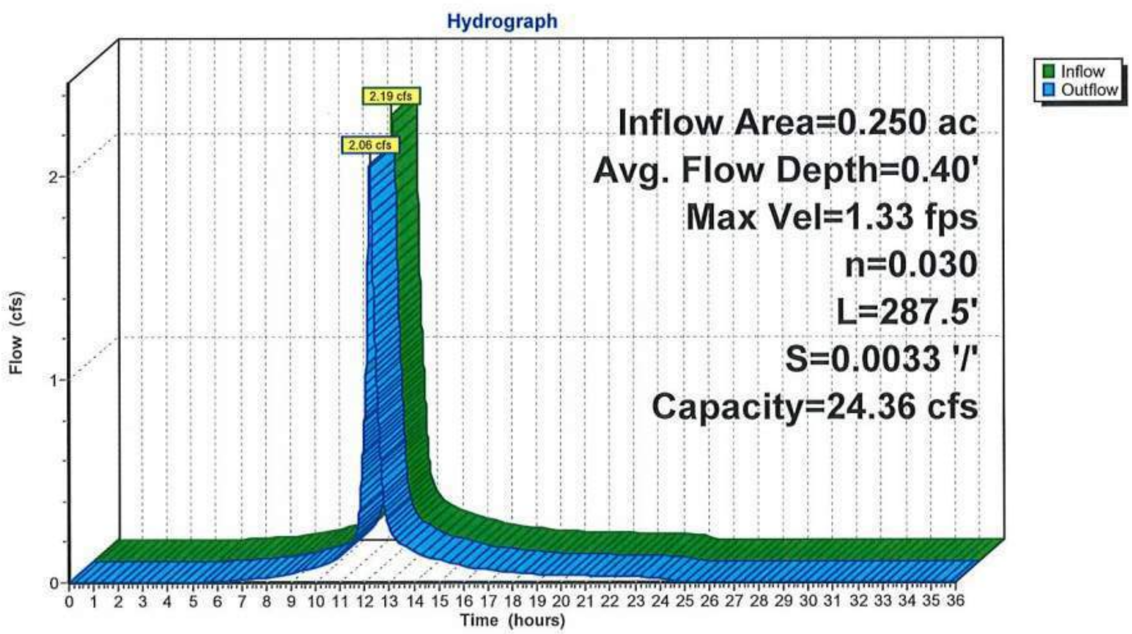
Inflow Area = 0.250 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 2.19 cfs @ 12.14 hrs, Volume= 0.184 af
Outflow = 2.06 cfs @ 12.23 hrs, Volume= 0.184 af, Atten= 6%, Lag= 5.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.33 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 13.2 min

Peak Storage= 443 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.36 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 287.5' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.55'

Reach C1SCCN2: C1SCCN2 Collector Channel



Summary for Reach C1SCCS1: C1SCCS1 Collector Channel

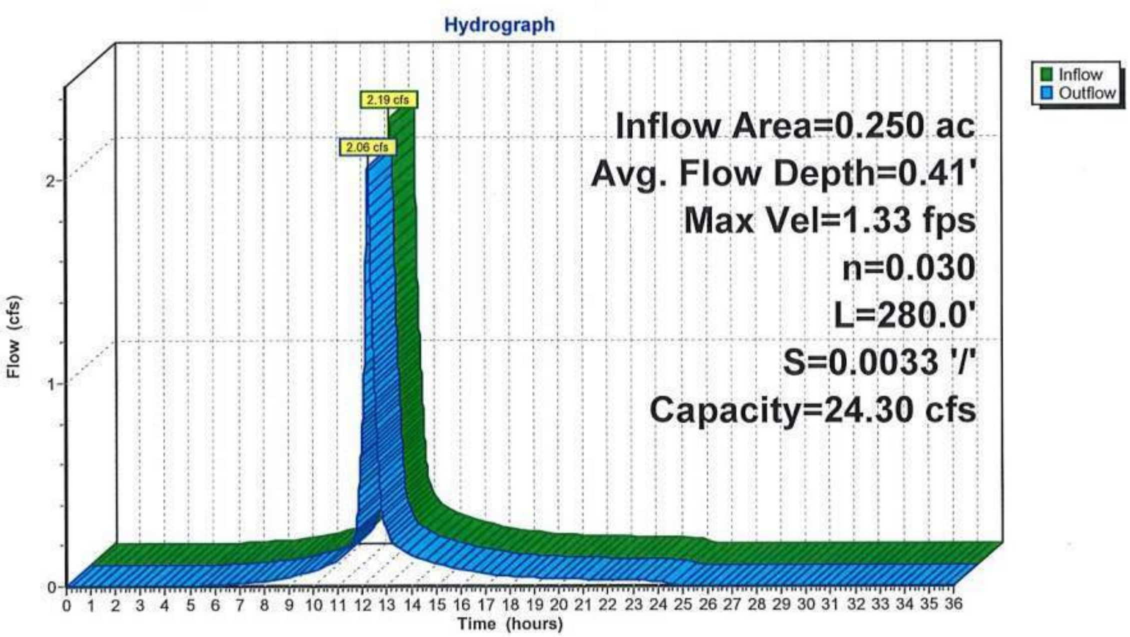
Inflow Area =	0.250 ac,	0.00% Impervious,	Inflow Depth =	8.83"	for 100-Year event
Inflow =	2.19 cfs @	12.14 hrs,	Volume=	0.184 af	
Outflow =	2.06 cfs @	12.23 hrs,	Volume=	0.184 af,	Atten= 6%, Lag= 5.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.33 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 12.9 min

Peak Storage= 433 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.30 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 280.0' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.58'

Reach C1SCCS1: C1SCCS1 Collector Channel



Summary for Reach C1SCCS2: C1SCCS2 Collector Channel

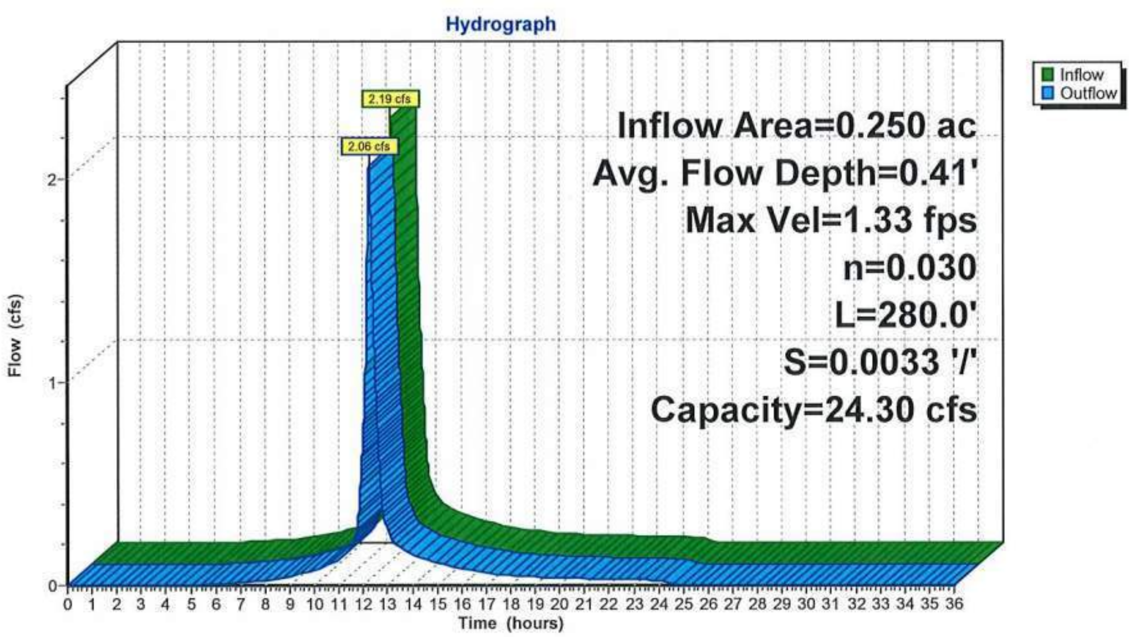
Inflow Area = 0.250 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 2.19 cfs @ 12.14 hrs, Volume= 0.184 af
Outflow = 2.06 cfs @ 12.23 hrs, Volume= 0.184 af, Atten= 6%, Lag= 5.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.33 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 12.9 min

Peak Storage= 433 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 1.50' Flow Area= 9.0 sf, Capacity= 24.30 cfs

3.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 280.0' Slope= 0.0033 '/'
Inlet Invert= 58.50', Outlet Invert= 57.58'

Reach C1SCCS2: C1SCCS2 Collector Channel



Summary for Reach C2-3: C2-3 Channel

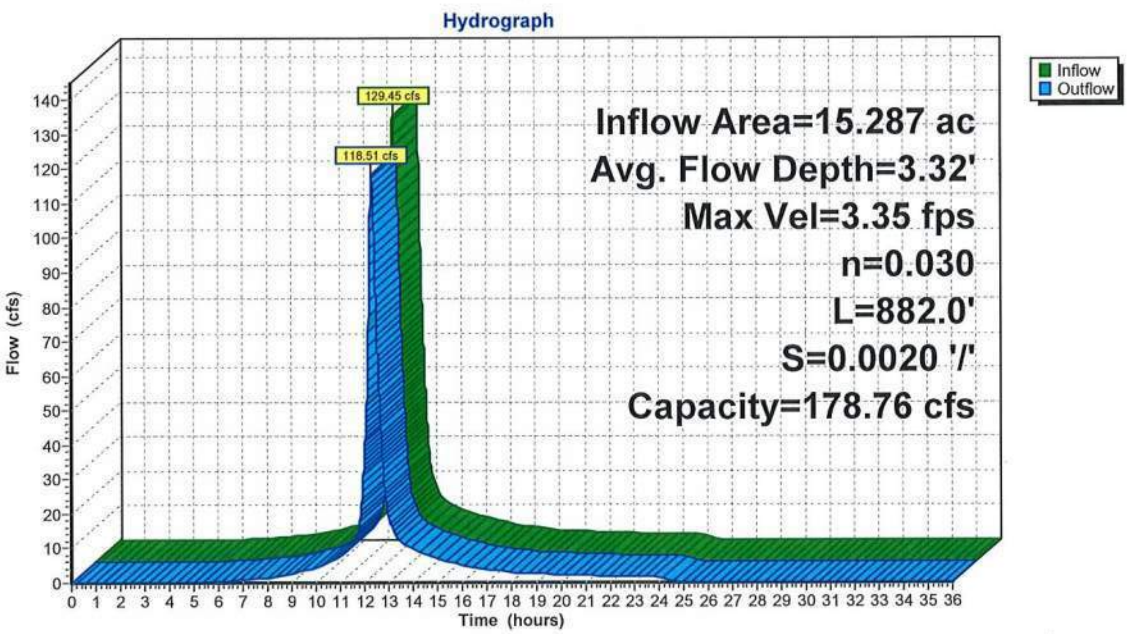
Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 129.45 cfs @ 12.16 hrs, Volume= 11.247 af
Outflow = 118.51 cfs @ 12.28 hrs, Volume= 11.247 af, Atten= 8%, Lag= 7.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.35 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 0.96 fps, Avg. Travel Time= 15.3 min

Peak Storage= 31,176 cf @ 12.21 hrs
Average Depth at Peak Storage= 3.32'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 178.76 cfs

4.00' x 4.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 2.0 '/' Top Width= 20.00'
Length= 882.0' Slope= 0.0020 '/'
Inlet Invert= 53.50', Outlet Invert= 51.75'

Reach C2-3: C2-3 Channel



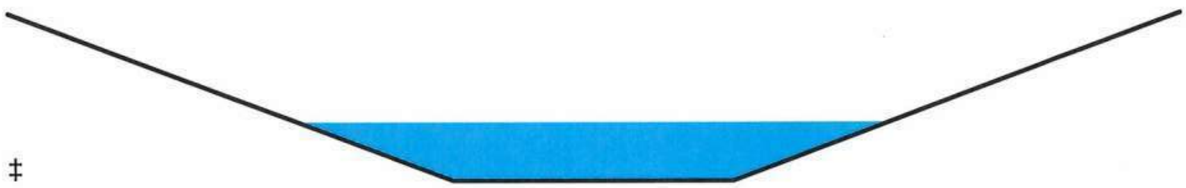
Summary for Reach C2-4: Chute-Concrete Block Open Cell

Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 118.38 cfs @ 12.29 hrs, Volume= 11.247 af
Outflow = 118.36 cfs @ 12.29 hrs, Volume= 11.247 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 21.63 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 5.92 fps, Avg. Travel Time= 0.1 min

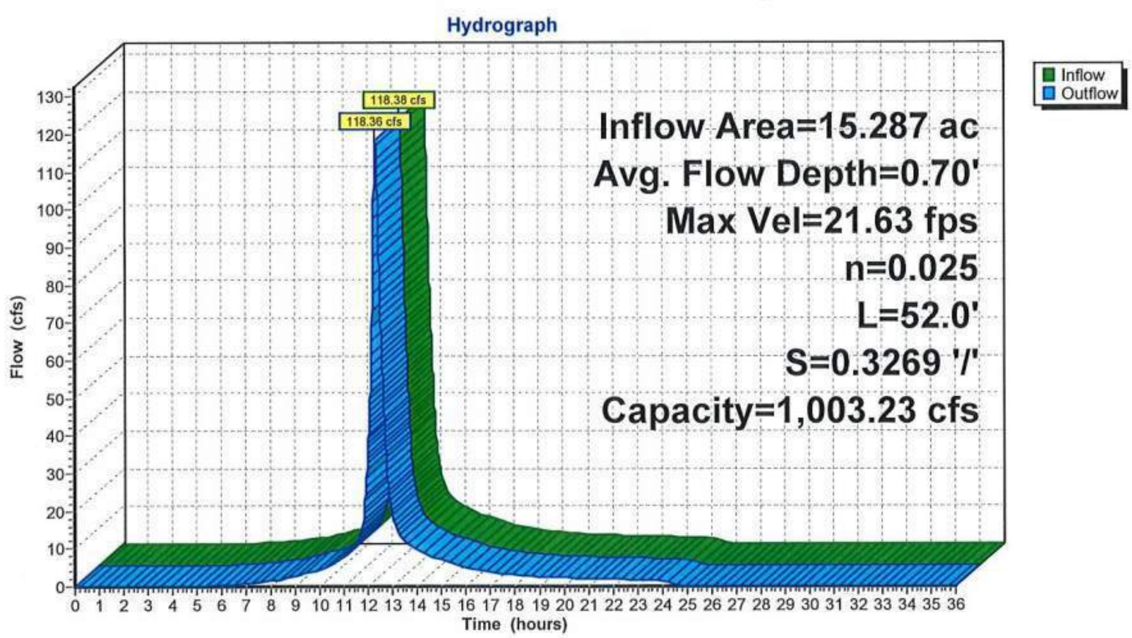
Peak Storage= 285 cf @ 12.29 hrs
Average Depth at Peak Storage= 0.70'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 1,003.23 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 52.0' Slope= 0.3269 '/'
Inlet Invert= 48.00', Outlet Invert= 31.00'



‡

Reach C2-4: Chute-Concrete Block Open Cell



Post Development 100 Yr Drainage *Type III 24-hr 100-Year Rainfall=11.50"*
Prepared by Hanson Professional Services Inc. Printed 8/20/2018
HydroCAD® 10.00-17 s/n 09651 © 2016 HydroCAD Software Solutions LLC Page 61

Summary for Reach C2-5: C2-5 Channel

Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 118.48 cfs @ 12.28 hrs, Volume= 11.247 af
Outflow = 118.38 cfs @ 12.29 hrs, Volume= 11.247 af, Atten= 0%, Lag= 0.3 min

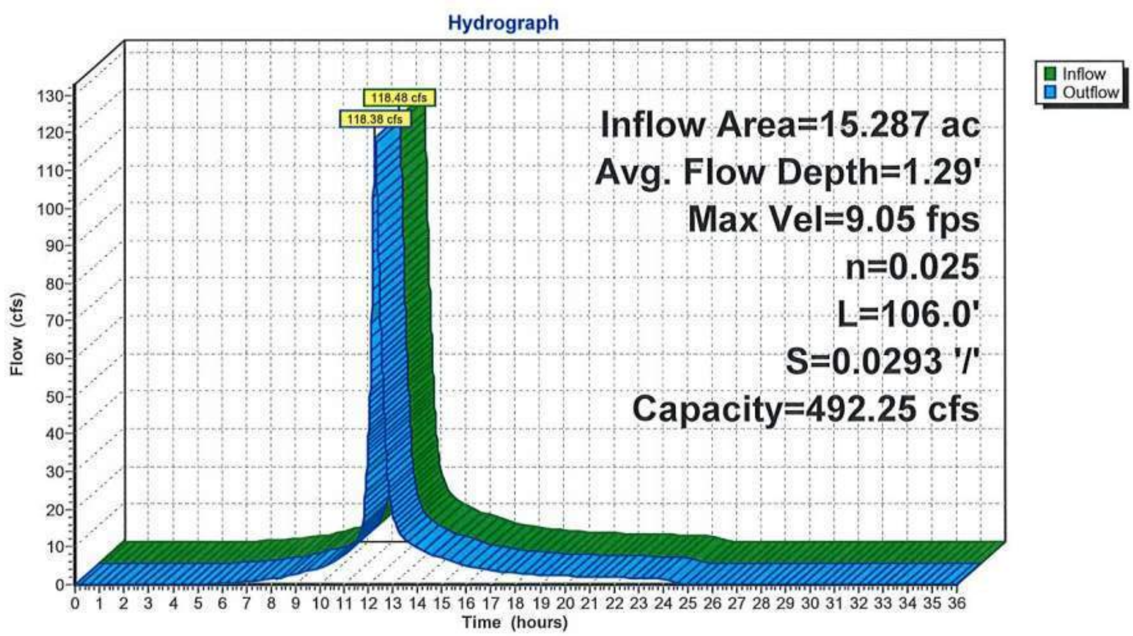
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.05 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.55 fps, Avg. Travel Time= 0.7 min

Peak Storage= 1,388 cf @ 12.28 hrs
Average Depth at Peak Storage= 1.29'
Bank-Full Depth= 2.50' Flow Area= 37.5 sf, Capacity= 492.25 cfs

5.00' x 2.50' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 25.00'
Length= 106.0' Slope= 0.0293 '/'
Inlet Invert= 51.11', Outlet Invert= 48.00'

‡

Reach C2-5: C2-5 Channel



Summary for Reach CC: Chute-Concrete Block Open Cell

Inflow Area = 1.480 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 11.11 cfs @ 12.30 hrs, Volume= 1.089 af
Outflow = 11.10 cfs @ 12.31 hrs, Volume= 1.089 af, Atten= 0%, Lag= 0.6 min

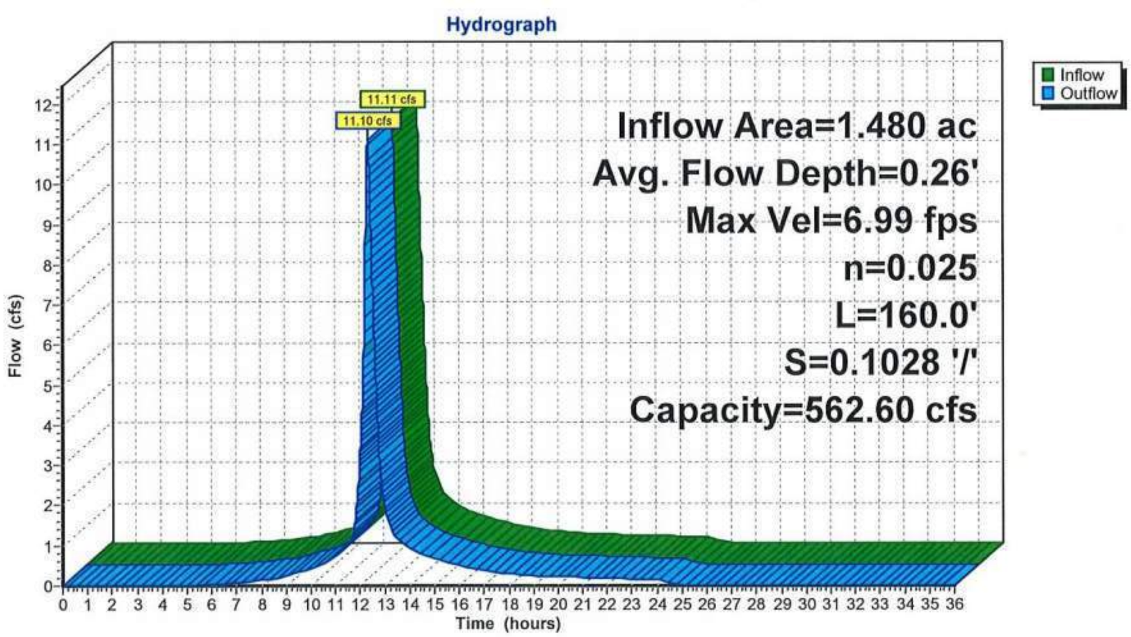
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.99 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.01 fps, Avg. Travel Time= 1.3 min

Peak Storage= 254 cf @ 12.31 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 562.60 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 160.0' Slope= 0.1028 '/'
Inlet Invert= 53.20', Outlet Invert= 36.75'

‡

Reach CC: Chute-Concrete Block Open Cell



Summary for Reach E: Chute-Concrete Block Open Cell

Inflow Area = 17.798 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 150.87 cfs @ 12.14 hrs, Volume= 13.094 af
Outflow = 150.58 cfs @ 12.16 hrs, Volume= 13.094 af, Atten= 0%, Lag= 0.6 min

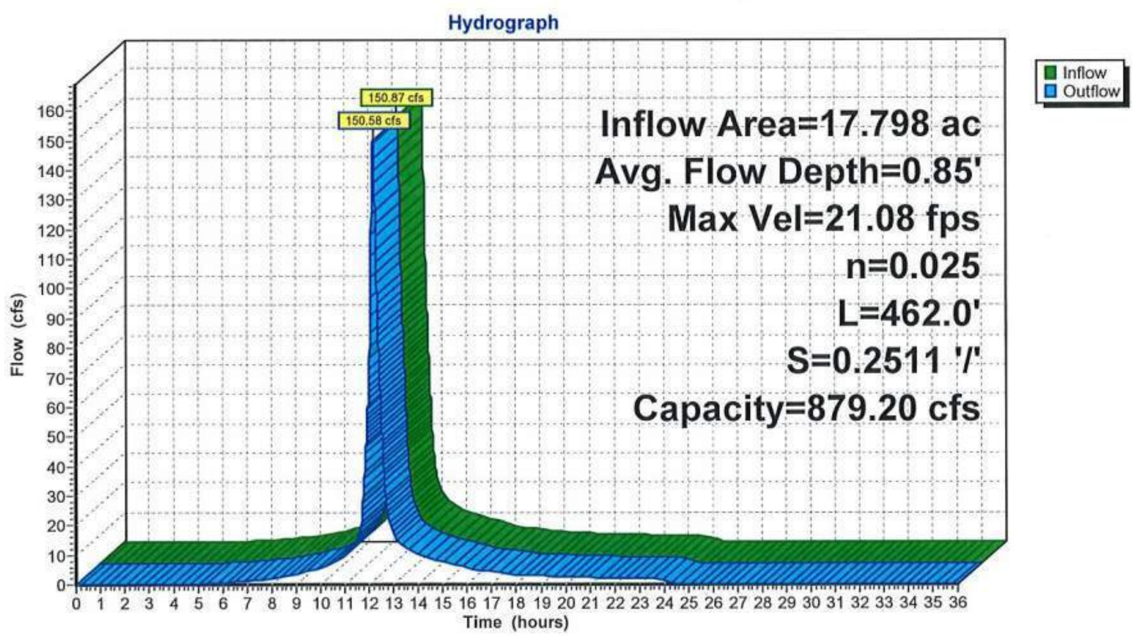
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 21.08 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.60 fps, Avg. Travel Time= 1.2 min

Peak Storage= 3,305 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.85'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 879.20 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 462.0' Slope= 0.2511 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'

‡

Reach E: Chute-Concrete Block Open Cell



Summary for Reach NE: Chute-Concrete Block Open Cell

Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 129.70 cfs @ 12.14 hrs, Volume= 11.247 af
Outflow = 129.45 cfs @ 12.16 hrs, Volume= 11.247 af, Atten= 0%, Lag= 0.7 min

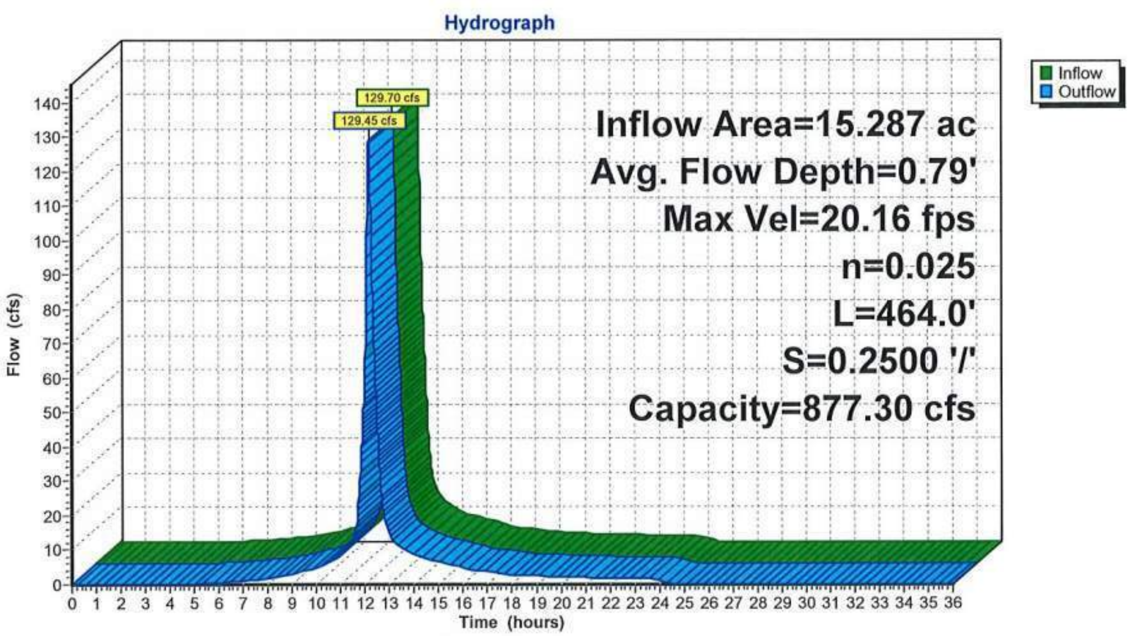
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.16 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.26 fps, Avg. Travel Time= 1.2 min

