



# Run-on and Run-off Control System Plan

## J.H. CAMPBELL GENERATING FACILITY

### DRY ASH LANDFILL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

West Olive, Michigan

Pursuant to 40 CFR 257.81

**Submitted To:** Consumers Energy Company  
1945 W. Parnall Road  
Jackson, Michigan 49201

**Submitted By:** Golder Associates Inc.  
15851 South US 27, Suite 50  
Lansing, Michigan 48906

October 2016

1654923





## CERTIFICATION

### Professional Engineer Certification Statement [40 CFR 257.81(c)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.81 (40 CFR Part 257.81), I attest that this Run-on and Run-off Control System Plan is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.81.

Golder Associates Inc.



Signature

October 14, 2016

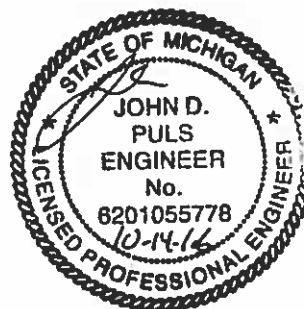
Date of Report Certification

John D. Puls, PE

Name

6201055787

Professional Engineer Certification Number





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## 1.0 INTRODUCTION

### 1.1 Background

J.H. Campbell Generating Facility (JH Campbell) is a coal-fired power generation facility located near West Olive, Michigan as presented on Figure 1 – Site Location Map. The JH Campbell Dry Ash Landfill (Dry Ash Landfill) serves as the facility's primary disposal site for dry ash and consists of four dual composite lined landfill cells and two leachate storage ponds. The Dry Ash Landfill utilizes a dual composite liner system with primary and secondary leachate collection layers between each composite liner. Total permitted capacity of the Dry Ash Landfill is 9,380,000 cubic yards (cy). As of October of 5, 2015, approximately 4,285,000 cy of airspace was consumed per an airspace evaluation completed by Engineering & Environmental Solutions, LLC (E&ES) in 2015. It is anticipated that the total permitted volume will be consumed once the seven permitted cells have been constructed and filled.

### 1.2 Purpose

The purpose of the Run-on and Run-off Control System Plan (Plan) is to provide a basis for the certification required by 40 CFR 257.81 Run-on and Run-off Controls for Coal Combustion Residuals (CCR) Landfills. The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:

- A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour 25-year storm
- A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour 25-year storm



## 2.0 RUN-ON AND RUN-OFF CONTROLS

To meet the requirements of 40 CFR 257.81(a), the run-on and run-off control system must prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour 25-year storm and collect and control at least the water volume resulting from a 24-hour 25-year storm. The 24-hour 25-year storm depth is 4.97 inches as provided in Appendix A. Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under 40 CFR 257.3-3.

### 2.1 Run-on Control System

Run-on to the active portions of the Dry Ash Landfill is controlled using two methods. The first method is a combination of an elevated perimeter berm and drainage channels. The perimeter berm is constructed a minimum of four feet above the existing topography. The elevated perimeter berm minimizes the volume of run-on entering the Dry Ash Landfill. Drainage channels divert storm flow from closed portions of the Dry Ash Landfill around the perimeter of the landfill away from active areas to onsite stormwater ponds before being discharged to the Pigeon River. The perimeter berms and channels are shown on Figure 2 - Site Plan.

The second method is positive grading away from the active areas so that run-off from closed areas (non-contact water) is not diverted into the leachate collection system. The closed areas of the Dry Ash Landfill are graded away from the active areas so that run-on is not directed into the active portions of the Dry Ash Landfill.

**Table 2.1.1 - 24-hour 25-year Storm Channel Summary**

Channel	Channel Type	Bottom Width (ft)	Depth (ft)	Side Slope	24-hr, 25-yr Design Flow (cfs)	24-hr, 25-yr Flow Depth (ft)	24-hr, 25-yr Freeboard (ft)
South Drainage	Trap	8.0	10.0	2:1	26.08	0.81	7.19
West Drainage	Trap	4.0	3.0	2:1	78.12	2.91	0.08



## 2.2 Run-off Control System

Run-off from the active portions of the Dry Ash Landfill is controlled within the open landfill cells. Water that comes in contact with CCR is directed to landfill leachate collection pipes where it is then pumped to the leachate holding ponds. As shown in Table 2.2.1, the volume of runoff from the 24-hour 25-year storm event is contained within the active portions of the Dry Ash Landfill. Model data is provided in Appendix B. Stormwater is discharged under the current National Pollutant Discharge Elimination System (NPDES) Permit No. MI0001422.