Peak Storage= 2,982 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.79'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 464.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'

‡

Reach NE: Chute-Concrete Block Open Cell



Summary for Reach NW: Chute-Concrete Block Open Cell

Inflow Area = 13.115 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 109.40 cfs @ 12.15 hrs, Volume= 9.649 af
Outflow = 109.21 cfs @ 12.16 hrs, Volume= 9.649 af, Atten= 0%, Lag= 0.7 min

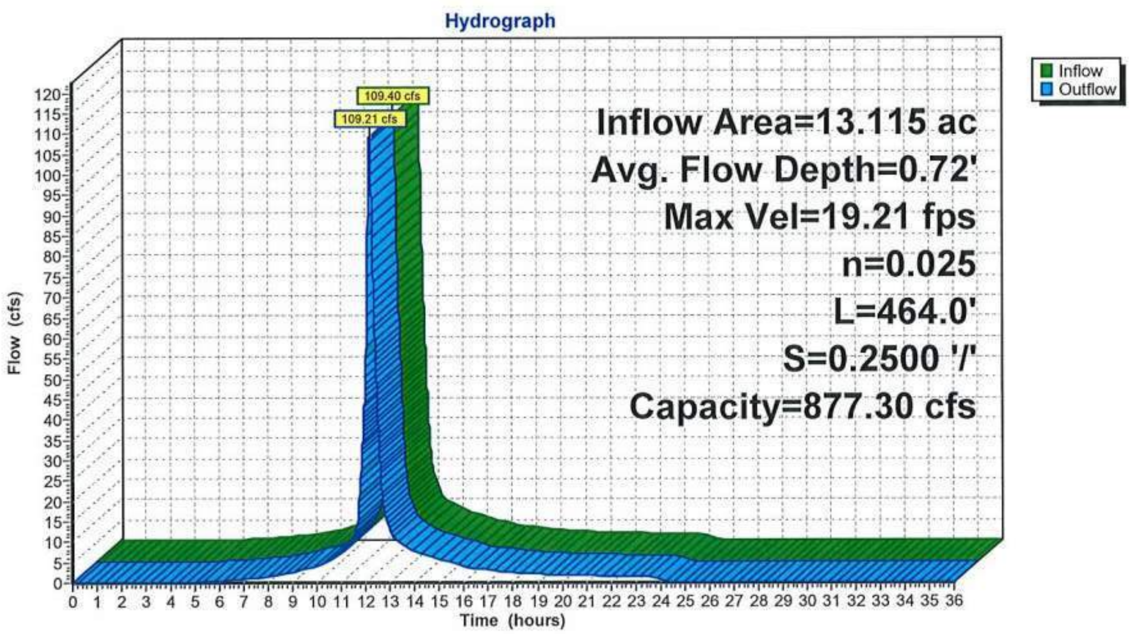
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.21 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.93 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,640 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 464.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'

‡

Reach NW: Chute-Concrete Block Open Cell



Summary for Reach OC: Existing Offsite Channel

Inflow Area =	42.338 ac,	0.00% Impervious, Inflow Depth > 8.85"	for 100-Year event
Inflow =	42.26 cfs @	12.98 hrs, Volume=	31.217 af
Outflow =	41.59 cfs @	14.06 hrs, Volume=	31.108 af, Atten= 2%, Lag= 64.9 min

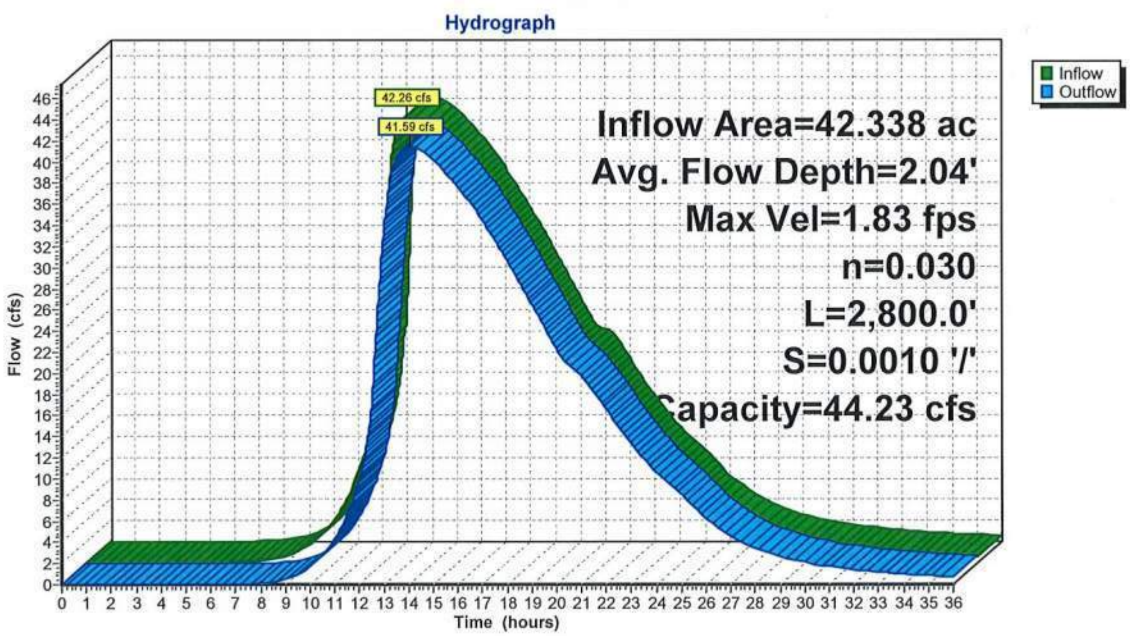
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.83 fps, Min. Travel Time= 25.4 min
Avg. Velocity = 0.95 fps, Avg. Travel Time= 49.3 min

Peak Storage= 63,491 cf @ 13.64 hrs
Average Depth at Peak Storage= 2.04'
Bank-Full Depth= 2.10' Flow Area= 23.7 sf, Capacity= 44.23 cfs

5.00' x 2.10' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 17.60'
Length= 2,800.0' Slope= 0.0010 '/'
Inlet Invert= 46.66', Outlet Invert= 43.86'

‡

Reach OC: Existing Offsite Channel



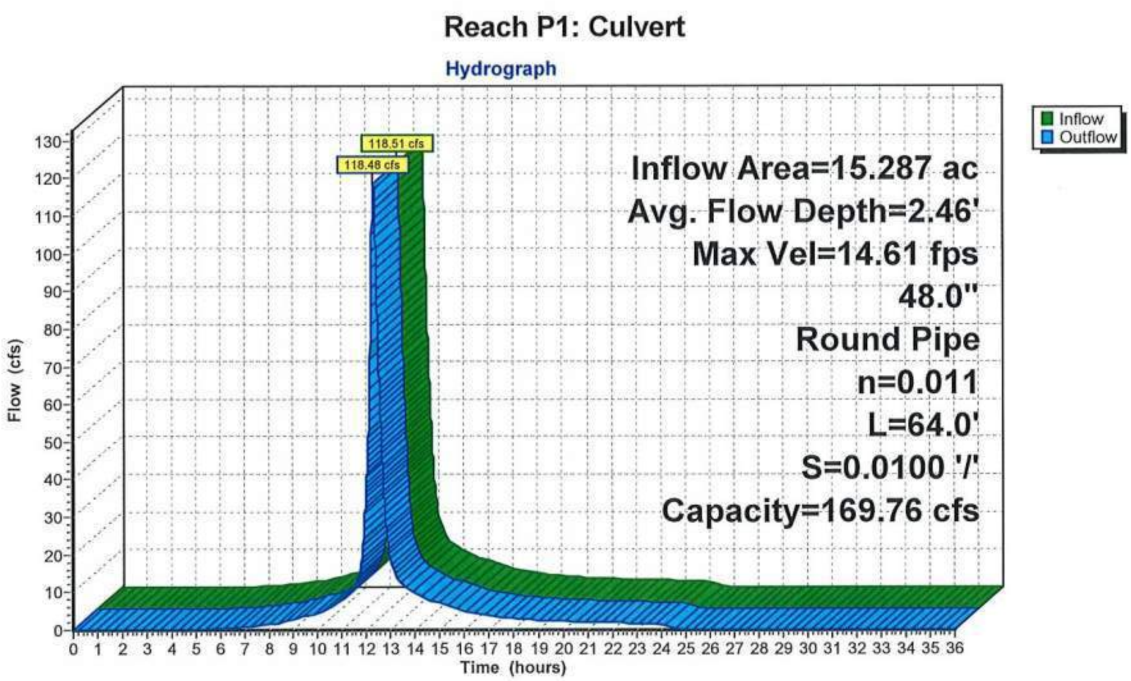
Summary for Reach P1: Culvert

Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 118.51 cfs @ 12.28 hrs, Volume= 11.247 af
Outflow = 118.48 cfs @ 12.28 hrs, Volume= 11.247 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 14.61 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.39 fps, Avg. Travel Time= 0.2 min

Peak Storage= 519 cf @ 12.28 hrs
Average Depth at Peak Storage= 2.46'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 169.76 cfs

48.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 64.0' Slope= 0.0100 '/'
Inlet Invert= 51.75', Outlet Invert= 51.11'



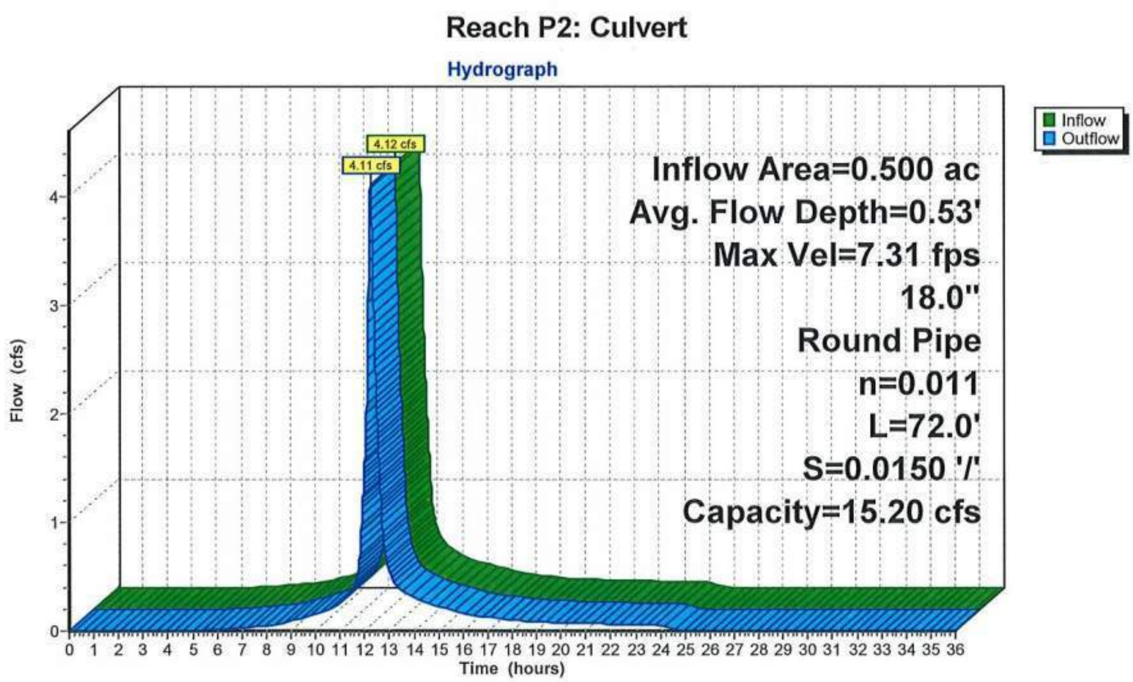
Summary for Reach P2: Culvert

Inflow Area =	0.500 ac,	0.00% Impervious, Inflow Depth = 8.83"	for 100-Year event
Inflow =	4.12 cfs @	12.23 hrs, Volume=	0.368 af
Outflow =	4.11 cfs @	12.24 hrs, Volume=	0.368 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.31 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.37 fps, Avg. Travel Time= 0.5 min

Peak Storage= 41 cf @ 12.24 hrs
Average Depth at Peak Storage= 0.53'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 15.20 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 72.0' Slope= 0.0150 '/'
Inlet Invert= 54.39', Outlet Invert= 53.31'



Summary for Reach P2-1: Chute-Concrete Block Open Cell

Inflow Area = 0.500 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 4.11 cfs @ 12.24 hrs, Volume= 0.368 af
Outflow = 4.11 cfs @ 12.24 hrs, Volume= 0.368 af, Atten= 0%, Lag= 0.2 min

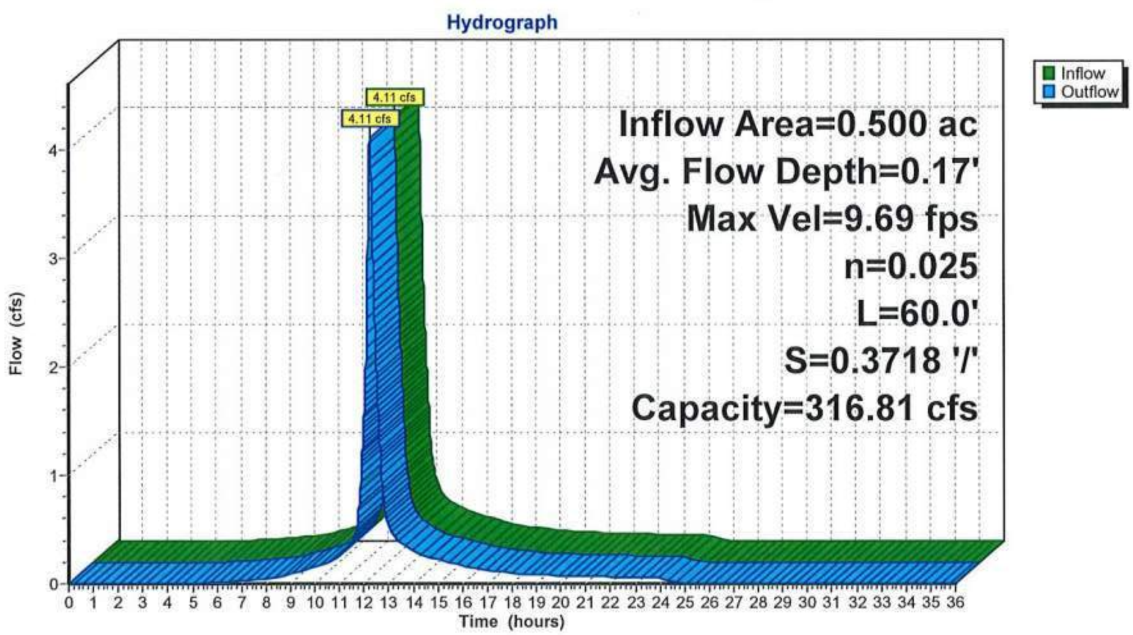
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.69 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.91 fps, Avg. Travel Time= 0.3 min

Peak Storage= 25 cf @ 12.24 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.50' Flow Area= 9.8 sf, Capacity= 316.81 cfs

2.00' x 1.50' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 60.0' Slope= 0.3718 '/'
Inlet Invert= 53.31', Outlet Invert= 31.00'

‡

Reach P2-1: Chute-Concrete Block Open Cell



Summary for Reach P3: Culvert

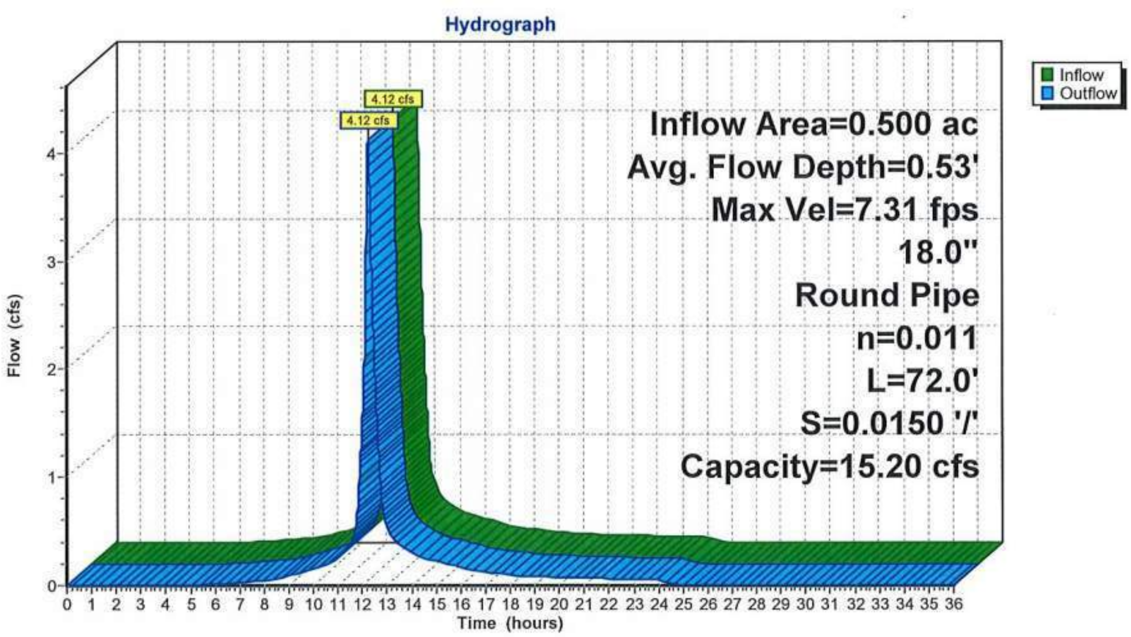
Inflow Area = 0.500 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 4.12 cfs @ 12.23 hrs, Volume= 0.368 af
Outflow = 4.12 cfs @ 12.24 hrs, Volume= 0.368 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.31 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.38 fps, Avg. Travel Time= 0.5 min

Peak Storage= 41 cf @ 12.23 hrs
Average Depth at Peak Storage= 0.53'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 15.20 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 72.0' Slope= 0.0150 '/'
Inlet Invert= 55.41', Outlet Invert= 54.33'

Reach P3: Culvert



Summary for Reach P3-1: Chute-Concrete Block Open Cell

Inflow Area =	0.500 ac,	0.00% Impervious, Inflow Depth = 8.83"	for 100-Year event
Inflow =	4.12 cfs @	12.24 hrs, Volume=	0.368 af
Outflow =	4.12 cfs @	12.24 hrs, Volume=	0.368 af, Atten= 0%, Lag= 0.2 min

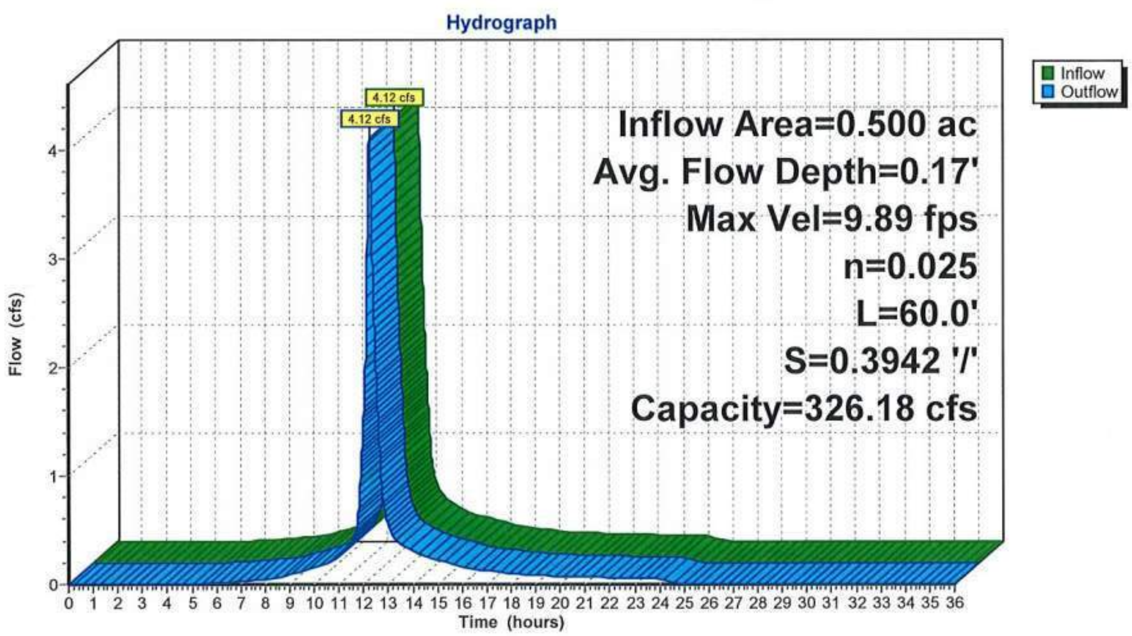
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.89 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.98 fps, Avg. Travel Time= 0.3 min

Peak Storage= 25 cf @ 12.24 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.50' Flow Area= 9.8 sf, Capacity= 326.18 cfs

2.00' x 1.50' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 60.0' Slope= 0.3942 '/'
Inlet Invert= 54.65', Outlet Invert= 31.00'

‡

Reach P3-1: Chute-Concrete Block Open Cell



Summary for Reach S: Chute-Concrete Block Open Cell

Inflow Area =	17.361 ac,	0.00% Impervious, Inflow Depth = 8.83"	for 100-Year event
Inflow =	152.24 cfs @	12.14 hrs, Volume=	12.773 af
Outflow =	151.93 cfs @	12.15 hrs, Volume=	12.773 af, Atten= 0%, Lag= 0.6 min

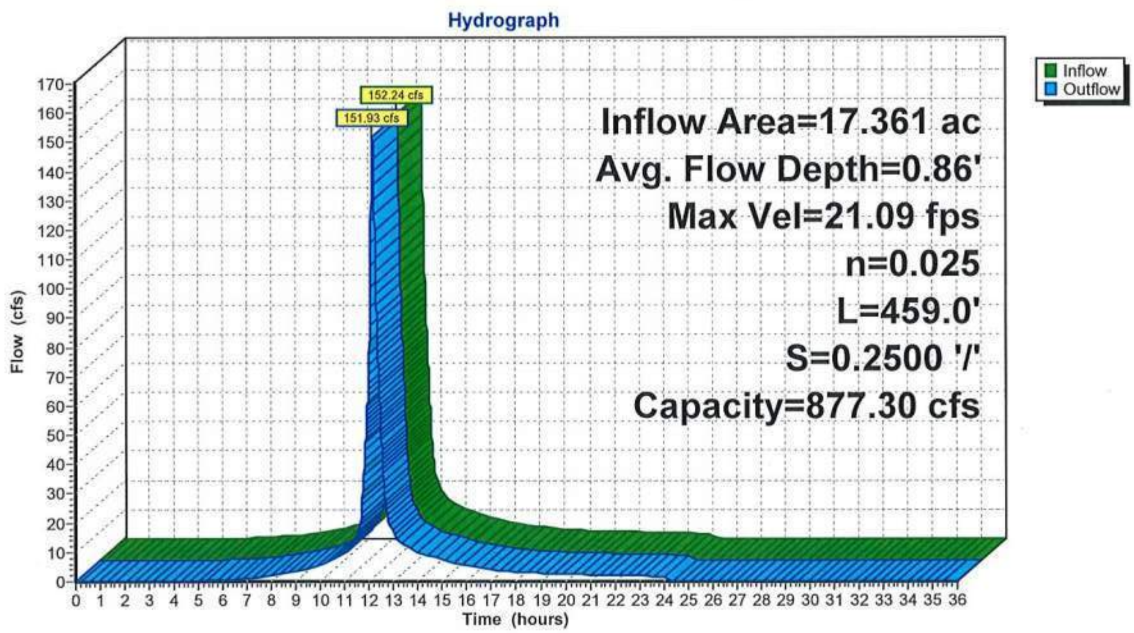
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 21.09 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.55 fps, Avg. Travel Time= 1.2 min

Peak Storage= 3,309 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.86'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 459.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 59.25'

‡

Reach S: Chute-Concrete Block Open Cell



Summary for Reach SE: Chute-Concrete Block Open Cell

Inflow Area = 18.249 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 142.28 cfs @ 12.15 hrs, Volume= 13.426 af
Outflow = 142.07 cfs @ 12.17 hrs, Volume= 13.426 af, Atten= 0%, Lag= 0.7 min

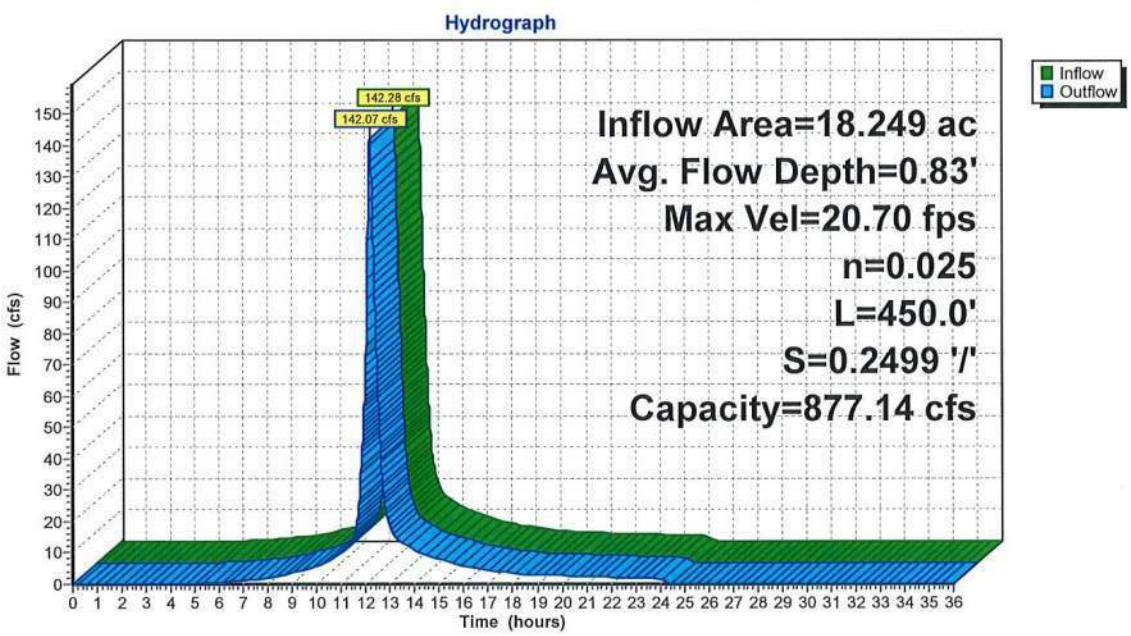
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.70 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.61 fps, Avg. Travel Time= 1.1 min

Peak Storage= 3,091 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.83'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.14 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 450.0' Slope= 0.2499 '/'
Inlet Invert= 174.00', Outlet Invert= 61.54'

‡

Reach SE: Chute-Concrete Block Open Cell



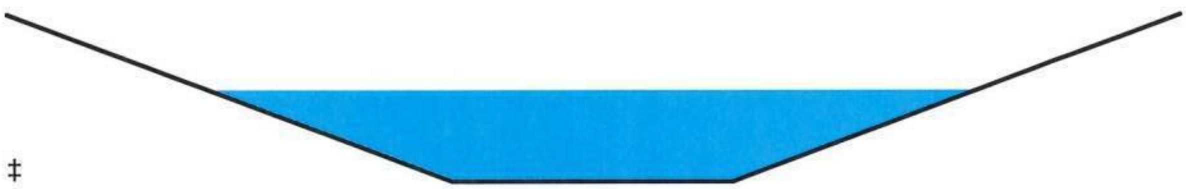
Summary for Reach SE1: Chute-Concrete Block Open Cell

Inflow Area = 18.249 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 142.07 cfs @ 12.17 hrs, Volume= 13.426 af
Outflow = 142.01 cfs @ 12.17 hrs, Volume= 13.426 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.74 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.54 fps, Avg. Travel Time= 0.2 min

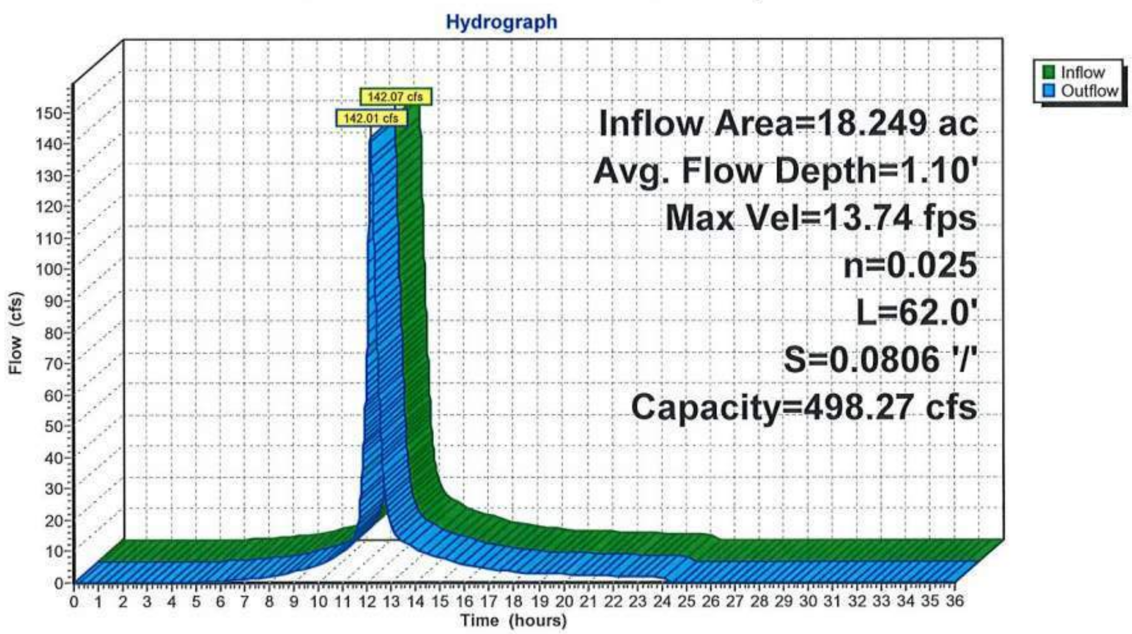
Peak Storage= 641 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.10'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 498.27 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 62.0' Slope= 0.0806 '/'
Inlet Invert= 61.54', Outlet Invert= 56.54'



‡

Reach SE1: Chute-Concrete Block Open Cell



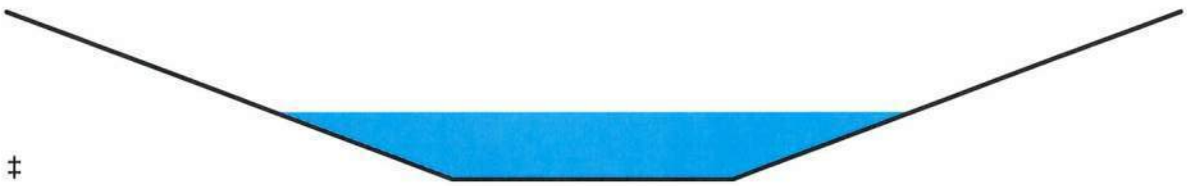
Summary for Reach SW: Chute-Concrete Block Open Cell

Inflow Area = 15.434 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 135.35 cfs @ 12.14 hrs, Volume= 11.355 af
Outflow = 135.10 cfs @ 12.14 hrs, Volume= 11.355 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.41 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 6.30 fps, Avg. Travel Time= 1.1 min

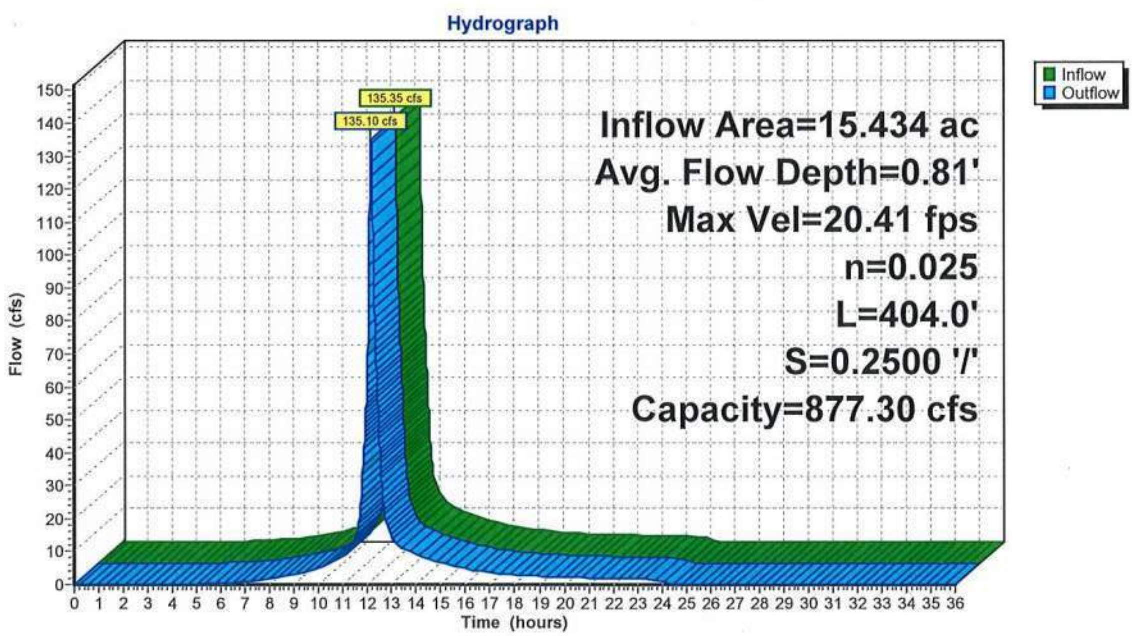
Peak Storage= 2,677 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.81'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 404.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 73.00'



‡

Reach SW: Chute-Concrete Block Open Cell



Summary for Reach SW-1: Chute-Concrete Block Open Cell

Inflow Area = 15.434 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 135.10 cfs @ 12.14 hrs, Volume= 11.355 af
Outflow = 134.87 cfs @ 12.15 hrs, Volume= 11.355 af, Atten= 0%, Lag= 0.5 min

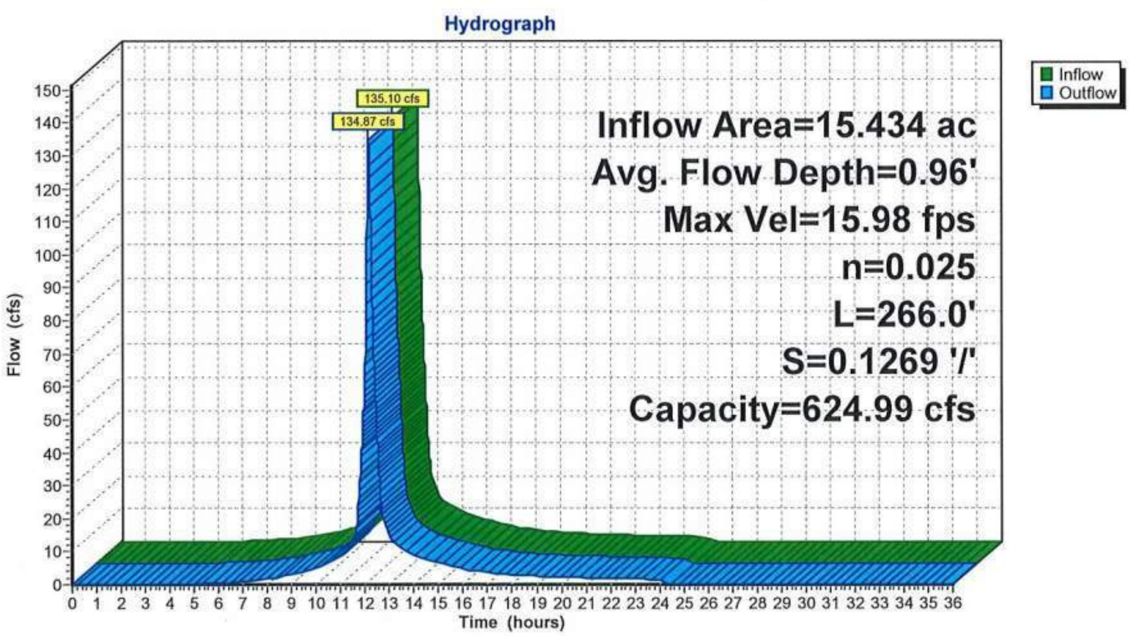
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 15.98 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 5.02 fps, Avg. Travel Time= 0.9 min

Peak Storage= 2,248 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.96'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 624.99 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 266.0' Slope= 0.1269 '/'
Inlet Invert= 70.50', Outlet Invert= 36.75'

‡

Reach SW-1: Chute-Concrete Block Open Cell



Summary for Reach W: Chute-Concrete Block Open Cell

Inflow Area =	22.383 ac,	0.00% Impervious, Inflow Depth = 8.83"	for 100-Year event	
Inflow =	179.96 cfs @	12.15 hrs, Volume=	16.468 af	
Outflow =	179.70 cfs @	12.16 hrs, Volume=	16.468 af,	Atten= 0%, Lag= 0.6 min

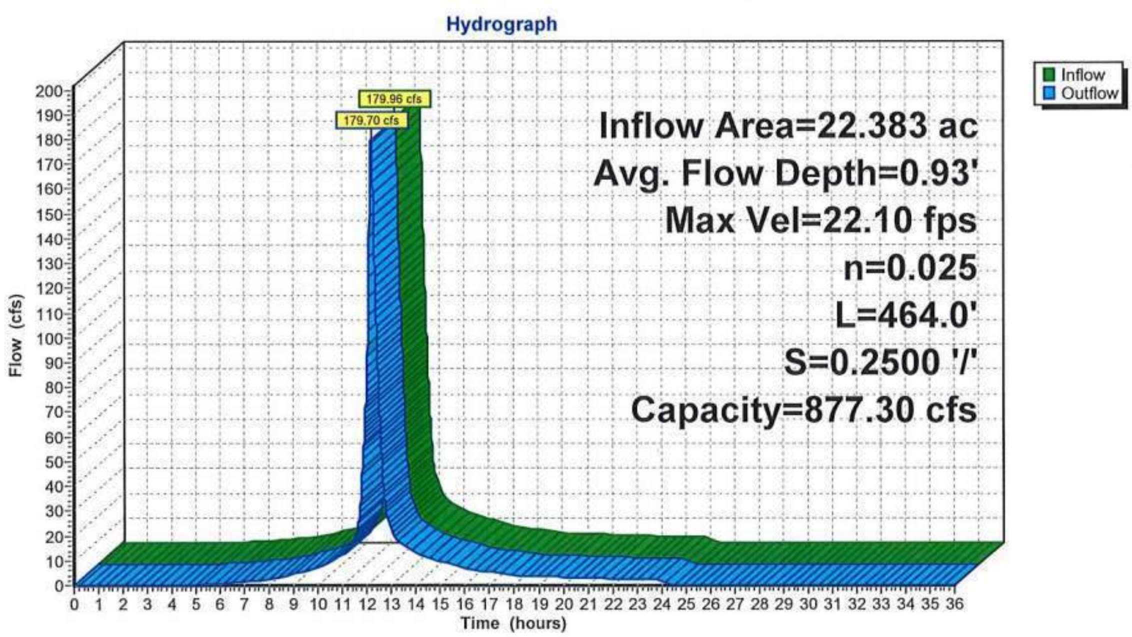
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 22.10 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 7.09 fps, Avg. Travel Time= 1.1 min

Peak Storage= 3,776 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.93'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 464.0' Slope= 0.2500 '/'
Inlet Invert= 174.00', Outlet Invert= 58.00'

‡

Reach W: Chute-Concrete Block Open Cell



Summary for Pond PA: Retention Pond A

No Discharge. Reshaping of Existing Pond A Bottom Required.

Inflow Area =	47.697 ac,	0.00% Impervious, Inflow Depth = 9.28"	for 100-Year event
Inflow =	324.39 cfs @	12.21 hrs, Volume=	36.905 af
Outflow =	0.00 cfs @	0.00 hrs, Volume=	0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 49.73' @ 36.00 hrs Surf.Area= 4.915 ac Storage= 36.905 af

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	36.75'	82.379 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
36.75	1.340	1,049.8	0.000	0.000	1.340
37.00	1.380	1,064.9	0.340	0.340	1.399
38.00	1.540	1,125.4	1.459	1.799	1.642
39.00	1.720	1,171.5	1.629	3.428	1.837
40.00	1.890	1,216.8	1.804	5.233	2.037
41.00	2.120	1,292.5	2.004	7.237	2.385
42.00	2.360	1,370.6	2.239	9.476	2.766
43.00	2.620	1,447.9	2.489	11.964	3.166
44.00	2.900	1,537.3	2.759	14.723	3.654
45.00	3.210	1,623.3	3.054	17.777	4.152
46.00	3.550	1,699.4	3.379	21.156	4.616
47.00	3.910	1,769.6	3.729	24.884	5.062
48.00	4.270	1,832.8	4.089	28.973	5.480
49.00	4.640	1,894.6	4.454	33.426	5.903
50.00	5.020	1,956.1	4.829	38.255	6.338
51.00	5.450	2,024.3	5.234	43.489	6.836
52.00	5.860	2,075.6	5.654	49.143	7.223
53.00	6.180	2,125.3	6.019	55.162	7.608
54.00	6.490	2,167.2	6.334	61.496	7.940
55.00	6.800	2,209.1	6.644	68.141	8.279
56.00	7.120	2,250.9	6.959	75.100	8.623
57.00	7.440	2,292.6	7.279	82.379	8.973

Post Development 100 Yr Drainage *Type III 24-hr 100-Year Rainfall=11.50"*
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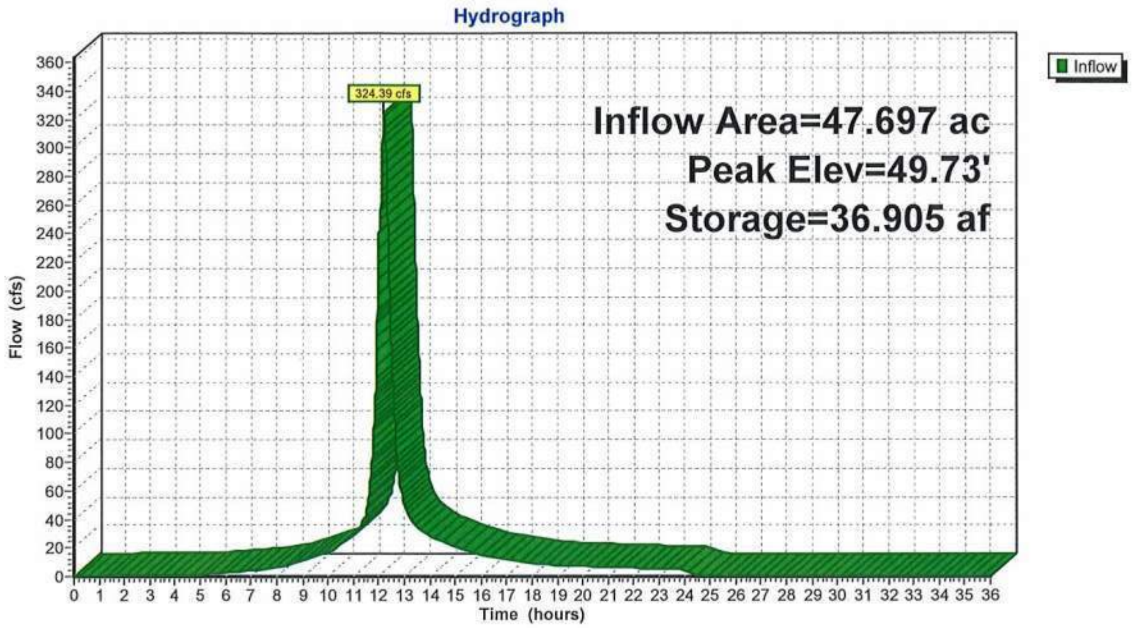
Pond PA: Retention Pond A



Post Development 100 Yr Drainage *Type III 24-hr 100-Year Rainfall=11.50"*
Prepared by Hanson Professional Services Inc. Printed 8/20/2018
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Summary for Pond PB: Detention Pond B

Inflow Area = 42.338 ac, 0.00% Impervious, Inflow Depth = 9.07" for 100-Year event
Inflow = 331.73 cfs @ 12.16 hrs, Volume= 32.018 af
Outflow = 42.26 cfs @ 12.98 hrs, Volume= 31.217 af, Atten= 87%, Lag= 49.7 min
Primary = 42.26 cfs @ 12.98 hrs, Volume= 31.217 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 52.22' @ 12.98 hrs Surf.Area= 3.914 ac Storage= 16.607 af

Plug-Flow detention time= 253.1 min calculated for 31.217 af (97% of inflow)
Center-of-Mass det. time= 237.9 min (1,027.8 - 789.9)

Volume	Invert	Avail.Storage	Storage Description
#1	47.00'	19.739 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
47.00	2.450	3,998.7	0.000	0.000	2.450
48.00	2.730	4,022.7	2.589	2.589	2.814
49.00	3.010	4,046.7	2.869	5.458	3.179
50.00	3.290	4,070.7	3.149	8.607	3.547
51.00	3.570	4,094.6	3.429	12.036	3.916
52.00	3.850	4,118.8	3.709	15.745	4.291
53.00	4.140	4,158.1	3.994	19.739	4.893

Device	Routing	Invert	Outlet Devices
#1	Primary	47.00'	**21.0" Round RCP_Round 21"** L= 128.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 47.00' / 46.75' S= 0.0020 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 2.41 sf
#2	Primary	47.00'	**21.0" Round RCP_Round 21"** L= 128.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 47.00' / 46.75' S= 0.0020 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 2.41 sf

Primary OutFlow Max=42.26 cfs @ 12.98 hrs HW=52.22' (Free Discharge)
1=RCP_Round 21" (Barrel Controls 21.13 cfs @ 8.78 fps)
2=RCP_Round 21" (Barrel Controls 21.13 cfs @ 8.78 fps)

Post Development 100 Yr Drainage *Type III 24-hr 100-Year Rainfall=11.50"*
Prepared by Hanson Professional Services Inc. Printed 8/20/2018
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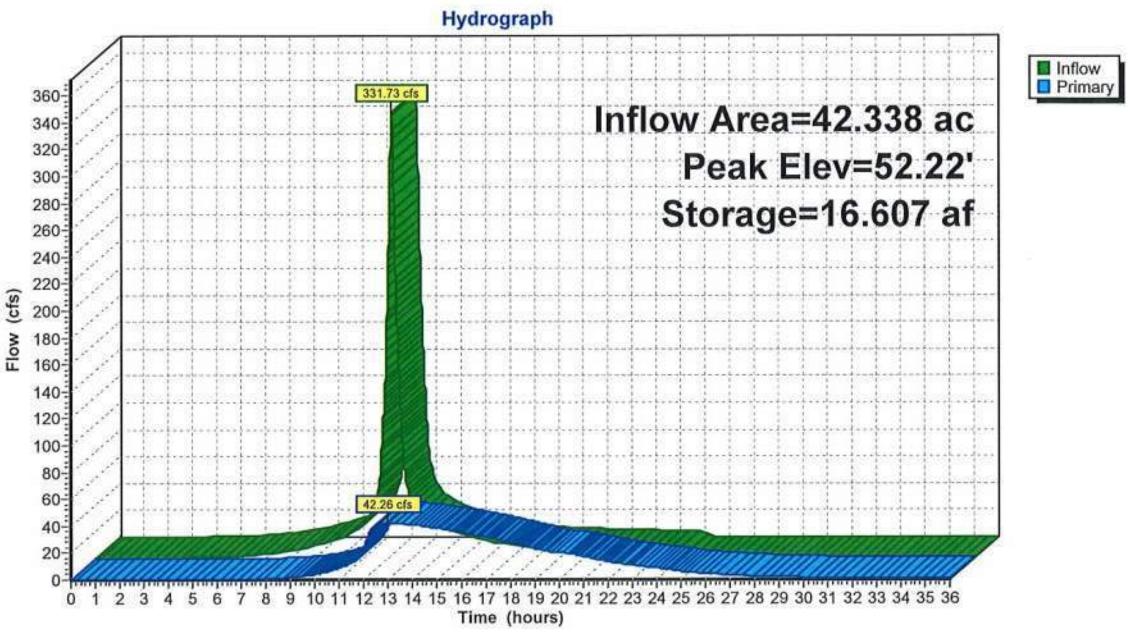
Pond PB: Detention Pond B



Summary for Pond PC: Retention Pond C

No Discharge. Constructrion of Perimeter Berm to Elevation 48 ft. Required.

Inflow Area = 61.564 ac, 0.00% Impervious, Inflow Depth = 9.05" for 100-Year event
Inflow = 446.58 cfs @ 12.22 hrs, Volume= 46.421 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

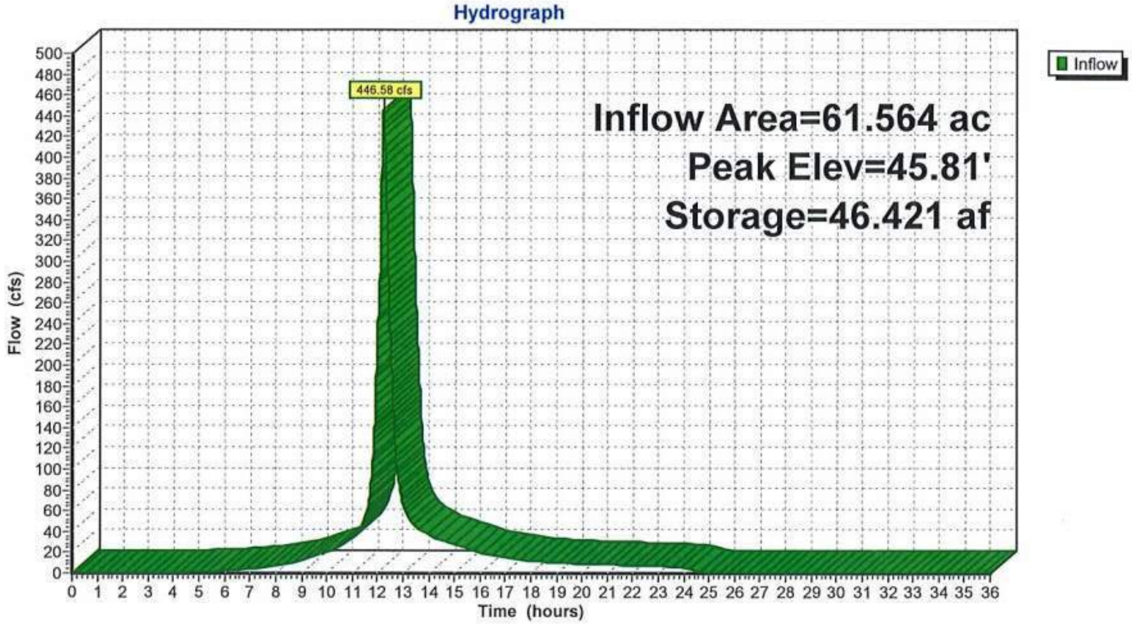
Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 45.81' @ 36.00 hrs Surf.Area= 4.259 ac Storage= 46.421 af

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	31.00'	56.115 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
31.00	2.060	2,014.1	0.000	0.000	2.060
32.00	2.200	2,032.9	2.130	2.130	2.207
33.00	2.340	2,051.7	2.270	4.399	2.354
34.00	2.480	2,070.5	2.410	6.809	2.504
35.00	2.630	2,089.2	2.555	9.364	2.654
36.00	2.770	2,108.0	2.700	12.063	2.806
37.00	2.920	2,126.8	2.845	14.908	2.959
38.00	3.060	2,145.6	2.990	17.898	3.114
39.00	3.210	2,164.4	3.135	21.032	3.270
40.00	3.360	2,183.2	3.285	24.317	3.427
41.00	3.510	2,201.9	3.435	27.752	3.585
42.00	3.660	2,220.7	3.585	31.337	3.745
43.00	3.820	2,239.5	3.740	35.076	3.907
44.00	3.970	2,258.3	3.895	38.971	4.070
45.00	4.130	2,277.1	4.050	43.021	4.234
46.00	4.290	2,295.9	4.210	47.230	4.400
47.00	4.440	2,314.6	4.365	51.595	4.566
48.00	4.600	2,333.4	4.520	56.115	4.734

Pond PC: Retention Pond C



APPENDIX 6B.6

HYDROCAD MODEL POST DEVELOPMENT 25 YEAR POND SUMMARY

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

25 YEAR POND SUMMARY

Retention Pond A (Irregular Shape)