**Table 2.2.1 - 24-hour 25-year Storm Summary**

<b>Dry Ash Landfill Area</b>	<b>Volume of Run-off (Acre-feet)</b>	<b>Berm Elevation (NGVD29)</b>	<b>Peak Water Elevation (NGVD29)</b>	<b>Peak Outflow (cfs)</b>
Cell 1	3.19	614.00	613.92	2.40
Cells 3 and 4	5.59	611.00	609.09	0.96



### 3.0 PLAN REVISION AND RECORDKEEPING

Per 40 CFR 257.81(c)(2); “The owner or operator of the CCR unit may amend the written run-on and run-off control system plan at any time provided the revised plan is placed in the facility's operating record as required by §257.105(g)(3). The owner or operator must amend the written run-on and run-off control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.”

Per 40 CFR 257.81(c)(4); “The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed a run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(3).”



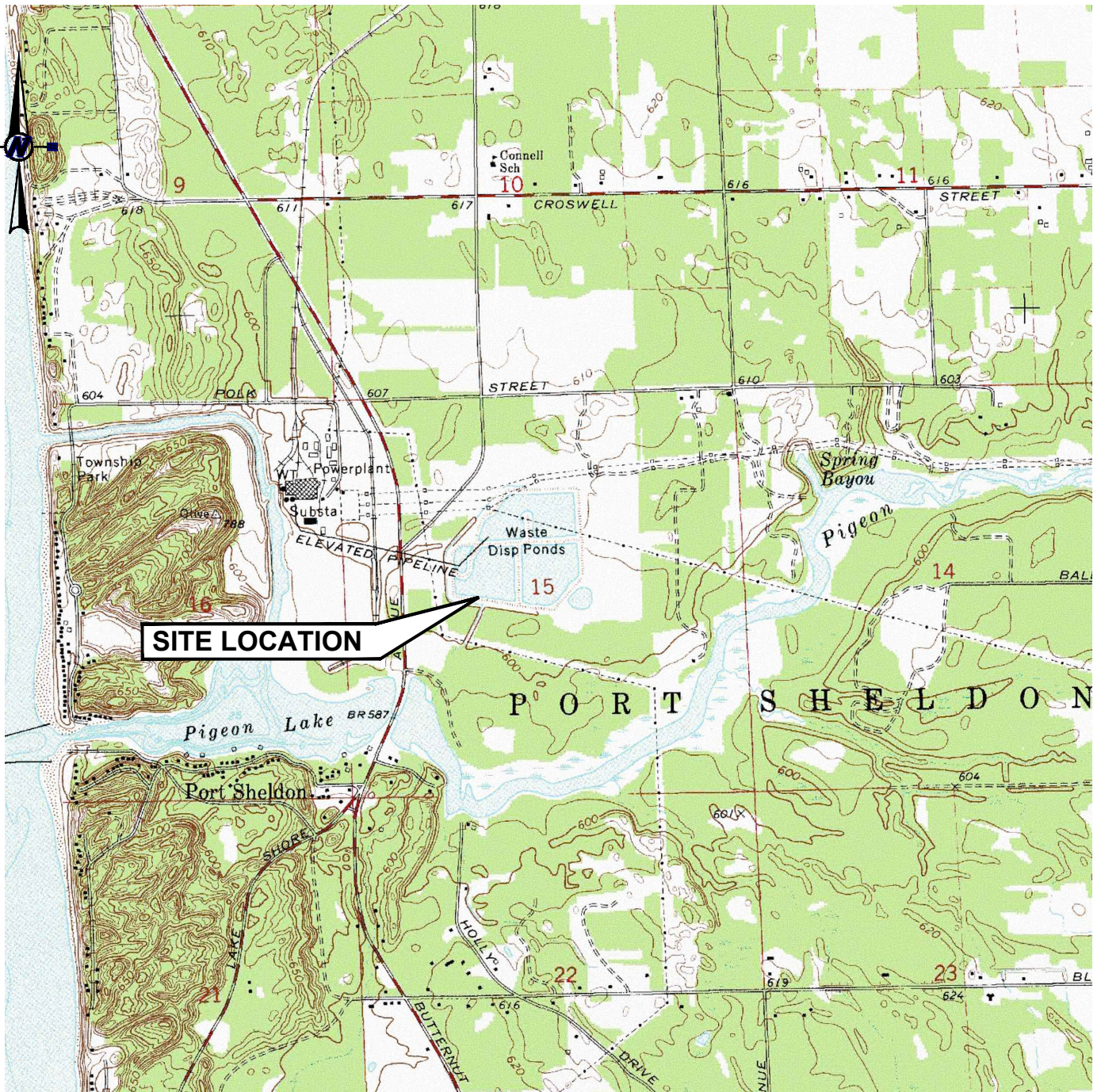
## 4.0 REFERENCES

Engineering & Environmental Solutions, LLC, 2015. J.H. Campbell Dry Landfill Airspace Evaluation

USEPA (US Environmental Protection Agency). 2015. Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 40 CFR Part 257. Effective Date October 19, 2015.