Elevation (ft)	Surface Area (sf)	Surface Area (acres)	Perimeter (ft)	Cum. Store (Ac-ft)
36.75	58430.13	1.34	1049.83	0.00
37	60148.48	1.38	1064.95	0.34
38	67269.32	1.54	1125.40	1.80
39	74737.41	1.72	1171.54	3.43
40	82487.17	1.89	1216.78	5.23
41	92350.92	2.12	1292.54	7.24
42	102766.37	2.36	1370.62	9.48
43	114109.20	2.62	1447.92	11.96
44	126406.25	2.90	1537.27	14.72
45	139784.84	3.21	1623.30	17.78
46	154666.98	3.55	1699.39	21.16
47	170157.85	3.91	1769.61	24.88
48	185990.18	4.27	1832.75	28.97
49	201992.64	4.64	1894.58	33.43
50	218522.96	5.02	1956.10	38.26
51	237214.05	5.45	2024.29	43.49
52	255380.19	5.86	2075.63	49.14
53	268998.35	6.18	2125.30	55.16
54	282587.03	6.49	2167.18	61.50
55	296319.75	6.80	2209.05	68.14
56	310196.38	7.12	2250.89	75.10
57	324212.86	7.44	2292.64	82.38

Summary
Pond Depth = 20.25 ft
Peak Elevation = 47.33 ft
Peak Inflow = 225.75 cfs
Peak Outflow = No Discharge
Peak Storage = 26.20 Ac-ft
Freeboard = 9.67 ft

Detention Pond B (Irregular Shape)

Elevation (ft)	Surface Area (sf)	Surface Area (acres)	Perimeter (ft)	Cum. Store (Ac-ft)
47	106908.62	2.45	3998.70	0.00
48	118939.02	2.73	4022.70	2.59
49	131040.75	3.01	4046.70	5.46
50	143213.79	3.29	4070.70	8.61
51	155458.15	3.57	4094.60	12.04
52	167773.82	3.85	4118.80	15.75
53	180160.81	4.14	4158.10	19.74

Summary
Pond Depth = 6 ft
Peak Elevation = 50.87 ft
Peak Inflow = 235.89 cfs
Peak Outflow = 33.70 cfs
Peak Storage = 11.56 Ac-ft
Culvert size = 2 X 21 in x 128 ft RCP
Culvert Slope = 0.20%
Freeboard = 2.13 ft

Retention Pond C (Irregular Shape)

Elevation (ft)	Surface Area (sf)	Surface Area (acres)	Perimeter (ft)	Cum. Store (Ac-ft)
31	89848.61	2.06	2014.10	0.00
32	95917.31	2.20	2032.90	2.13
33	102041.29	2.34	2051.70	4.40
34	108220.56	2.48	2070.50	6.81
35	114455.12	2.63	2089.20	9.36
36	120744.98	2.77	2108.00	12.06
37	127090.14	2.92	2126.80	14.91
38	133490.60	3.06	2145.60	17.90
39	139946.35	3.21	2164.40	21.03
40	146457.40	3.36	2183.20	24.32
41	153023.74	3.51	2201.90	27.75
42	159645.38	3.66	2220.70	31.34
43	166322.32	3.82	2239.50	35.08
44	173054.56	3.97	2258.30	38.97
45	179842.09	4.13	2277.10	43.02
46	186684.91	4.29	2295.90	47.23
47	193583.04	4.44	2314.60	51.60
48	200536.46	4.60	2333.40	56.12

Summary
Pond Depth = 17 ft
Peak Elevation = 42.36 ft
Peak Inflow = 313.19 cfs
Peak Outflow = No Discharge
Peak Storage = 32.68 Ac-ft
Freeboard = 5.64 ft

APPENDIX 6B.6.1

POST DEVELOPMENT DRAINAGE PLAN-25 YEAR

STATE OF TEXAS
JOSE C. GARZA
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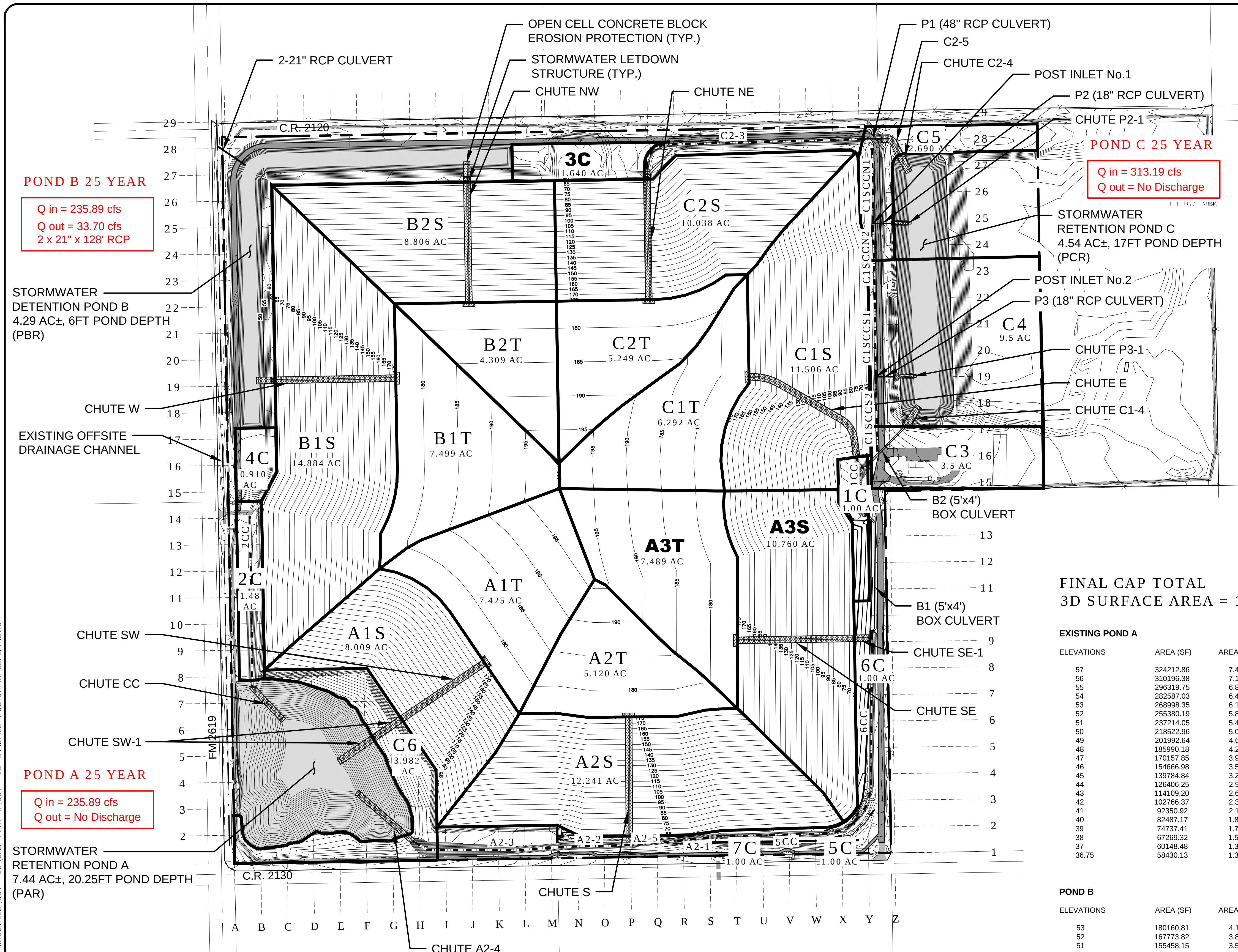
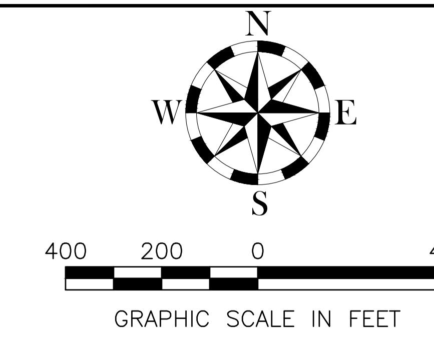
09/12/18
Jose C. Garza, P.E.





LEGEND:

- EXISTING FENCE CORNER
- EXISTING FENCE
- EXISTING CONTOUR
- EXISTING ROAD
- PERMIT BOUNDARY LIMITS
- FINAL COVER CONTOURS
- PROPOSED ROAD
- PROPOSED STORMWATER LETDOWN STRUCTURE
- PROPOSED STORMWATER PONDS
- PROPOSED STORMWATER COLLECTOR CHANNELS

FINAL CAP TOTAL
3D SURFACE AREA = 119.63 AC

EXISTING POND A

ELEVATIONS	AREA (SF)	AREA (AC)	PERIMETER
57	324212.86	7.44	2292.64
56	310196.38	7.12	2250.89
55	296319.75	6.80	2209.05
54	282587.03	6.49	2167.18
53	268998.35	6.18	2125.30
52	255380.19	5.86	2075.63
51	237214.05	5.45	2024.29
50	218522.96	5.02	1956.10
49	201992.64	4.64	1894.58
48	185990.18	4.27	1832.75
47	170157.85	3.91	1769.61
46	154666.98	3.55	1699.39
45	139784.84	3.21	1623.30
44	126406.25	2.90	1537.27
43	114109.20	2.62	1447.92
42	102766.37	2.36	1370.62
41	92350.92	2.12	1292.54
40	82487.17	1.89	1216.78
39	74737.41	1.72	1171.54
38	67269.32	1.54	1125.40
37	60148.48	1.38	1064.95
36.75	58430.13	1.34	1049.83

EXISTING POND C

ELEVATIONS	AREA (SF)	AREA (AC)	PERIMETER
48	200536.46	4.60	2333.43
47	193583.04	4.44	2314.65
46	186684.91	4.29	2295.86
45	179842.09	4.13	2277.08
44	173054.56	3.97	2258.30
43	166322.32	3.82	2239.51
42	159645.38	3.66	2220.73
41	153023.74	3.51	2201.94
40	146457.40	3.36	2183.16
39	139946.35	3.21	2164.38
38	133490.60	3.06	2145.59
37	127090.14	2.92	2126.81
36	120744.98	2.77	2108.02
35	114455.12	2.63	2089.24
34	108220.56	2.48	2070.46
33	102041.29	2.34	2051.67
32	95917.31	2.20	2032.89
31	89848.61	2.06	2014.10

POND B

ELEVATIONS	AREA (SF)	AREA (AC)	PERIMETER
53	180160.81	4.14	4158.15
52	167773.82	3.85	4118.62
51	155458.15	3.57	4094.65
50	143213.79	3.29	4070.67
49	131040.75	3.01	4046.70
48	118939.02	2.73	4022.72
47	106908.62	2.45	3998.75

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED PROFESSIONAL ENGINEER
09/12/18

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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TBAE F-BR 2458

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(800) 677-2831
www.hanson-inc.com
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PART III, ATTACHMENT 6, APPENDIX 6B.6.1
POST DEVELOPMENT DRAINAGE PLAN-25 YEAR
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.6.1

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APPENDIX 6B.7

HYDROCAD MODEL POST DEVELOPMENT 100 YEAR POND SUMMARY

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

100 YEAR POND SUMMARY

Retention Pond A (Irregular Shape)

Elevation (ft)	Surface Area (sf)	Surface Area (acres)	Perimeter (ft)	Cum. Store (Ac-ft)
36.75	58430.13	1.34	1049.83	0.00
37	60148.48	1.38	1064.95	0.34
38	67269.32	1.54	1125.40	1.80
39	74737.41	1.72	1171.54	3.43
40	82487.17	1.89	1216.78	5.23
41	92350.92	2.12	1292.54	7.24
42	102766.37	2.36	1370.62	9.48
43	114109.20	2.62	1447.92	11.96
44	126406.25	2.90	1537.27	14.72
45	139784.84	3.21	1623.30	17.78
46	154666.98	3.55	1699.39	21.16
47	170157.85	3.91	1769.61	24.88
48	185990.18	4.27	1832.75	28.97
49	201992.64	4.64	1894.58	33.43
50	218522.96	5.02	1956.10	38.26
51	237214.05	5.45	2024.29	43.49
52	255380.19	5.86	2075.63	49.14
53	268998.35	6.18	2125.30	55.16
54	282587.03	6.49	2167.18	61.50
55	296319.75	6.80	2209.05	68.14
56	310196.38	7.12	2250.89	75.10
57	324212.86	7.44	2292.64	82.38

Summary
Pond Depth = 20.25 ft
Peak Elevation = 49.73 ft
Peak Inflow = 324.39 cfs
Peak Outflow = No Discharge
Peak Storage = 36.90 Ac-ft
Freeboard = 7.27 ft

Detention Pond B (Irregular Shape)

Elevation (ft)	Surface Area (sf)	Surface Area (acres)	Perimeter (ft)	Cum. Store (Ac-ft)
47	106908.62	2.45	3998.70	0.00
48	118939.02	2.73	4022.70	2.59
49	131040.75	3.01	4046.70	5.46
50	143213.79	3.29	4070.70	8.61
51	155458.15	3.57	4094.60	12.04
52	167773.82	3.85	4118.80	15.75
53	180160.81	4.14	4158.10	19.74

Summary
Pond Depth = 6 ft
Peak Elevation = 52.22 ft
Peak Inflow = 331.73 cfs
Peak Outflow = 42.46 cfs
Peak Storage = 16.607 Ac-ft
Culvert size = 2 X 21 in x 128 ft RCP
Culvert Slope = 0.20%
Freeboard = 0.78 ft

Retention Pond C (Irregular Shape)

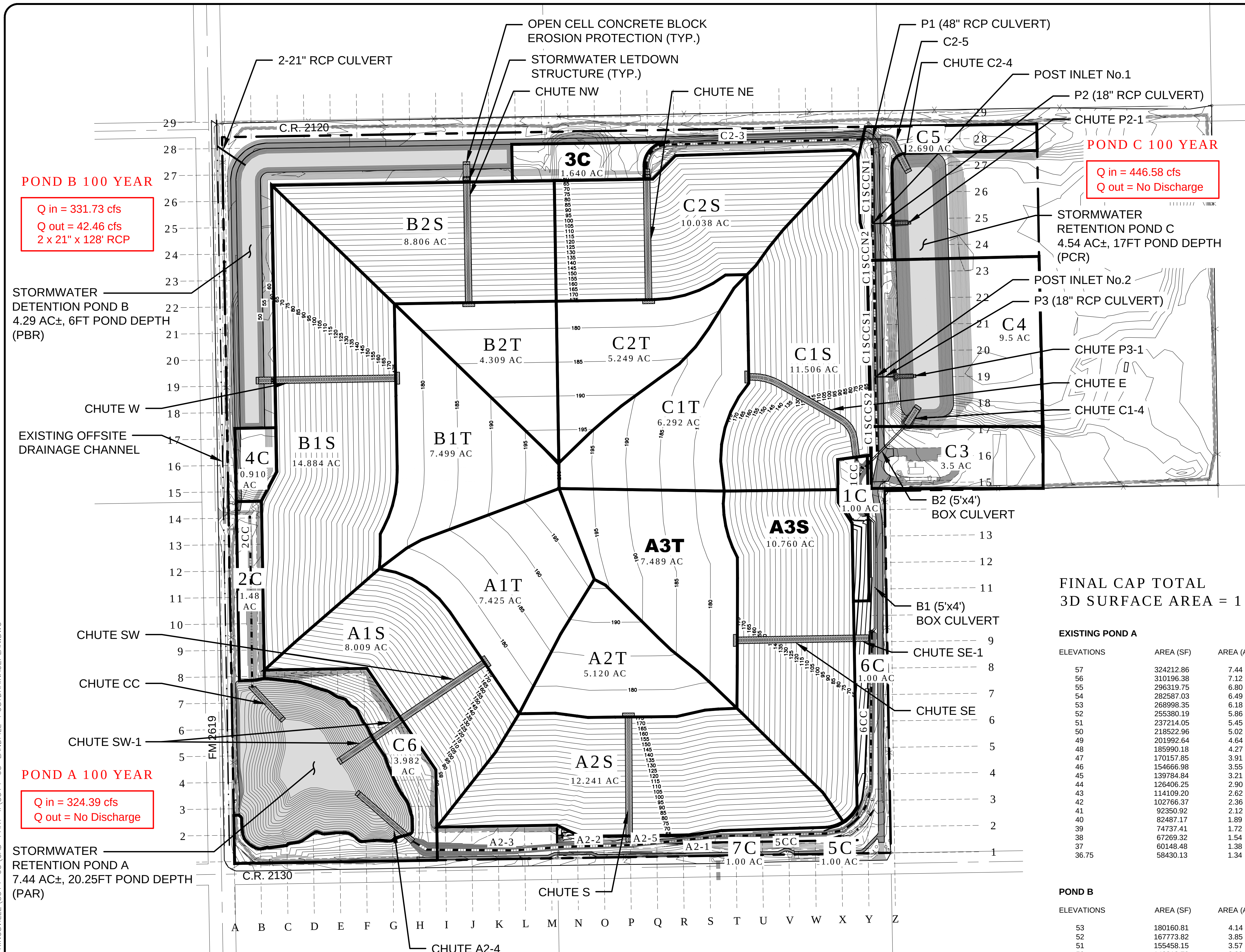
Elevation (ft)	Surface Area (sf)	Surface Area (acres)	Perimeter (ft)	Cum. Store (Ac-ft)
31	89848.61	2.06	2014.10	0.00
32	95917.31	2.20	2032.90	2.13
33	102041.29	2.34	2051.70	4.40
34	108220.56	2.48	2070.50	6.81
35	114455.12	2.63	2089.20	9.36
36	120744.98	2.77	2108.00	12.06
37	127090.14	2.92	2126.80	14.91
38	133490.60	3.06	2145.60	17.90
39	139946.35	3.21	2164.40	21.03
40	146457.40	3.36	2183.20	24.32
41	153023.74	3.51	2201.90	27.75
42	159645.38	3.66	2220.70	31.34
43	166322.32	3.82	2239.50	35.08
44	173054.56	3.97	2258.30	38.97
45	179842.09	4.13	2277.10	43.02
46	186684.91	4.29	2295.90	47.23
47	193583.04	4.44	2314.60	51.60
48	200536.46	4.60	2333.40	56.12

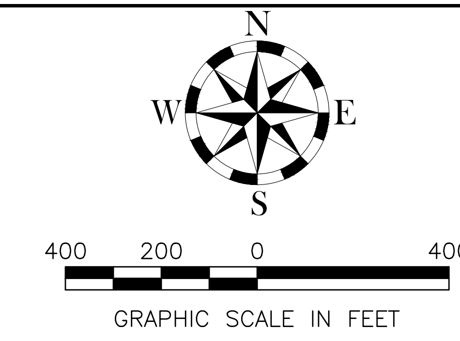
Summary
Pond Depth = 17 ft
Peak Elevation = 45.81 ft
Peak Inflow = 446.58 cfs
Peak Outflow = No Discharge
Peak Storage = 46.42 Ac-ft
Freeboard = 2.19 ft

APPENDIX 6B.7.1

POST DEVELOPMENT DRAINAGE PLAN-100 YEAR

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.





LEGEND:

- EXISTING FENCE CORNER
- EXISTING FENCE
- EXISTING CONTOUR
- EXISTING ROAD
- PERMIT BOUNDARY LIMITS
- FINAL COVER CONTOURS
- PROPOSED ROAD
- PROPOSED STORMWATER LETDOWN STRUCTURE
- PROPOSED STORMWATER PONDS
- PROPOSED STORMWATER COLLECTOR CHANNELS

FINAL CAP TOTAL
3D SURFACE AREA = 119.63 AC

EXISTING POND A

ELEVATIONS	AREA (SF)	AREA (AC)	PERIMETER
57	324212.86	7.44	2292.64
56	310196.38	7.12	2250.89
55	296319.75	6.80	2209.05
54	282587.03	6.49	2167.18
53	268998.35	6.18	2125.30
52	255380.19	5.86	2075.63
51	237214.05	5.45	2024.29
50	218522.96	5.02	1956.10
49	201992.64	4.64	1894.58
48	185990.18	4.27	1832.75
47	170157.85	3.91	1769.61
46	154666.98	3.55	1699.39
45	139784.84	3.21	1623.30
44	126406.25	2.90	1537.27
43	114109.20	2.62	1447.92
42	102766.37	2.36	1370.62
41	92350.92	2.12	1292.54
40	82487.17	1.89	1216.78
39	74737.41	1.72	1171.54
38	67269.32	1.54	1125.40
37	60148.48	1.38	1064.95
36.75	58430.13	1.34	1049.83

EXISTING POND C

ELEVATIONS	AREA (SF)	AREA (AC)	PERIMETER
48	200536.46	4.60	2333.43
47	193583.04	4.44	2314.65
46	186684.91	4.29	2295.86
45	179842.09	4.13	2277.08
44	173054.56	3.97	2258.30
43	166322.32	3.82	2239.51
42	159645.38	3.66	2220.73
41	153023.74	3.51	2201.94
40	146457.40	3.36	2183.16
39	139946.35	3.21	2164.38
38	133490.60	3.06	2145.59
37	127090.14	2.92	2126.81
36	120744.98	2.77	2108.02
35	114455.12	2.63	2089.24
34	108220.56	2.48	2070.46
33	102041.29	2.34	2051.67
32	95917.31	2.20	2032.89
31	89848.61	2.06	2014.10

POND B

ELEVATIONS	AREA (SF)	AREA (AC)	PERIMETER
53	180160.81	4.14	4158.15
52	167773.82	3.85	4118.62
51	155458.15	3.57	4094.65
50	143213.79	3.29	4070.67
49	131040.75	3.01	4046.70
48	118939.02	2.73	4022.72
47	106908.62	2.45	3998.75

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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TBPE F-417
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(800) 677-2831
www.hanson-inc.com
Offices Nationwide

PART III, ATTACHMENT 6, APPENDIX 6B.7.1
POST DEVELOPMENT DRAINAGE PLAN-100 YEAR
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.7.1

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APPENDIX 6B.8

KINGSVILLE LANDFILL PERMIT AMENDMENT 235-B

KINGSVILLE LANDFILL PERMIT AMENDMENT 235-B

PORTION OF ATTACHMENT 6 GROUNDWATER AND SURFACEWATER PROTECTION PLAN (PRE-DEVELOPMENT/POST DEVELOPMENT DRAINAGE CONDITIONS & DESIGN)

PORTION OF APPENDIX 6A-PRE-DEVELOPMENT CONDITIONS (FIGURE A-1 PRE-DEVELOPMENT DRAINAGE MAP)

PORTION OF APPENDIX 6B-FINAL DEVELOPMENT CONDITIONS (FIGURE B-1 FINAL DEVELOPMENT DRAINAGE MAP)

PORTION OF APPENDIX 6C DETENTION PONDS AND DISCHARGE CULVERTS (25-YEAR STORM STRATEGY/COMPARATIVE SUMMARY OF PEAK FLOWS)

STATE OF TEXAS
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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

APPENDIX 6B.8.1

PORTION OF ATTACHMENT 6 GROUNDWATER AND SURFACE WATER PROTECTION PLAN (PRE-DEVELOPMENT/POST DEVELOPMENT DRAINAGE CONDITIONS AND DESIGN [ANNOTATED]

STATE OF TEXAS
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09/12/18
Jose C. Garza, P.E.

Attachment 6

Groundwater and Surface Water Protection Plan

City of Kingsville Municipal Landfill Facility
Permit Amendment Application 235-B

Prepared by: Alpha Engineering

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Appendices

STATE OF TEXAS
HOMERO CASTILLO
57521
REGISTERED
PROFESSIONAL ENGINEER
5-29-98

THIS DOCUMENT IS ISSUED FOR PERMITTING PURPOSES ONLY
May 1998
Revision No. 1

are as follows. From 2.0 Pre-Development Drainage Conditions

Watershed	Drainage Area Name	25-Year Peak Flow (cfs)
A	PA1	27.3
	PA2	22.0
	PA3	13.7
B	PB1	19.0
	PB2	4.3
	PB3	5.4
C	PC1	39.6
	PC2	15.7
	PC3	3.1

3.0 POST-DEVELOPMENT DRAINAGE CONDITIONS AND DESIGN

The post-development peak discharge analysis defines the hydrologic conditions for the final landfill development. The method for calculating the 25-year peak discharge flows also follows the TR-55 worksheets and is shown in Appendix 6B. Since the composition of the final cover material and slopes are different from the pre-existing conditions, the CN values also change to reflect an increase runoff, and are shown below.

Description	CN
Unimproved, 0 – 7% slope	60
Unimproved, greater than 7% slope	70

Appendix 6B includes final development contour maps, drainage area boundaries, slope map, and each worksheet necessary to calculate the post-development peak discharges for the strategic points. Although the landfill facility changes the storm water drainage patterns from the site pre-development conditions, the surrounding natural drainage patterns will not be adversely affected. The peak discharge flows **before detention** are as follows.

Watershed	Drainage Area Name	25-Year Peak Flow (cfs)
A	FA	87.3
B	FB	68.0
C	FC	71.7

Kingsville Landfill Permit Amendment 235-B
Attachment 6

Appendix 6A
Pre-Development Conditions

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STATE OF TEXAS
HOMERO CASTILLO
57621
REGISTERED
PROFESSIONAL ENGINEER
5-27-98

May 1998
Revision 1

APPENDIX 6B.8.2

PORTION OF APPENDIX 6A-PRE-DEVELOPMENT CONDITIONS (FIGURE A-1 PRE-DEVELOPMENT DRAINAGE MAP) [ANNOTATED]

STATE OF TEXAS
JOSE C. GARZA
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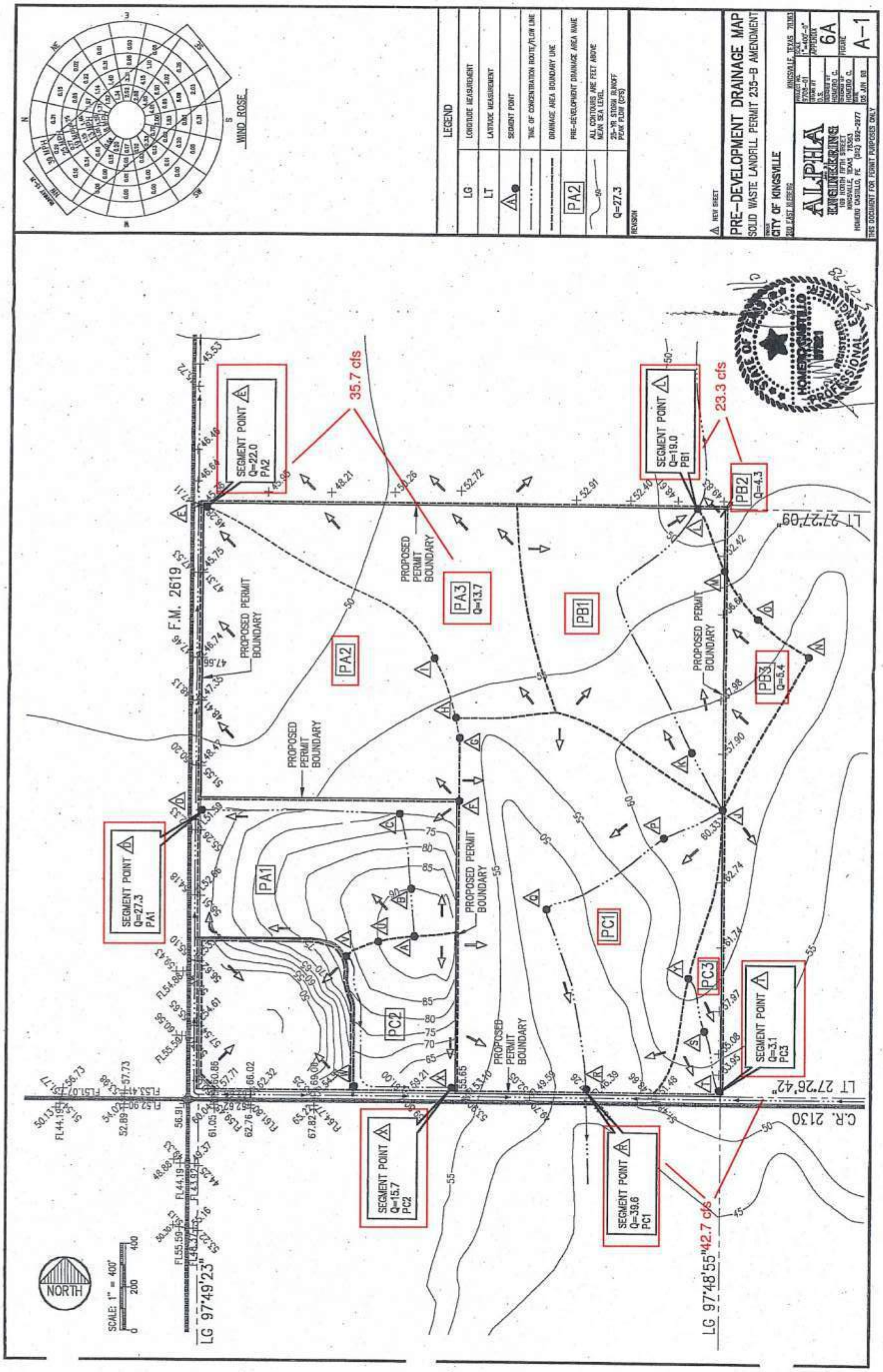
09/12/18
Jose C. Garza, P.E.


PRE-DEVELOPMENT DRAINAGE MAP
SOLID WASTE LANDFILL PERMIT 235-B AMENDMENT
CITY OF KINGSVILLE
LEGEND
WIND ROSE
35.7 cfs
23.3 cfs
42.7 cfs
SEGMENT POINT
Q=22.0
PA2
Q=19.0
PB1
Q=27.3
PA1
Q=15.7
PC2
Q=39.6
PC1
Q=3.1
PC3
PA3
Q=13.7
PB2
Q=4.3
PB3
Q=5.4
F.M. 2619
C.R. 2130
PROPOSED PERMIT BOUNDARY
LG 97°49'23"
LG 97°48'55"
LT 27°27'09"
LT 27°26'42"
NORTH
A-1

Kingsville Landfill Permit Amendment 235-B
Attachment 6

Appendix 6B
Final Development Conditions

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STATE OF TEXAS
HOMERO CASTILLO
57521
REGISTERED
PROFESSIONAL ENGINEER
5-29-98

May 1998
Revision 1

APPENDIX 6B.8.3

PORTION OF APPENDIX 6B-FINAL DEVELOPMENT CONDITIONS (FIGURE B-1 FINAL DEVELOPMENT DRAINAGE MAP) [ANNOTATED]

STATE OF TEXAS
JOSE C. GARZA
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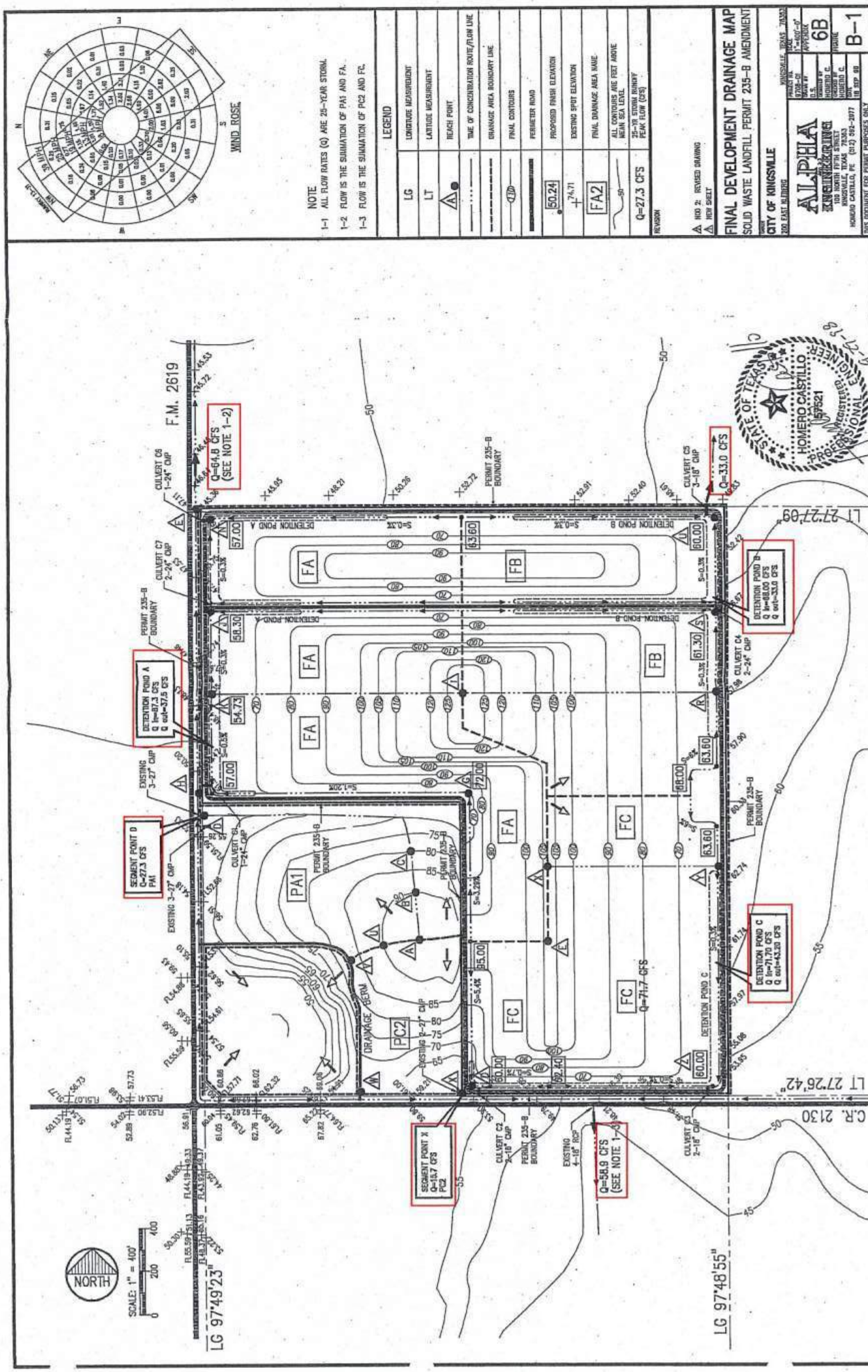
LICENSED PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.


FINAL DEVELOPMENT DRAINAGE MAP
SOLID WASTE LANDFILL PERMIT 235-B AMENDMENT
CITY OF KINGSVILLE
WIND ROSE
LEGEND
F.M. 2619
C.R. 2130
LG 97°49'23"
LG 97°48'55"
LT 27°27'09"
LT 27°26'42"
NORTH
SCALE: 1" = 400'
6B
B-1

APPENDIX 6B.8.4

PORTION OF APPENDIX 6C DETENTION PONDS AND DISCHARGE CULVERTS (25-YEAR STORM STRATEGY/COMPARATIVE SUMMARY OF PEAK FLOWS) [ANNOTATED]

STATE OF TEXAS
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Appendix 6C
Detention Ponds and Discharge Culverts

TABLE OF CONTENTS

STATE OF TEXAS
HOMERO CASTILLO
57521
REGISTERED
PROFESSIONAL ENGINEER
5-29-98

May 1998
Revision 1

25-Year Stormwater Detention Strategy

Watershed A

Pre-Development Conditions

Area No.	Peak Flow (cfs)
PA2	22.0
PA3	13.7
Total	**35.7**

Final Development Conditions (before detention)

Area No.	Peak Flow (cfs)
FA	87.3
Total	87.3

Maximum Final Development discharge for Watershed A shall not exceed 35.7 cfs

Watershed B

Pre-Development Conditions

Area No.	Peak Flow (cfs)
PB1	19.0
PB2	4.3
Total	**23.3**

Final Development Conditions (before detention)

Area No.	Peak Flow (cfs)
FB	68.0
Total	68.0

Maximum Final Development discharge for Watershed B shall not exceed 23.3 cfs

Watershed C

Pre-Development Conditions

Area No.	Peak Flow (cfs)
PC1	39.6
PC3	3.1
Total	**42.7**

Final Development Conditions (before detention)

Area No.	Peak Flow (cfs)
FC	71.7
Total	71.7

Maximum Final Development discharge for Watershed ~~B~~ C shall not exceed 42.7 cfs

Comparative Summary of Peak Flows

	Pre-Development 25-Year Peak Flow	Final Development 25-Year Peak Flow (after detention)
Watershed A	35.7 cfs	37.5 cfs
Watershed B	23.3 cfs	33.0 cfs
Watershed C	42.7 cfs	43.2 cfs

APPENDIX 6B.9

PERIMETER CHANNELS, COLLECTOR CHANNELS, AND CHUTES-25 YEAR SUMMARY TABLE

STATE OF TEXAS
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09/12/18
Jose C. Garza, P.E.

25 Year Perimeter Channels, Collector Channels, & Chutes Summary Table

Channel ID	Length (FT)	Begining			Ending				Trapezoidal, Triangular, Box, & Pipe Channels														
		Existing NG Elev	Depth (FT)	FL	Existing NG Elev	Slope (FT/FT)	FL	Depth (FT)	Base Width (Ft)	Avg Channel Depth (FT)	**Avg Channel Flow Depth (FT)	***Hydraulic Grade Elev	Freeboard (FT)	Bottom Slope (FT/FT)	Side Slope	Top Width (FT)	Manning n	Wetted Permeter (FT)	Area (SF)	Hydraulic Radius	Velocity (FPS)	Qp (CFS)
EAST																						
6CC	740.00	61.71	2.21	59.50	62.36	0.0040	56.54	5.82	2.00	4.02	0.77	60.27	1.4	0.0040	2.00	10.84	0.030	5.44	2.73	0.50	1.98	5.40
B1	464.00	62.36	4.00	56.54	65.59	0.0057	53.89	4.00	5.00	4.00	2.17	58.71	1.8	0.0057	0.00	5.00	0.013	9.34	10.85	1.16	9.57	103.85
1CC	222.00	65.59	11.70	53.89	61.74	0.0020	53.45	8.29	3.00	10.00	4.52	58.41	7.2	0.0020	2.00	49.80	0.030	23.21	54.42	2.34	3.90	212.35
B2	200.00	61.74	4.00	53.45	59.30	0.0183	49.80	4.00	5.00	4.00	2.44	55.85	1.6	0.0183	0.00	5.00	0.013	9.88	12.20	1.23	17.82	217.42
SOUTH																						
5CC	595.00	61.64	3.14	58.50	61.01	0.0015	57.61	3.40	2.00	3.27	0.97	59.47	2.2	0.0015	2.00	14.56	0.030	6.34	3.82	0.60	1.37	5.24
A2-1	250.50	61.01	3.40	57.61	60.16	0.0015	57.23	2.93	2.00	3.17	1.24	58.85	2.2	0.0015	2.00	15.60	0.030	7.55	5.56	0.74	1.58	8.76
A2-5	5.60	60.16	2.93	57.23	60.18	0.2482	55.84	4.34	2.00	3.64	0.30	57.53	2.6	0.2482	2.00	13.72	0.025	3.34	0.78	0.23	11.26	8.78
A2-2	257.00	60.18	4.34	55.84	60.98	0.0020	55.33	5.65	7.00	5.00	2.54	58.37	1.8	0.0020	2.00	24.36	0.025	18.36	30.68	1.67	3.74	114.73
A2-3	582.00	60.98	5.65	55.33	60.40	0.0020	54.17	6.23	8.00	5.94	2.58	57.90	3.1	0.0020	2.00	30.60	0.030	19.54	33.95	1.74	3.20	108.82
NORTH																						
C2-3	882.00	57.50	4.00	53.50	57.50	0.0020	51.75	5.75	4.00	4.88	2.82	56.32	1.2	0.0020	2.00	20.00	0.030	16.61	27.18	1.64	3.07	83.52
P1	64.00	57.50	4.00	51.75	57.50	0.0100	51.11	4.00	4.00	4.00	1.97	53.72	2.0	0.0100	NA	4.00	0.011	6.22	6.16	0.99	13.46	82.95
C2-5	106.00	53.61	2.50	51.11	50.50	0.0293	48.00	2.50	5.00	2.50	1.08	52.19	1.4	0.0293	4.00	25.00	0.025	13.91	10.07	0.72	8.23	82.84
C1SCCN1	285.00	60.00	1.50	58.50	60.00	0.0033	57.55	2.45	3.00	1.98	0.33	58.83	1.2	0.0033	2.00	9.00	0.030	4.48	1.21	0.27	1.20	1.45
C1SCCN2	287.50	60.00	1.50	58.50	60.00	0.0033	57.55	2.45	3.00	1.98	0.33	58.83	1.2	0.0033	2.00	9.00	0.030	4.48	1.21	0.27	1.19	1.44
P2	72.00	60.00	1.50	54.39	60.00	0.0150	53.31	1.50	1.50	1.50	0.44	54.83	1.1	0.0150	NA	1.50	0.011	1.72	0.43	0.25	6.61	2.86
C1SCCS1	280.00	60.00	1.50	58.50	60.00	0.0033	57.58	2.42	3.00	1.96	0.33	58.83	1.2	0.0033	2.00	9.00	0.030	4.48	1.21	0.27	1.19	1.44
C1SCCS2	280.00	60.00	1.50	58.50	60.00	0.0033	57.58	2.42	3.00	1.96	0.33	58.83	1.2	0.0033	2.00	9.00	0.030	4.48	1.21	0.27	1.19	1.44
P3	72.00	60.00	1.50	55.41	60.00	0.0150	54.33	1.50	1.50	1.50	0.44	55.85	1.1	0.0150	NA	1.50	0.011	1.72	0.43	0.25	6.61	2.86
WEST																						
2CC	650.00	57.70	3.20	54.50	59.94	0.0020	53.20	6.74	0.00	4.97	1.28	55.78	1.9	0.0020	3.00	19.20	0.030	8.10	4.92	0.61	1.59	7.83

*Chute ID	Length (FT)	Begining			Ending				Trapezoidal Channel													
		Existing Elev	Depth (FT)	FL	Existing Elev	Slope (FT/FT)	FL	Depth (FT)	Base Width (FT)	Avg Channel Depth	**Avg Channel Flow Depth (FT)	***Hydraulic Grade Elev	Freeboard (FT)	Bottom Slope (FT/FT)	Side Slope	Top Width (FT)	Manning n	Wetted Permeter (FT)	Area (SF)	Hydraulic Radius	Velocity (FPS)	Qp (CFS)
SE	450.00	176.00	2.00	174.00	63.54	0.2500	61.54	2.00	5.00	2.00	0.69	174.69	1.3	0.2500	4.00	21.00	0.025	10.69	5.35	0.50	18.79	100.64
SE1	62.00	63.54	2.00	61.54	58.54	0.0806	56.54	2.00	5.00	2.00	0.92	62.46	1.1	0.0806	4.00	21.00	0.025	12.59	7.99	0.63	12.49	99.77
S	451.00	176.00	2.00	174.00	61.25	0.2500	61.25	0.00	5.00	1.00	0.72	174.72	1.3	0.2500	4.00	21.00	0.025	10.94	5.67	0.52	19.24	109.15
SW	404.00	176.00	2.00	174.00	77.00	0.2500	73.00	4.00	5.00	3.00	0.67	174.67	1.3	0.2500	4.00	21.00	0.025	10.52	5.15	0.49	18.49	95.16
W	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.78	174.78	1.2	0.2500	4.00	21.00	0.025	11.43	6.33	0.55	20.10	127.32
NW	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.60	174.60	1.4	0.2500	4.00	21.00	0.025	9.95	4.44	0.45	17.40	77.27
NE	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.66	174.66	1.3	0.2500	4.00	21.00	0.025	10.44	5.04	0.48	18.34	92.49
E	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.71	174.71	1.3	0.2500	4.00	21.00	0.025	10.85	5.57	0.51	19.09	106.27
C1-4	76.00	51.80	2.00	49.80	33.00	0.2474	31.00	2.00	5.00	2.50	1.01	50.81	1.0	0.2474	4.00	21.00	0.025	13.33	9.13	0.69	23.04	210.33
C2-4	52.00	50.00	2.00	48.00	33.00	0.3269	31.00	2.00	5.00	2.00	0.58	48.58	1.4	0.3269	4.00	21.00	0.025	9.78	4.25	0.43	19.53	82.93
P2-1	60.00	56.15	1.50	53.31	32.50	0.3718	31.00	1.50	2.00	1.50	0.14	53.45	1.4	0.3718	3.00	11.00	0.025	2.89	0.34	0.12	8.71	2.95
P3-1	60.00	56.15	1.50	54.65	32.50	0.3942	31.00	1.50	2.00	1.50	0.14	54.79	1.4	0.3942	3.00	11.00	0.025	2.89	0.34	0.12	8.97	3.04
A2-4	250.00	56.17	2.00	54.17	38.75	0.0697	36.75	2.00	10.00	2.00	0.75	54.92	1.3	0.0697	4.00	26.00	0.025	16.18	9.75	0.60	11.22	109.41
SW-1	266.00	72.50	2.00	70.50	38.75	0.1269	36.75	2.00	5.00	2.00	0.80	71.30	1.2	0.1269	4.00	21.00	0.025	11.60	6.56	0.57	14.52	95.26
CC	160.00	55.20	2.00	53.20	38.75	0.1028	36.75	2.00	5.00	2.00	0.21	53.41	1.8	0.1028	4.00	21.00	0.025	6.73	1.23	0.18	6.14	7.53

*Chutes-Precast Interlocking Articulating Concrete Blocks
** Avg Channel Flow Depth Determined by HydroCAD
*** Hydraulic Grade Elevation Determined by HydroCAD

PerimeterChannel JCG Post 25 Yr 08.20.18.xlsx

APPENDIX 6B.10

PERIMETER CHANNELS, COLLECTOR CHANNELS, AND CHUTES-100 YEAR SUMMARY TABLE

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100 Year Perimeter Channels, Collector Channels, & Chutes Summary Table

Channel ID	Length (FT)	Begining			Ending				Trapezoidal, Triangular, Box, & Pipe Channels															
		Existing NG Elev	Depth (FT)	FL	Existing NG Elev	Slope (FT/FT)	FL	Depth (FT)	Base Width (Ft)	Avg Channel Depth (FT)	**Avg Channel Flow Depth (FT)	***Hydraulic Grade Elev	Freeboard (FT)	Bottom Slope (FT/FT)	Side Slope	Top Width (FT)	Manning n	Wetted Permeter (FT)	Area (SF)	Hydraulic Radius	Velocity (FPS)	Qp (CFS)
EAST																						
6CC	740.00	61.71	2.21	59.50	62.36	0.0040	56.54	5.82	2.00	4.02	0.92	60.42	1.3	0.0040	2.00	10.84	0.030	6.11	3.53	0.58	2.18	7.70
B1	464.00	62.36	4.00	56.54	65.59	0.0057	53.89	4.00	5.00	4.00	2.81	59.35	1.2	0.0057	0.00	5.00	0.013	10.62	14.05	1.32	10.44	146.66
1CC	222.00	65.59	11.70	53.89	61.74	0.0020	53.45	8.29	3.00	10.00	5.24	59.13	6.5	0.0020	2.00	49.80	0.030	26.43	70.64	2.67	4.26	300.75
B2	200.00	61.74	4.00	53.45	59.30	0.0183	49.80	4.00	5.00	4.00	3.12	56.57	0.9	0.0183	0.00	5.00	0.013	11.24	15.60	1.39	19.27	300.54
SOUTH																						
5CC	595.00	61.64	3.14	58.50	61.01	0.0015	57.61	3.40	2.00	3.27	1.15	59.65	2.0	0.0015	2.00	14.56	0.030	7.14	4.95	0.69	1.50	7.43
A2-1	250.50	61.01	3.40	57.61	60.16	0.0015	57.23	2.93	2.00	3.17	1.48	59.09	1.9	0.0015	2.00	15.60	0.030	8.62	7.34	0.85	1.74	12.76
A2-5	5.60	60.16	2.93	57.23	60.18	0.2482	55.84	4.34	2.00	3.64	0.37	57.60	2.6	0.2482	2.00	13.72	0.025	3.65	1.01	0.28	12.63	12.80
A2-2	257.00	60.18	4.34	55.84	60.98	0.0020	55.33	5.65	7.00	5.00	3.02	58.86	1.3	0.0020	2.00	24.36	0.025	20.51	39.38	1.92	4.10	161.54
A2-3	582.00	60.98	5.65	55.33	60.40	0.0020	54.17	6.23	8.00	5.94	3.09	58.42	2.6	0.0020	2.00	30.60	0.030	21.82	43.82	2.01	3.53	154.64
NORTH																						
C2-3	882.00	57.50	4.00	53.50	57.50	0.0020	51.75	5.75	4.00	4.88	3.32	56.82	0.7	0.0020	2.00	20.00	0.030	18.85	35.32	1.87	3.36	118.80
P1	64.00	57.50	4.00	51.75	57.50	0.0100	51.11	4.00	4.00	4.00	2.46	54.21	1.5	0.0100	NA	4.00	0.011	7.21	8.11	1.12	14.64	118.72
C2-5	106.00	53.61	2.50	51.11	50.50	0.0293	48.00	2.50	5.00	2.50	1.29	52.40	1.2	0.0293	4.00	25.00	0.025	15.64	13.11	0.84	9.08	118.94
C1SCCN1	285.00	60.00	1.50	58.50	60.00	0.0033	57.55	2.45	3.00	1.98	0.40	58.90	1.1	0.0033	2.00	9.00	0.030	4.79	1.52	0.32	1.33	2.03
C1SCCN2	287.50	60.00	1.50	58.50	60.00	0.0033	57.55	2.45	3.00	1.98	0.40	58.90	1.1	0.0033	2.00	9.00	0.030	4.79	1.52	0.32	1.33	2.02
P2	72.00	60.00	1.50	54.39	60.00	0.0150	53.31	1.50	1.50	1.50	0.53	54.92	1.0	0.0150	NA	1.50	0.011	1.91	0.56	0.29	7.31	4.08
C1SCCS1	280.00	60.00	1.50	58.50	60.00	0.0033	57.58	2.42	3.00	1.96	0.41	58.91	1.1	0.0033	2.00	9.00	0.030	4.83	1.57	0.32	1.34	2.10
C1SCCS2	280.00	60.00	1.50	58.50	60.00	0.0033	57.58	2.42	3.00	1.96	0.41	58.91	1.1	0.0033	2.00	9.00	0.030	4.83	1.57	0.32	1.34	2.10
P3	72.00	60.00	1.50	55.41	60.00	0.0150	54.33	1.50	1.50	1.50	0.53	55.94	1.0	0.0150	NA	1.50	0.011	1.91	0.56	0.29	7.31	4.08
WEST																						
2CC	650.00	57.70	3.20	54.50	59.94	0.0020	53.20	6.74	0.00	4.97	1.46	55.96	1.7	0.0020	3.00	19.20	0.030	9.23	6.39	0.69	1.74	11.12

*Chute ID	Length (FT)	Begining			Ending				Trapezoidal Channel													
		Existing Elev	Depth (FT)	FL	Existing Elev	Slope (FT/FT)	FL	Depth (FT)	Base Width (FT)	Avg Channel Depth	**Avg Channel Flow Depth (FT)	***Hydraulic Grade Elev	Freeboard (FT)	Bottom Slope (FT/FT)	Side Slope	Top Width (FT)	Manning n	Wetted Permeter (FT)	Area (SF)	Hydraulic Radius	Velocity (FPS)	Qp (CFS)
SE	450.00	176.00	2.00	174.00	63.54	0.2500	61.54	2.00	5.00	2.00	0.83	174.83	1.2	0.2500	4.00	21.00	0.025	11.84	6.91	0.58	20.80	143.62
SE1	62.00	63.54	2.00	61.54	58.54	0.0806	56.54	2.00	5.00	2.00	1.10	62.64	0.9	0.0806	4.00	21.00	0.025	14.07	10.34	0.73	13.78	142.47
S	451.00	176.00	2.00	174.00	61.25	0.2500	61.25	0.00	5.00	1.00	0.86	174.86	1.1	0.2500	4.00	21.00	0.025	12.09	7.26	0.60	21.21	153.92
SW	404.00	176.00	2.00	174.00	77.00	0.2500	73.00	4.00	5.00	3.00	0.81	174.81	1.2	0.2500	4.00	21.00	0.025	11.68	6.67	0.57	20.52	136.97
W	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.93	174.93	1.1	0.2500	4.00	21.00	0.025	12.67	8.11	0.64	22.13	179.50
NW	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.72	174.72	1.3	0.2500	4.00	21.00	0.025	10.94	5.67	0.52	19.24	109.15
NE	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.79	174.79	1.2	0.2500	4.00	21.00	0.025	11.51	6.45	0.56	20.24	130.49
E	456.00	176.00	2.00	174.00	60.00	0.2500	60.00	0.00	5.00	1.00	0.85	174.85	1.2	0.2500	4.00	21.00	0.025	12.01	7.14	0.59	21.07	150.44
C1-4	76.00	51.80	2.00	49.80	33.00	0.2474	31.00	2.00	5.00	2.50	1.21	51.01	0.8	0.2474	4.00	21.00	0.025	14.98	11.91	0.79	25.44	302.89
C2-4	52.00	50.00	2.00	48.00	33.00	0.3269	31.00	2.00	5.00	2.00	0.70	48.70	1.3	0.3269	4.00	21.00	0.025	10.77	5.46	0.51	21.66	118.28
P2-1	60.00	56.15	1.50	53.31	32.50	0.3718	31.00	1.50	2.00	1.50	0.17	53.48	1.3	0.3718	3.00	11.00	0.025	3.08	0.43	0.14	9.74	4.16
P3-1	60.00	56.15	1.50	54.65	32.50	0.3942	31.00	1.50	2.00	1.50	0.17	54.82	1.3	0.3942	3.00	11.00	0.025	3.08	0.43	0.14	10.03	4.28
A2-4	250.00	56.17	2.00	54.17	38.75	0.0697	36.75	2.00	10.00	2.00	0.91	55.08	1.1	0.0697	4.00	26.00	0.025	17.50	12.41	0.71	12.51	155.29
SW-1	266.00	72.50	2.00	70.50	38.75	0.1269	36.75	2.00	5.00	2.00	0.96	71.46	1.0	0.1269	4.00	21.00	0.025	12.92	8.49	0.66	16.05	136.17
CC	160.00	55.20	2.00	53.20	38.75	0.1028	36.75	2.00	5.00	2.00	0.26	54.46	1.7	0.1028	4.00	21.00	0.025	7.14	1.57	0.22	6.96	10.93

***Chutes-Precast Interlocking Articulating Concrete Blocks**
**** Avg Channel Flow Depth Determined by HydroCAD**
***** Hydraulic Grade Elevation Determined by HydroCAD**

PerimeterChannel JCG Post 100 Yr 08.20.18.xlsx

APPENDIX 6B.11

FIGURE 1 OVERALL SOUTHERN DRAINAGE PLAN

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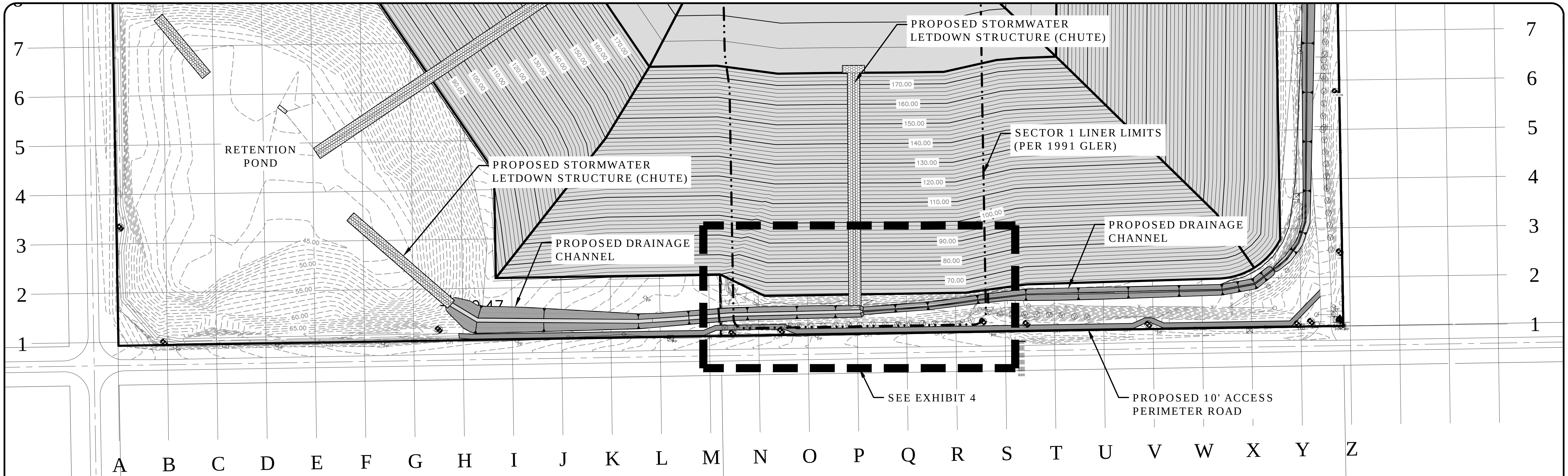
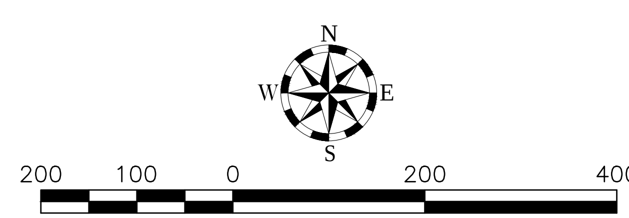


LEGEND:

EXISTING POWER POLE
EXISTING LANDFILL GAS VENT
EXISTING GROUND WATER MONITOR WELL
EXISTING FENCE
EXISTING CONTOUR
EXISTING PERMIT BOUNDARY LIMITS
PROPOSED FINAL COVER CONTOURS
PROPOSED STORMWATER LETDOWN STRUCTURE (CHUTE)
TOP OF SLOPE
TOE OF SLOPE



GRAPHIC SCALE IN FEET

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LICENSED PROFESSIONAL ENGINEER
09/12/18

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III, ATTACHMENT 6, APPENDIX 6B.11
OVERALL SOUTHERN DRAINAGE PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.11

SEP 11, 2018 2:21 PM TORRE01809
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APPENDIX 6B.11.1

FIGURE 2 ENLARGED SOUTHERN DRAINAGE PLAN

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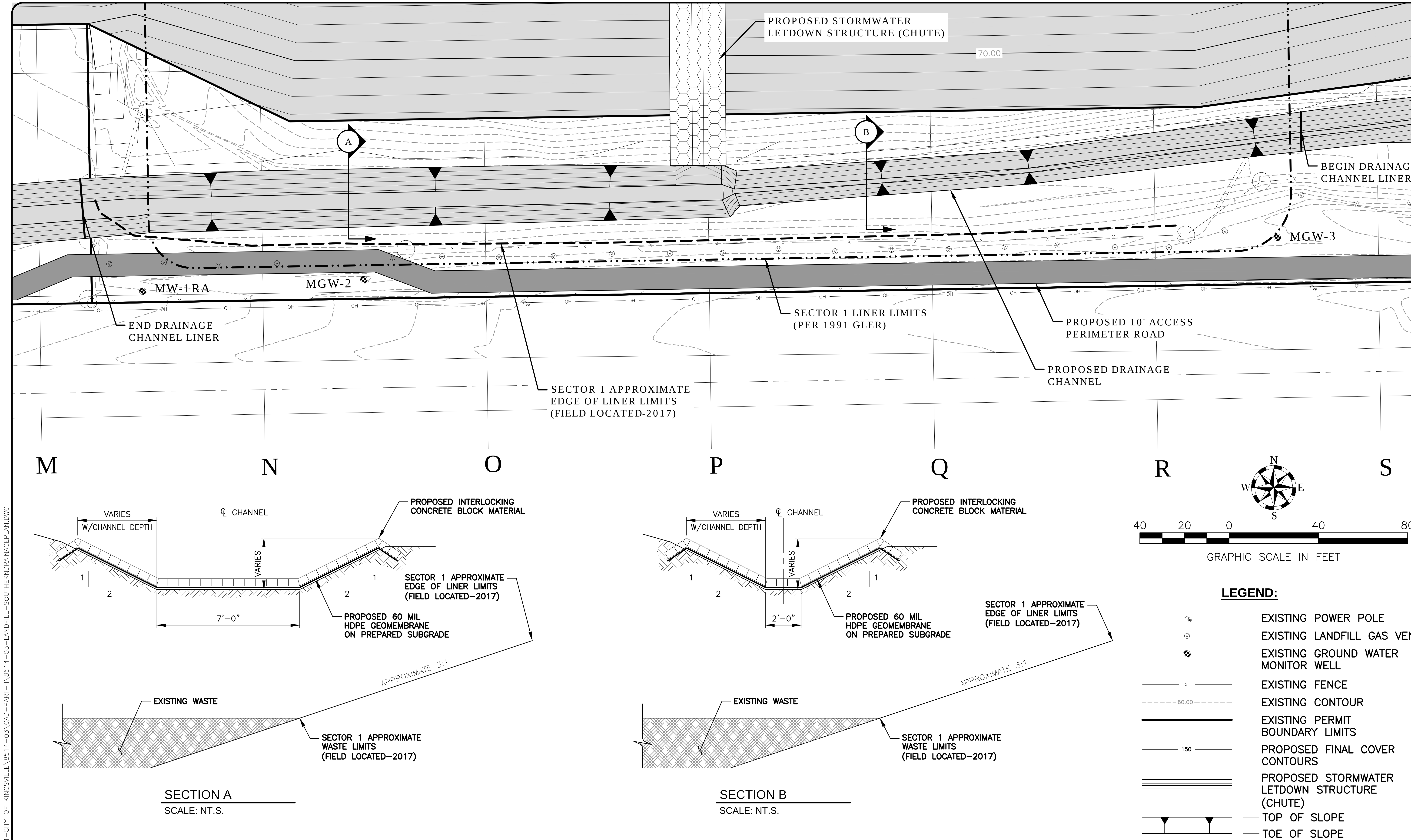

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LICENSED PROFESSIONAL ENGINEER
09/12/18

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Filename		
Scale	AS SHOWN	
Date	09/12/2018	
LAYOUT	DT	09/12/2018
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PART III, ATTACHMENT 6, APPENDIX 6B.11.1
ENLARGED SOUTHERN DRAINAGE PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.11.1

APPENDIX 6B.11.2

FIGURE 3 CROSS SECTIONS

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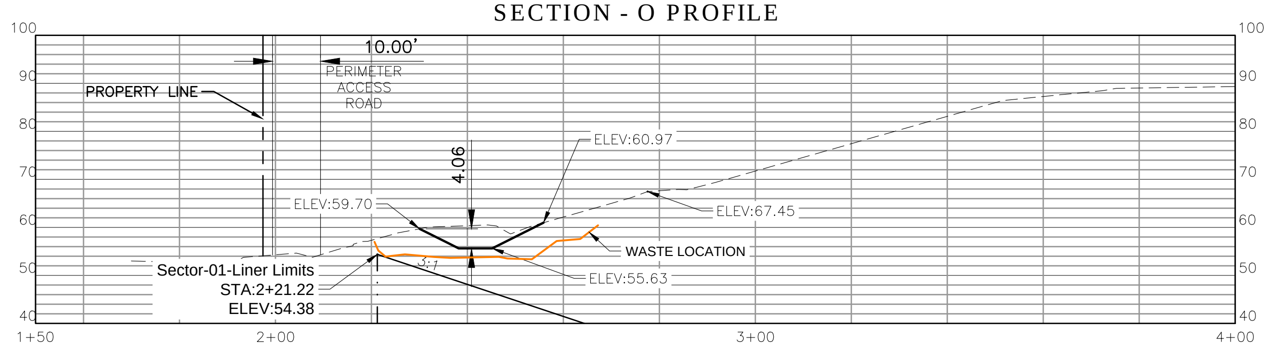
Jose C. Garza, P.E.

SECTION - O PROFILE



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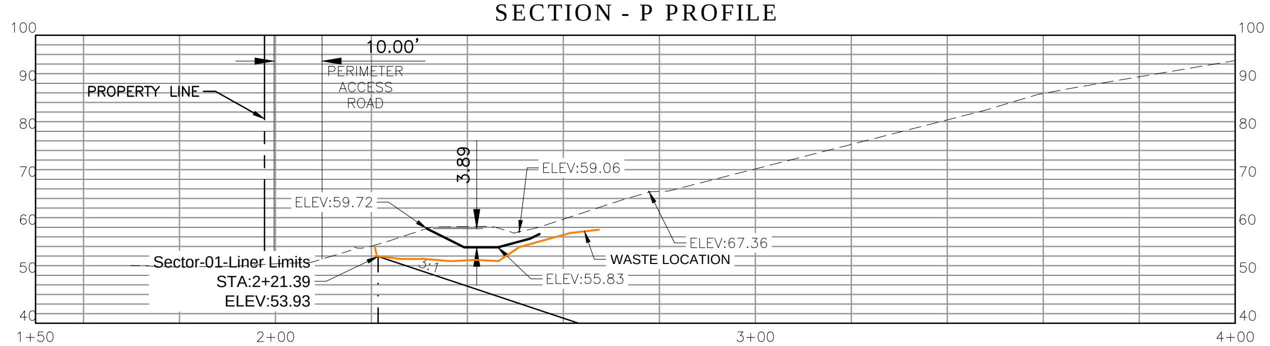

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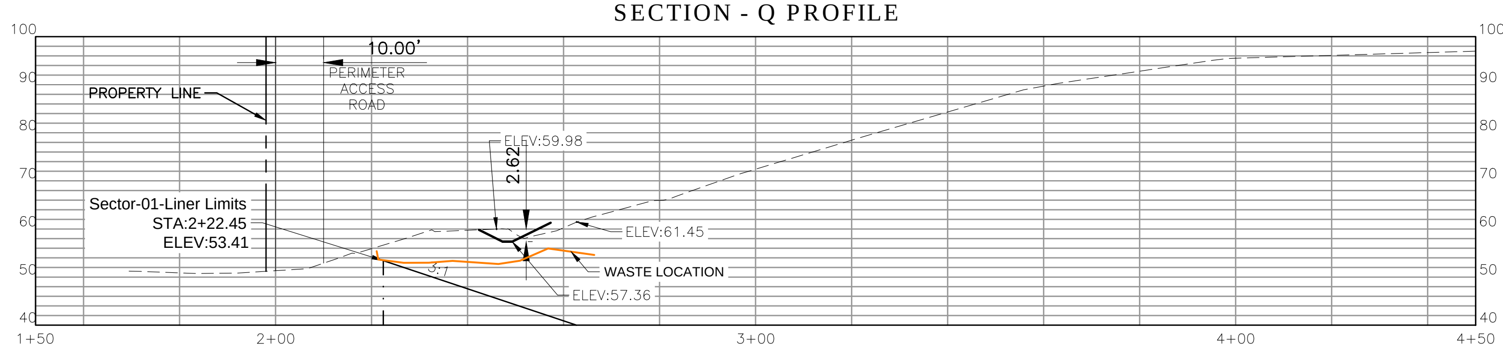

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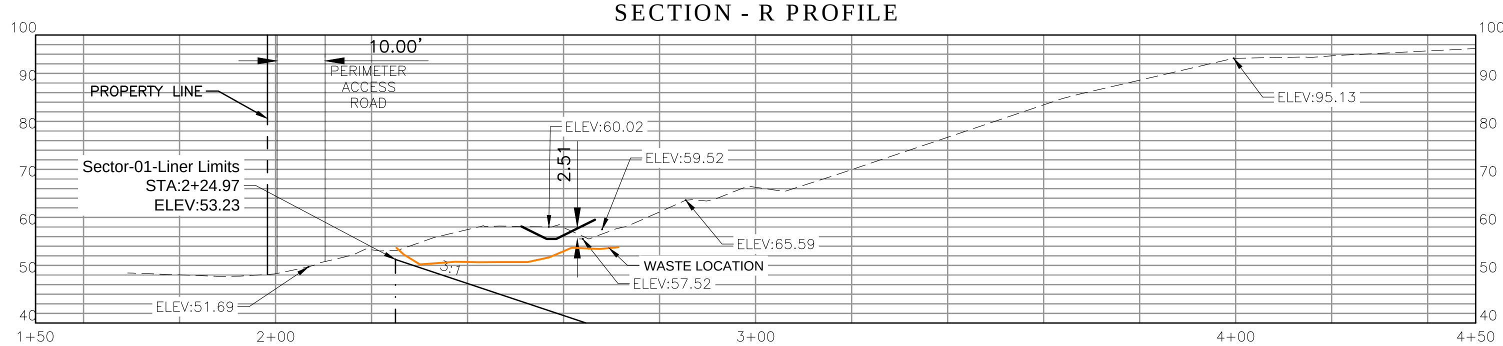

GRAPHIC SCALE IN FEET

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

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JOSE C. GARZA
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LICENSED PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III, ATTACHMENT 6, APPENDIX 6B.11.2
CROSS SECTIONS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.11.2

SEP 11, 2018 2:23 PM TORRE01809
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APPENDIX 6B.12

HYDROCAD MODEL 25 YEAR POST DEVELOPMENT CHUTES

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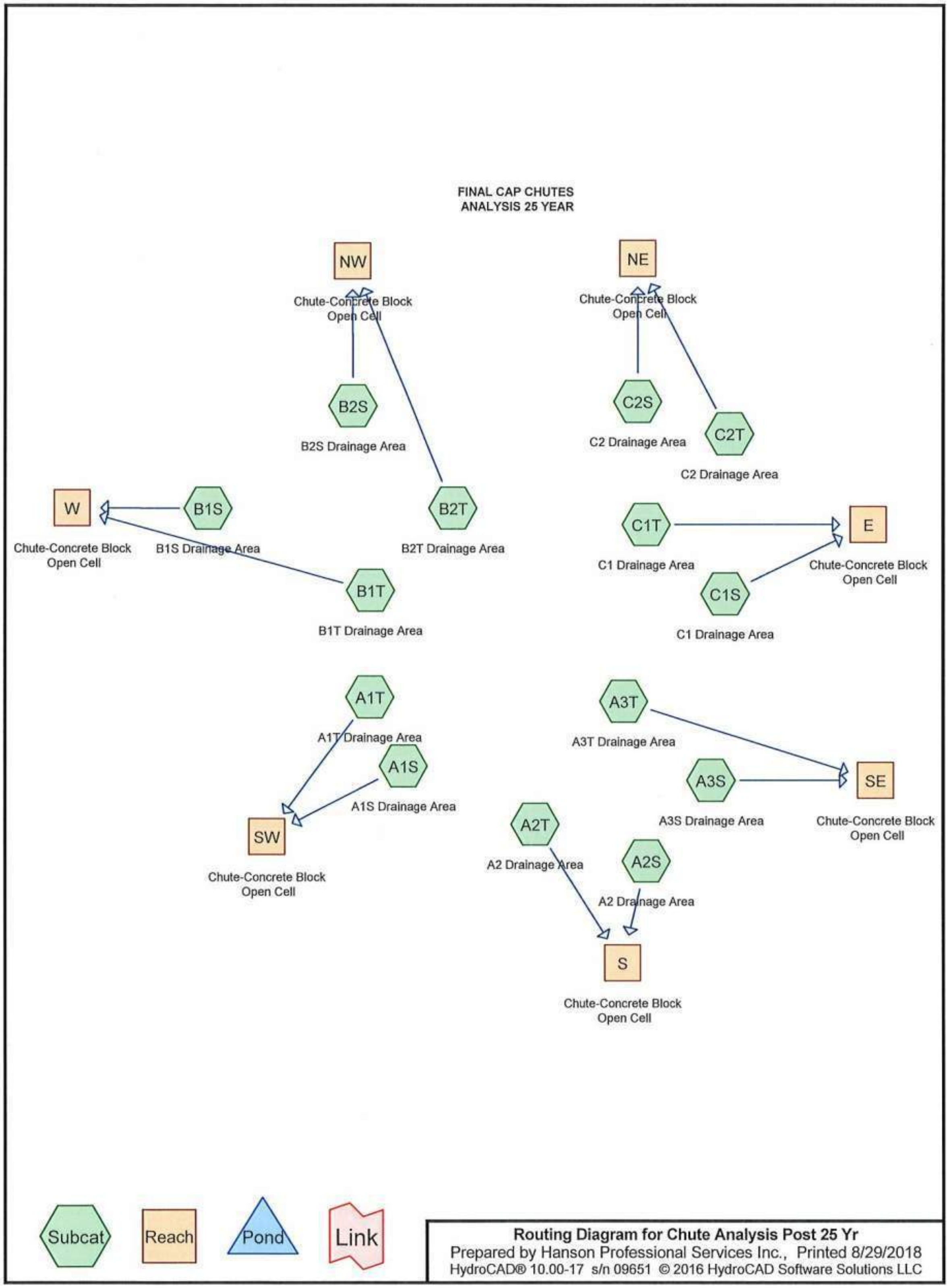
Jose C. Garza, P.E.


FINAL CAP CHUTES
ANALYSIS 25 YEAR
NW
Chute-Concrete Block
Open Cell
B2S
B2S Drainage Area
B2T
B2T Drainage Area
NE
Chute-Concrete Block
Open Cell
C2S
C2 Drainage Area
C2T
C2 Drainage Area
W
Chute-Concrete Block
Open Cell
B1S
B1S Drainage Area
B1T
B1T Drainage Area
C1T
C1 Drainage Area
E
Chute-Concrete Block
Open Cell
C1S
C1 Drainage Area
A1T
A1T Drainage Area
A1S
A1S Drainage Area
SW
Chute-Concrete Block
Open Cell
A3T
A3T Drainage Area
A3S
A3S Drainage Area
SE
Chute-Concrete Block
Open Cell
A2T
A2 Drainage Area
A2S
A2 Drainage Area
S
Chute-Concrete Block
Open Cell
Subcat
Reach
Pond
Link
Routing Diagram for Chute Analysis Post 25 Yr
Prepared by Hanson Professional Services Inc., Printed 8/29/2018
HydroCAD® 10.00-17 s/n 09651 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
119.627	79	50-75% Grass cover, Fair, HSG C (A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1T, C2S, C2T)
119.627	**79**	**TOTAL AREA**

Chute Analysis Post 25 Yr
Prepared by Hanson Professional Services Inc. Printed 8/29/2018
HydroCAD® 10.00-17 s/n 09651 © 2016 HydroCAD Software Solutions LLC Page 3

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
119.627	HSG C	A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1T, C2S, C2T
0.000	HSG D	
0.000	Other	
119.627		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	119.627	0.000	0.000	119.627	50-75% Grass cover, Fair	A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1T, C2S, C2T
0.000	**0.000**	**119.627**	**0.000**	**0.000**	**119.627**	**TOTAL AREA**	

Chute Analysis Post 25 Yr *Type III 24-hr 25-Year Rainfall=8.70"*
Prepared by Hanson Professional Services Inc. Printed 8/29/2018
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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A1S: A1S Drainage Area Runoff Area=8.009 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=49.80 cfs 4.113 af

Subcatchment A1T: A1T Drainage Area Runoff Area=7.425 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=46.16 cfs 3.813 af

Subcatchment A2S: A2 Drainage Area Runoff Area=12.241 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=76.11 cfs 6.287 af

Subcatchment A2T: A2 Drainage Area Runoff Area=5.120 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=31.83 cfs 2.629 af

Subcatchment A3S: A3S Drainage Area Runoff Area=10.760 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=66.90 cfs 5.526 af

Subcatchment A3T: A3T Drainage Area Runoff Area=7.489 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=1,050' Tc=16.7 min CN=79 Runoff=38.81 cfs 3.846 af

Subcatchment B1S: B1S Drainage Area Runoff Area=14.884 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=92.54 cfs 7.644 af

Subcatchment B1T: B1T Drainage Area Runoff Area=7.499 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=950' Tc=16.0 min CN=79 Runoff=39.52 cfs 3.851 af

Subcatchment B2S: B2S Drainage Area Runoff Area=8.806 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=54.75 cfs 4.522 af

Subcatchment B2T: B2T Drainage Area Runoff Area=4.309 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=850' Tc=13.7 min CN=79 Runoff=24.07 cfs 2.213 af

Subcatchment C1S: C1 Drainage Area Runoff Area=11.506 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=71.54 cfs 5.909 af

Subcatchment C1T: C1 Drainage Area Runoff Area=6.292 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=800' Tc=12.5 min CN=79 Runoff=36.29 cfs 3.231 af

Subcatchment C2S: C2 Drainage Area Runoff Area=10.038 ac 0.00% Impervious Runoff Depth=6.16"
Tc=10.0 min CN=79 Runoff=62.41 cfs 5.155 af

Subcatchment C2T: C2 Drainage Area Runoff Area=5.249 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=800' Tc=12.5 min CN=79 Runoff=30.27 cfs 2.696 af

Reach E: Chute-Concrete Block Avg. Flow Depth=0.71' Max Vel=19.08 fps Inflow=106.93 cfs 9.140 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=106.72 cfs 9.140 af

Reach NE: Chute-Concrete Block Avg. Flow Depth=0.66' Max Vel=18.27 fps Inflow=91.93 cfs 7.851 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=91.74 cfs 7.851 af

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Reach NW: Chute-Concrete Block Avg. Flow Depth=0.60' Max Vel=17.38 fps Inflow=77.52 cfs 6.735 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=77.39 cfs 6.735 af

Reach S: Chute-Concrete Block Avg. Flow Depth=0.72' Max Vel=19.13 fps Inflow=107.94 cfs 8.916 af
n=0.025 L=451.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=107.71 cfs 8.916 af

Reach SE: Chute-Concrete Block Avg. Flow Depth=0.69' Max Vel=18.76 fps Inflow=100.71 cfs 9.372 af
n=0.025 L=441.7' S=0.2500 '/' Capacity=877.36 cfs Outflow=100.58 cfs 9.372 af

Reach SW: Chute-Concrete Block Avg. Flow Depth=0.67' Max Vel=18.50 fps Inflow=95.96 cfs 7.926 af
n=0.025 L=406.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=95.76 cfs 7.926 af

Reach W: Chute-Concrete Block Avg. Flow Depth=0.78' Max Vel=20.06 fps Inflow=127.46 cfs 11.495 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=127.28 cfs 11.495 af

Total Runoff Area = 119.627 ac Runoff Volume = 61.436 af Average Runoff Depth = 6.16"
100.00% Pervious = 119.627 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment A1S: A1S Drainage Area

Use Conservative Value of Tc=10 min.

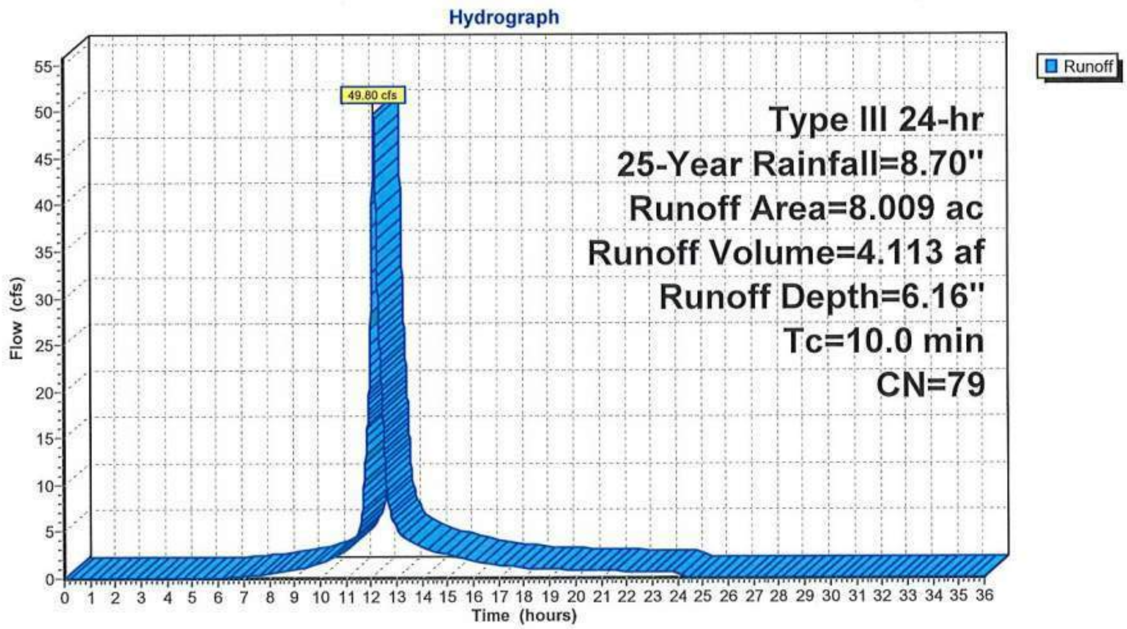
Runoff = 49.80 cfs @ 12.14 hrs, Volume= 4.113 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
8.009	79	50-75% Grass cover, Fair, HSG C
8.009		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1S-Chute Flow Evaluation**

Subcatchment A1S: A1S Drainage Area



Summary for Subcatchment A1T: A1T Drainage Area

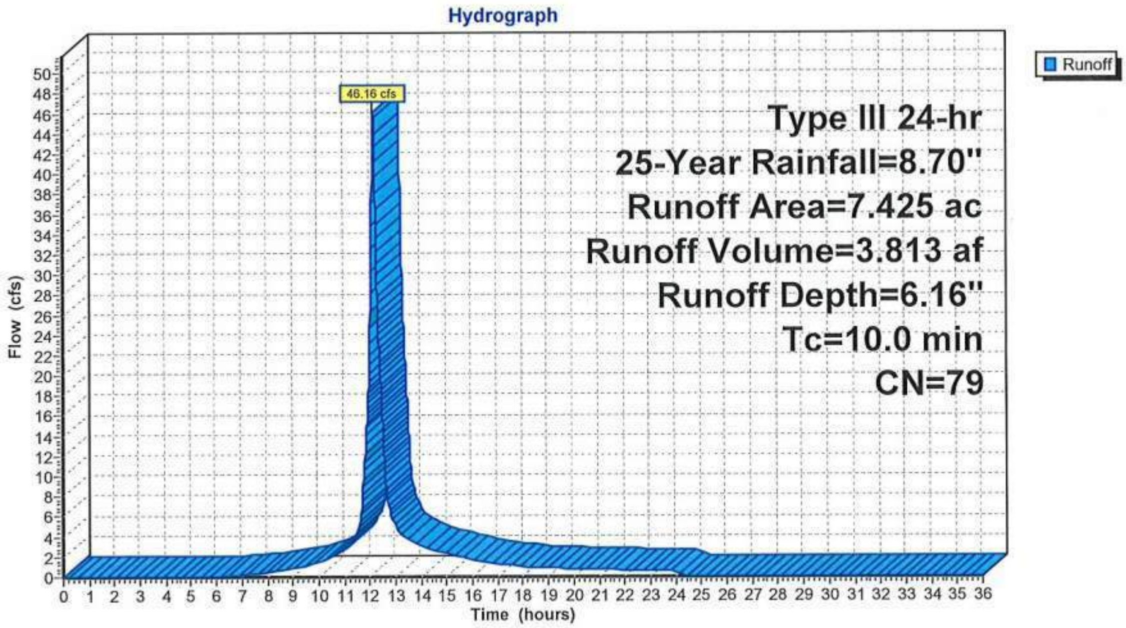
Runoff = 46.16 cfs @ 12.14 hrs, Volume= 3.813 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
7.425	79	50-75% Grass cover, Fair, HSG C
7.425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1T-Chute Flow Evaluation**

Subcatchment A1T: A1T Drainage Area



Summary for Subcatchment A2S: A2 Drainage Area

Use Conservative Value of Tc=10 min.

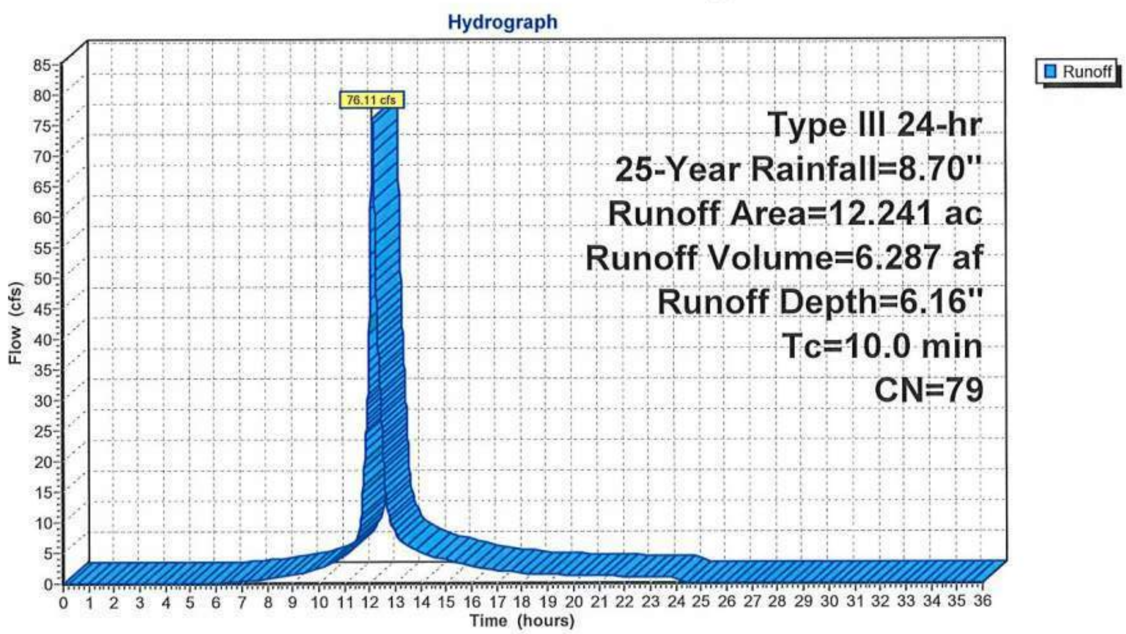
Runoff = 76.11 cfs @ 12.14 hrs, Volume= 6.287 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
12.241	79	50-75% Grass cover, Fair, HSG C
12.241		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A2 Drainage Area**

Subcatchment A2S: A2 Drainage Area



Summary for Subcatchment A2T: A2 Drainage Area

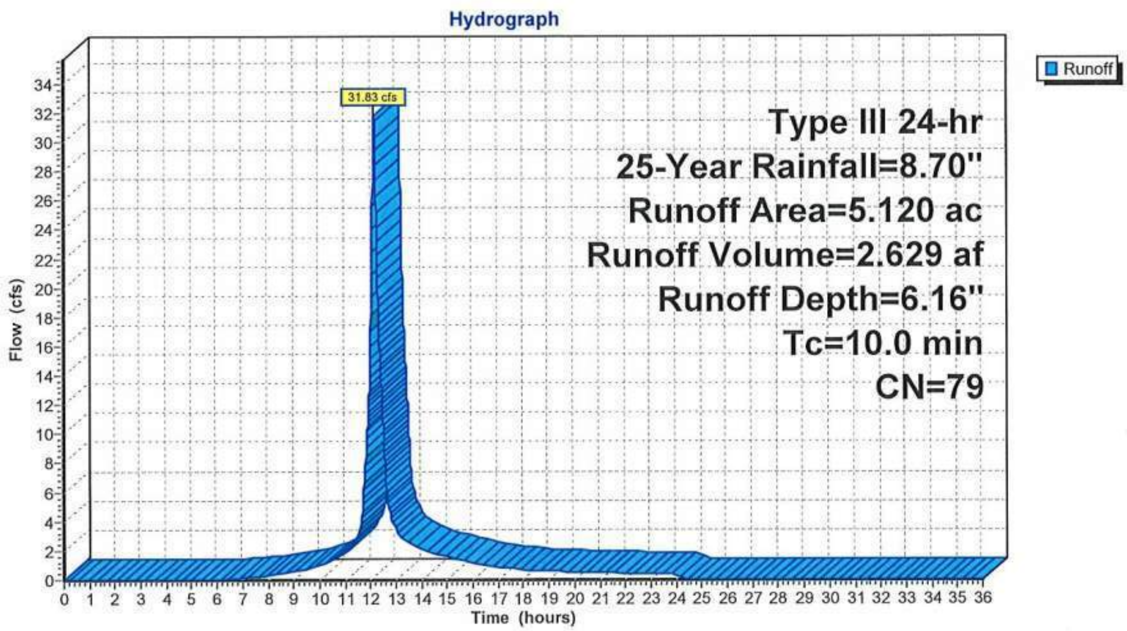
Runoff = 31.83 cfs @ 12.14 hrs, Volume= 2.629 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
5.120	79	50-75% Grass cover, Fair, HSG C
5.120		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A2 Drainage Area**

Subcatchment A2T: A2 Drainage Area



Summary for Subcatchment A3S: A3S Drainage Area

Use Conservative Value of Tc=10 min.

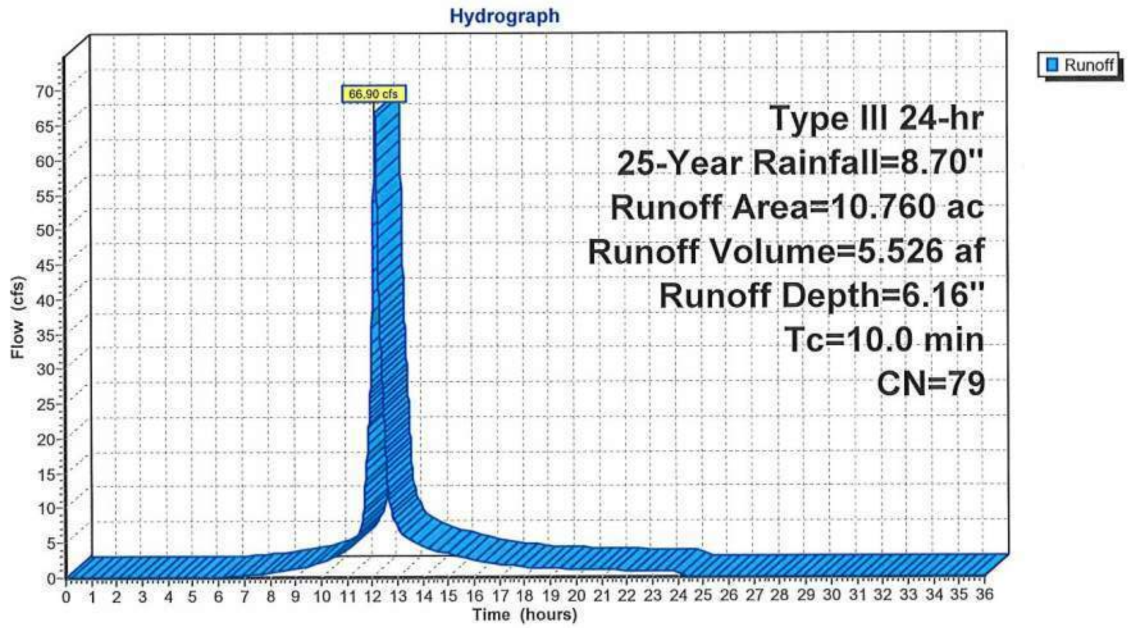
Runoff = 66.90 cfs @ 12.14 hrs, Volume= 5.526 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
10.760	79	50-75% Grass cover, Fair, HSG C
10.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A3S-Chute Flow Evaluation**

Subcatchment A3S: A3S Drainage Area



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Summary for Subcatchment A3T: A3T Drainage Area

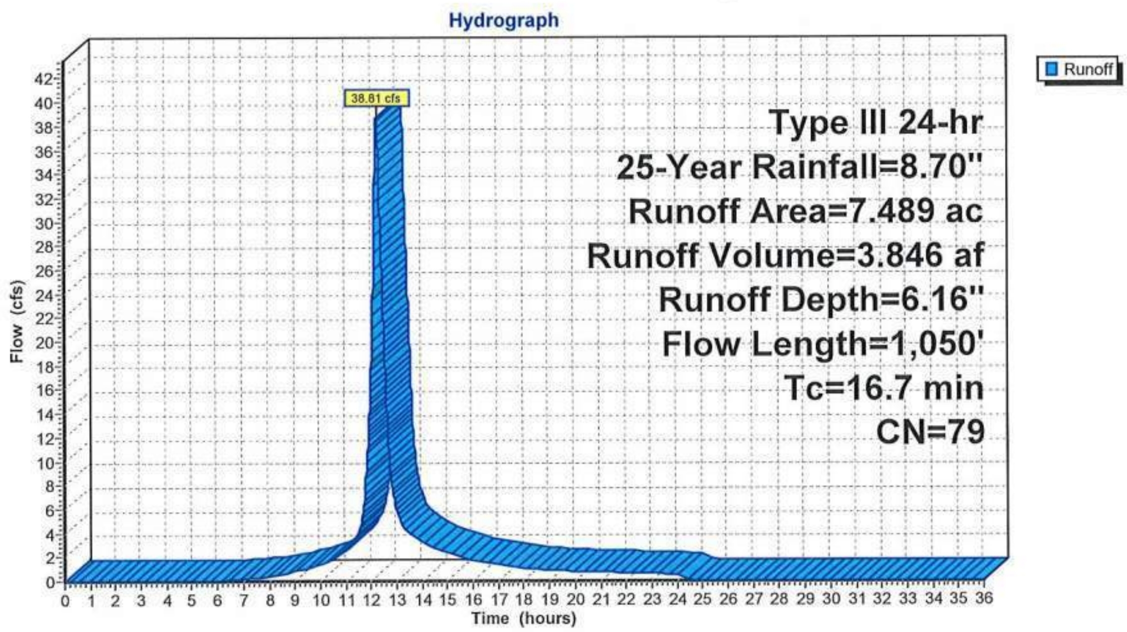
Runoff = 38.81 cfs @ 12.23 hrs, Volume= 3.846 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
7.489	79	50-75% Grass cover, Fair, HSG C
7.489		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	750		1.30		**Direct Entry, A3T-Chute Flow Evaluation**
7.1	300		0.70		**Direct Entry,**
16.7	1,050	Total			

Subcatchment A3T: A3T Drainage Area



Summary for Subcatchment B1S: B1S Drainage Area

Use Conservative Value of Tc=10 min.

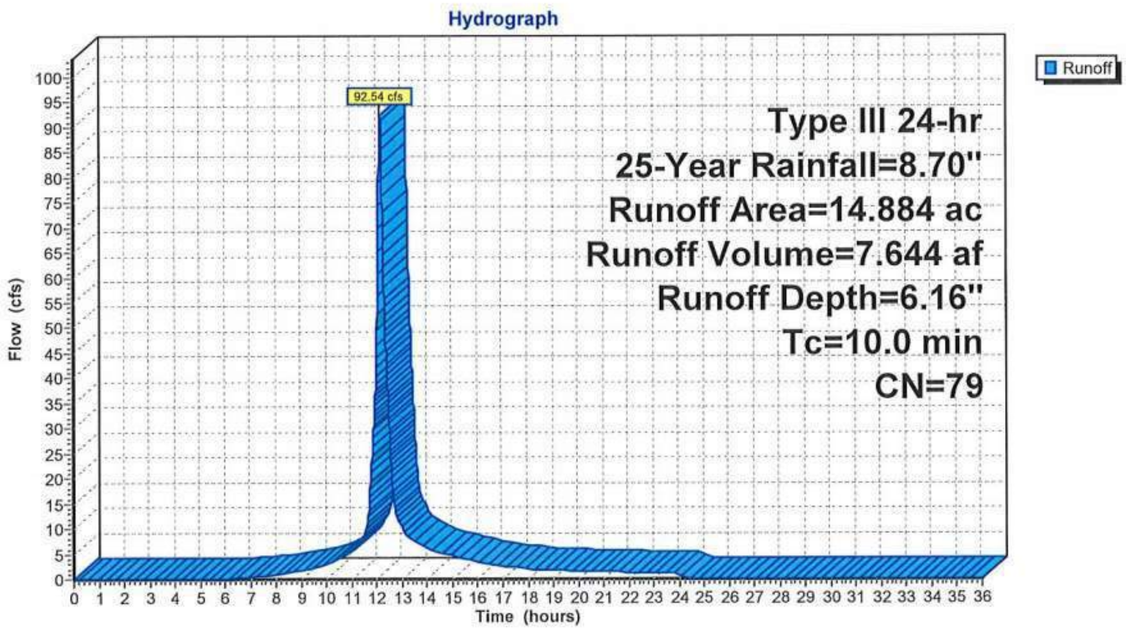
Runoff = 92.54 cfs @ 12.14 hrs, Volume= 7.644 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
14.884	79	50-75% Grass cover, Fair, HSG C
14.884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S-Chute Flow Evaluation**

Subcatchment B1S: B1S Drainage Area



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Summary for Subcatchment B1T: B1T Drainage Area

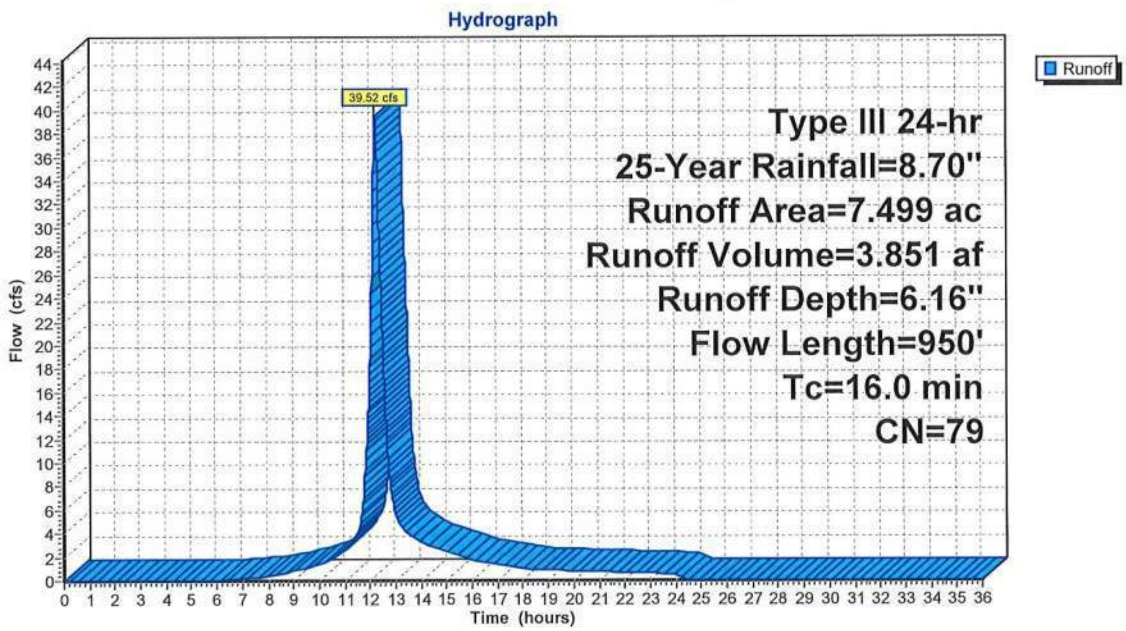
Runoff = 39.52 cfs @ 12.21 hrs, Volume= 3.851 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
7.499	79	50-75% Grass cover, Fair, HSG C
7.499		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T-Chute Flow Evaluation**
8.3	350		0.70		**Direct Entry,**
16.0	950	Total			

Subcatchment B1T: B1T Drainage Area



Summary for Subcatchment B2S: B2S Drainage Area

Use Conservative Value of Tc=10 min.

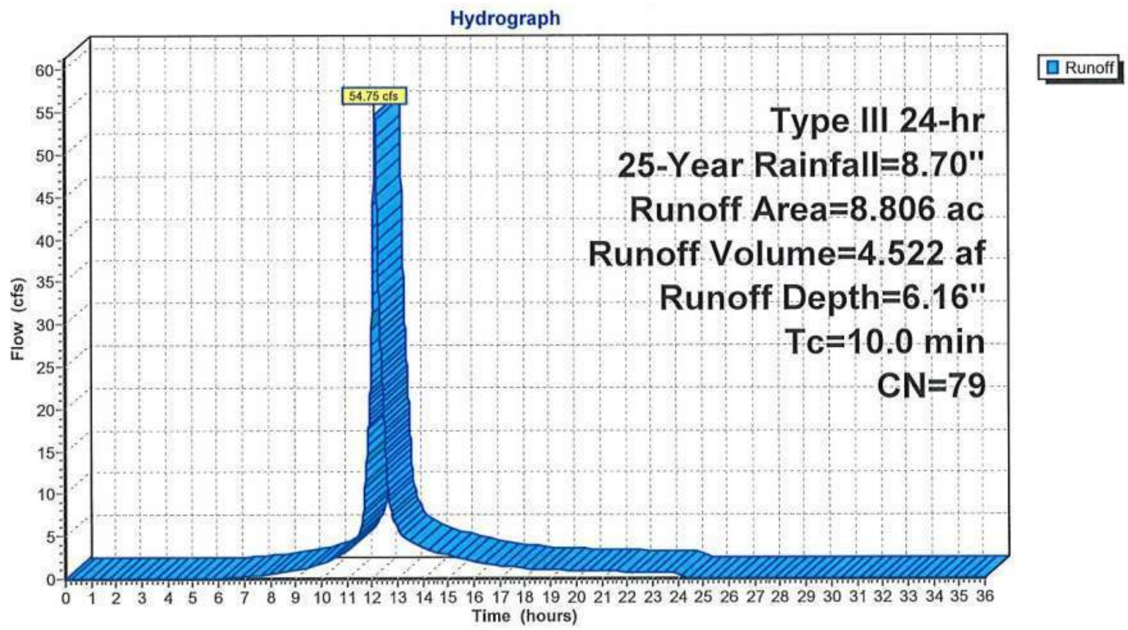
Runoff = 54.75 cfs @ 12.14 hrs, Volume= 4.522 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
8.806	79	50-75% Grass cover, Fair, HSG C
8.806		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B2S-Chute Flow Evaluation**

Subcatchment B2S: B2S Drainage Area



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Summary for Subcatchment B2T: B2T Drainage Area

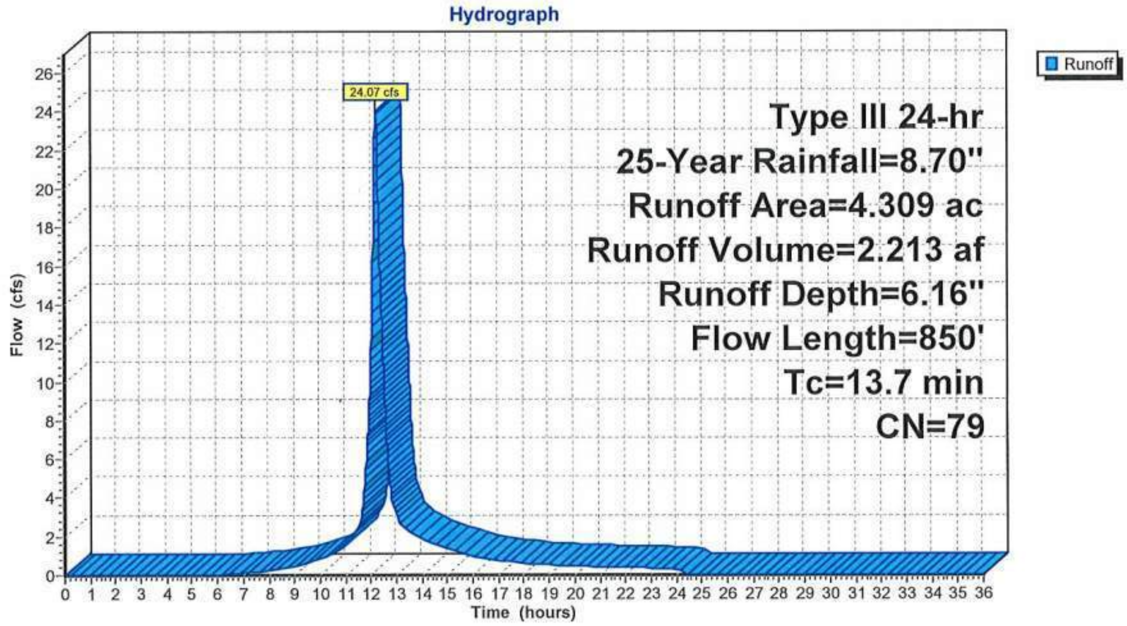
Runoff = 24.07 cfs @ 12.19 hrs, Volume= 2.213 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
4.309	79	50-75% Grass cover, Fair, HSG C
4.309		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B2T-Chute Flow Evaluation**
6.0	250		0.70		**Direct Entry,**
13.7	850	Total			

Subcatchment B2T: B2T Drainage Area



Summary for Subcatchment C1S: C1 Drainage Area

Use Conservative Value of Tc=10 min.

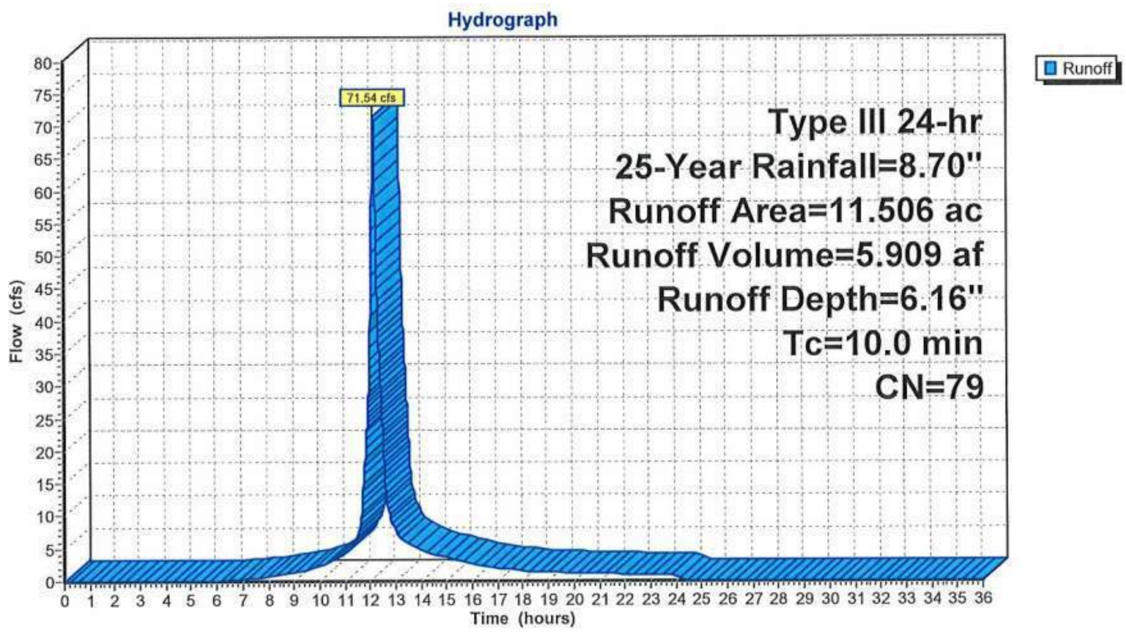
Runoff = 71.54 cfs @ 12.14 hrs, Volume= 5.909 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
11.506	79	50-75% Grass cover, Fair, HSG C
11.506		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C1 Drainage Area**

Subcatchment C1S: C1 Drainage Area



Summary for Subcatchment C1T: C1 Drainage Area

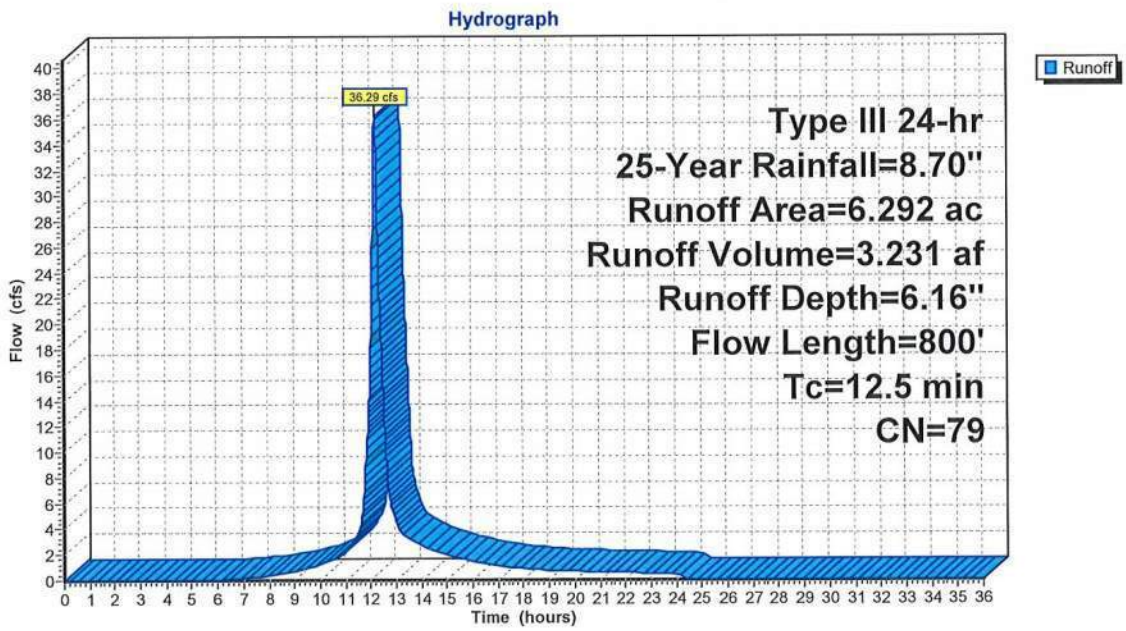
Runoff = 36.29 cfs @ 12.17 hrs, Volume= 3.231 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
6.292	79	50-75% Grass cover, Fair, HSG C
6.292		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C1 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C1T: C1 Drainage Area



Summary for Subcatchment C2S: C2 Drainage Area

Use Conservative Value of Tc=10 min.

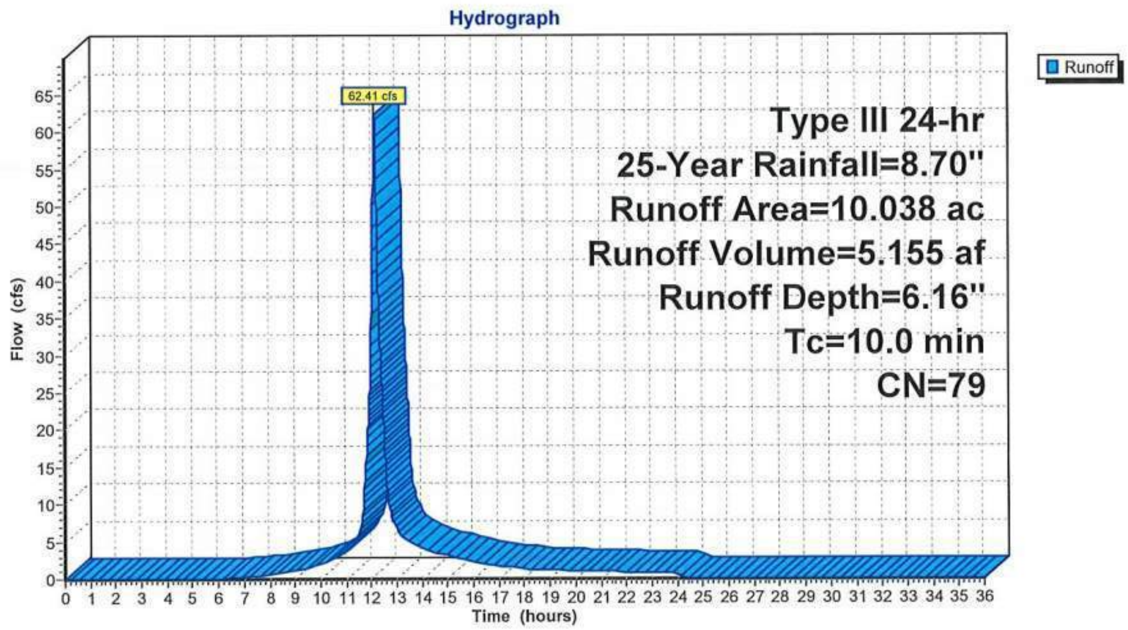
Runoff = 62.41 cfs @ 12.14 hrs, Volume= 5.155 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
10.038	79	50-75% Grass cover, Fair, HSG C
10.038		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C2 Drainage Area**

Subcatchment C2S: C2 Drainage Area



Summary for Subcatchment C2T: C2 Drainage Area

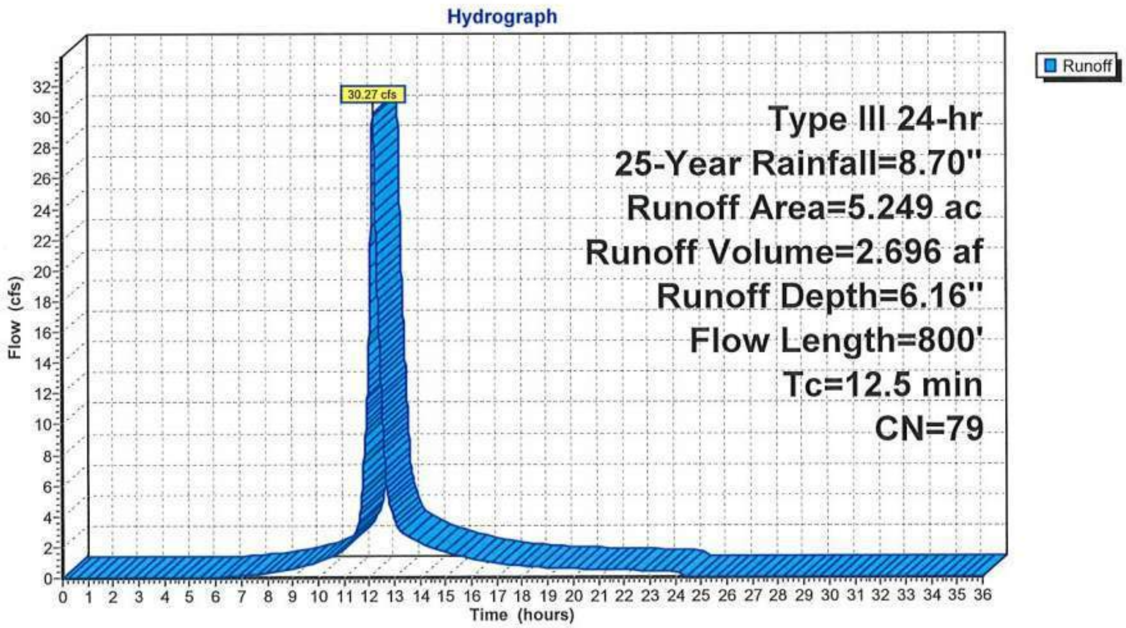
Runoff = 30.27 cfs @ 12.17 hrs, Volume= 2.696 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
5.249	79	50-75% Grass cover, Fair, HSG C
5.249		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C2 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C2T: C2 Drainage Area



Summary for Reach E: Chute-Concrete Block Open Cell

Inflow Area = 17.798 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 106.93 cfs @ 12.15 hrs, Volume= 9.140 af
Outflow = 106.72 cfs @ 12.16 hrs, Volume= 9.140 af, Atten= 0%, Lag= 0.7 min

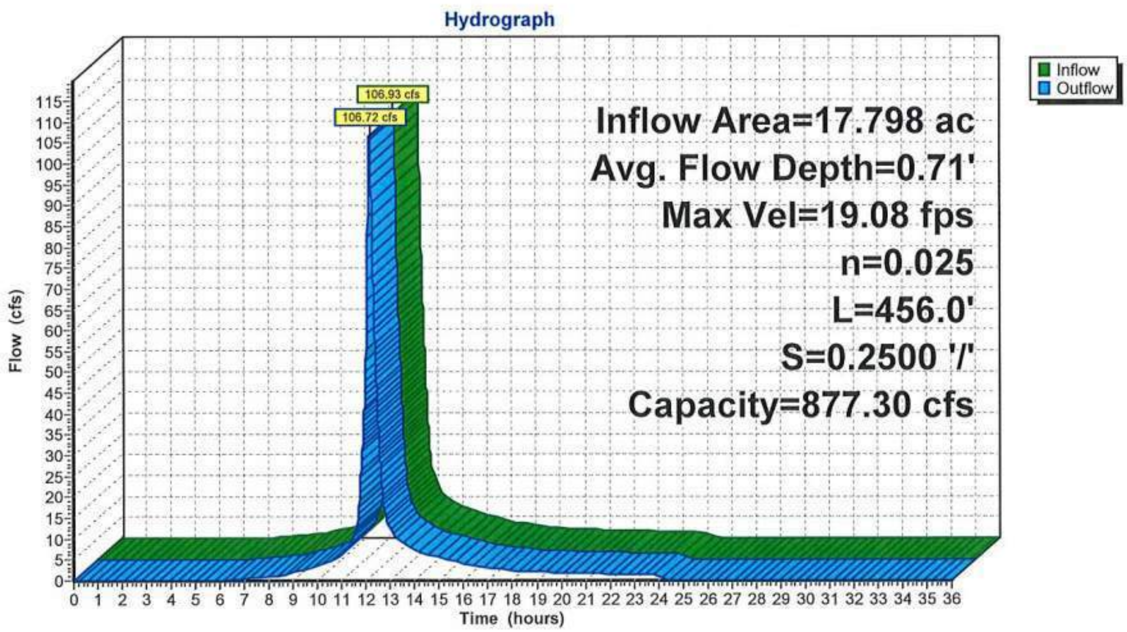
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.08 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.95 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,552 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach E: Chute-Concrete Block Open Cell



Summary for Reach NE: Chute-Concrete Block Open Cell

Inflow Area =	15.287 ac,	0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event	
Inflow =	91.93 cfs @	12.15 hrs, Volume=	7.851 af	
Outflow =	91.74 cfs @	12.16 hrs, Volume=	7.851 af,	Atten= 0%, Lag= 0.7 min

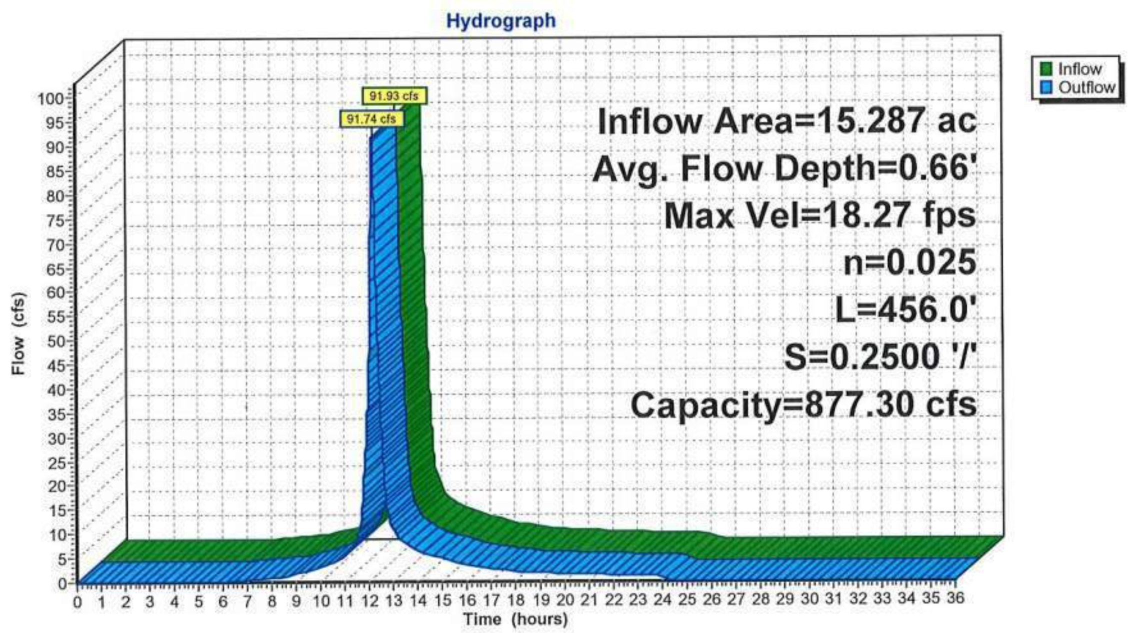
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 18.27 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.65 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,292 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach NE: Chute-Concrete Block Open Cell



Summary for Reach NW: Chute-Concrete Block Open Cell

Inflow Area = 13.115 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 77.52 cfs @ 12.15 hrs, Volume= 6.735 af
Outflow = 77.39 cfs @ 12.16 hrs, Volume= 6.735 af, Atten= 0%, Lag= 0.8 min

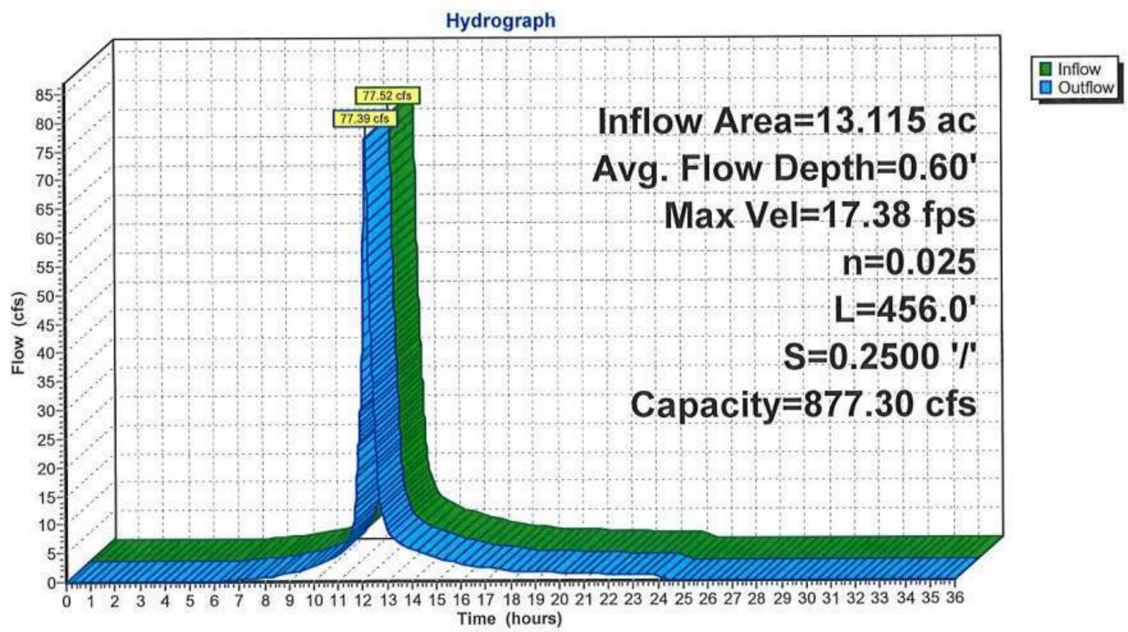
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 17.38 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.36 fps, Avg. Travel Time= 1.4 min

Peak Storage= 2,032 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.60'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach NW: Chute-Concrete Block Open Cell



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Summary for Reach S: Chute-Concrete Block Open Cell

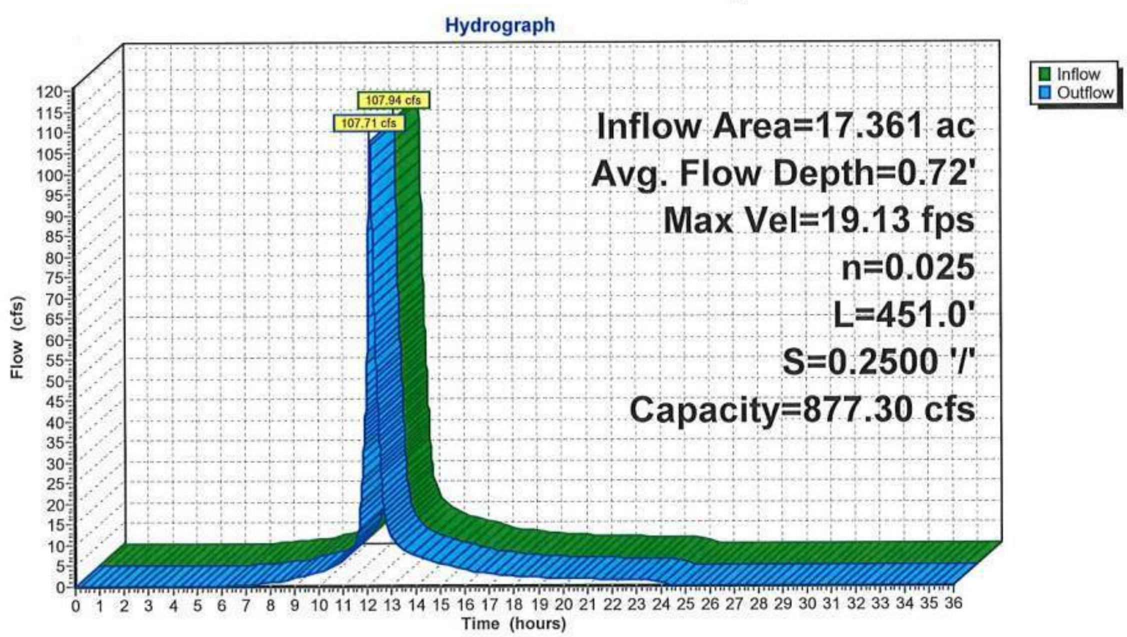
Inflow Area = 17.361 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 107.94 cfs @ 12.14 hrs, Volume= 8.916 af
Outflow = 107.71 cfs @ 12.15 hrs, Volume= 8.916 af, Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.13 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.91 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,541 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 451.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 59.25'

Reach S: Chute-Concrete Block Open Cell



Summary for Reach SE: Chute-Concrete Block Open Cell

Inflow Area = 18.249 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 100.71 cfs @ 12.16 hrs, Volume= 9.372 af
Outflow = 100.58 cfs @ 12.17 hrs, Volume= 9.372 af, Atten= 0%, Lag= 0.7 min

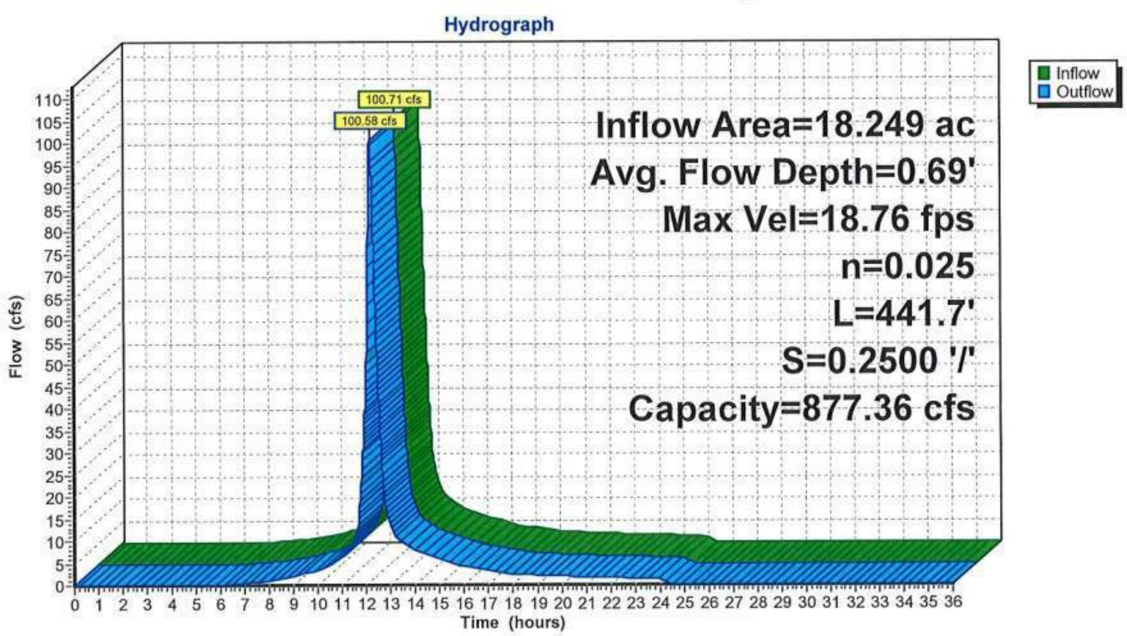
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 18.76 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.97 fps, Avg. Travel Time= 1.2 min

Peak Storage= 2,370 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.36 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 441.7' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 61.56'

‡

Reach SE: Chute-Concrete Block Open Cell



Summary for Reach SW: Chute-Concrete Block Open Cell

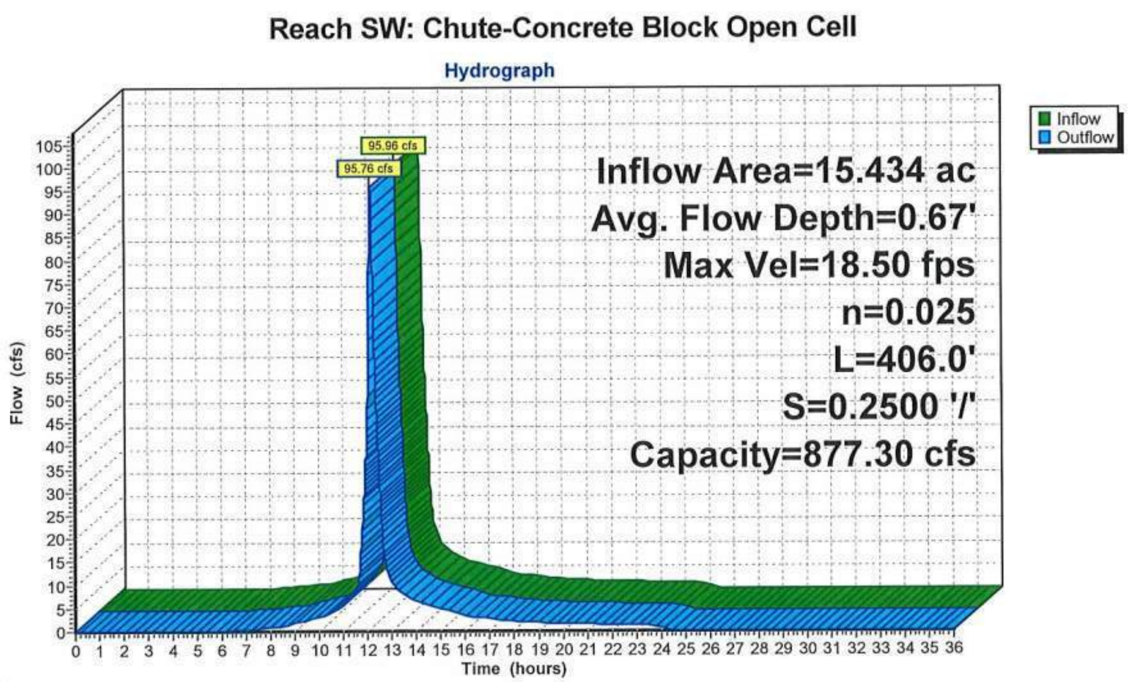
Inflow Area = 15.434 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 95.96 cfs @ 12.14 hrs, Volume= 7.926 af
Outflow = 95.76 cfs @ 12.15 hrs, Volume= 7.926 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 18.50 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.68 fps, Avg. Travel Time= 1.2 min

Peak Storage= 2,104 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.67'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 406.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 70.50'

‡



Summary for Reach W: Chute-Concrete Block Open Cell

Inflow Area = 22.383 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 127.46 cfs @ 12.15 hrs, Volume= 11.495 af
Outflow = 127.28 cfs @ 12.16 hrs, Volume= 11.495 af, Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.06 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.41 fps, Avg. Travel Time= 1.2 min

Peak Storage= 2,895 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.78'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach W: Chute-Concrete Block Open Cell