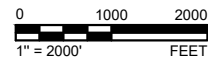
## FIGURES



**MICHIGAN COUNTIES**  
NOT TO SCALE

**REFERENCE(S)**

1. BASE MAP TAKEN FROM 7.5 MINUTE U.S.G.S. QUADRANGLES OF PORT SHELDON MICHIGAN, DOWNLOADED FROM MICHIGAN DNR WEBSITE JUNE 2016.



CLIENT  
**CONSUMERS ENERGY COMPANY**  
 17000 CROSWELL ST.  
 WEST OLIVE, MI 49460

CONSULTANT



YYYY-MM-DD	2016-06-06
DESIGNED	BAL
PREPARED	ARM
REVIEWED	DJS
APPROVED	MAB

PROJECT  
**J.H. CAMPBELL GENERATING FACILITY**  
**DRY ASH LANDFILL RUN-ON AND RUN-OFF CONTROL**  
**SYSTEM PLAN**

TITLE  
**SITE LOCATION MAP**

PROJECT NO.  
**1654923**

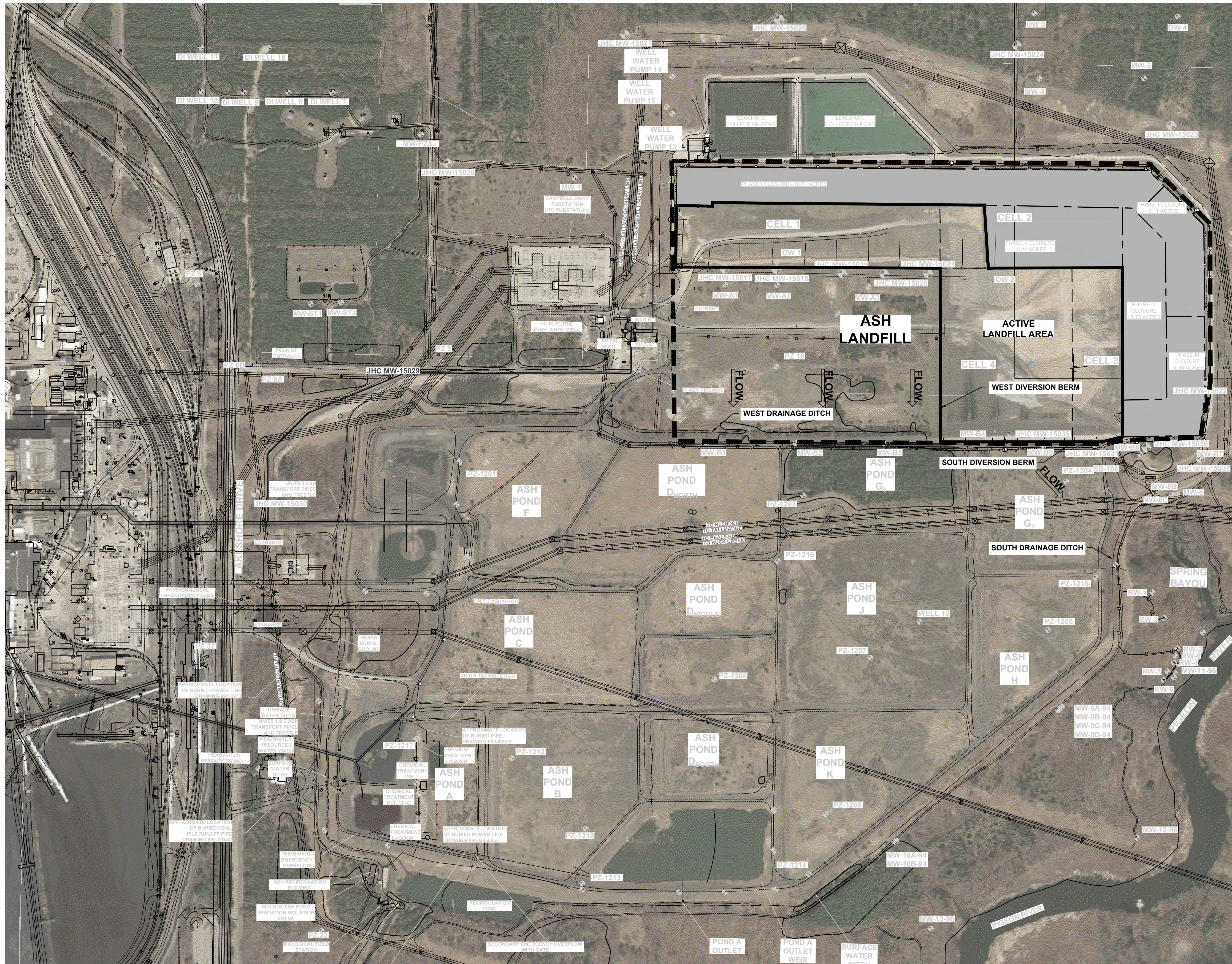
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FIGURE  
**1**

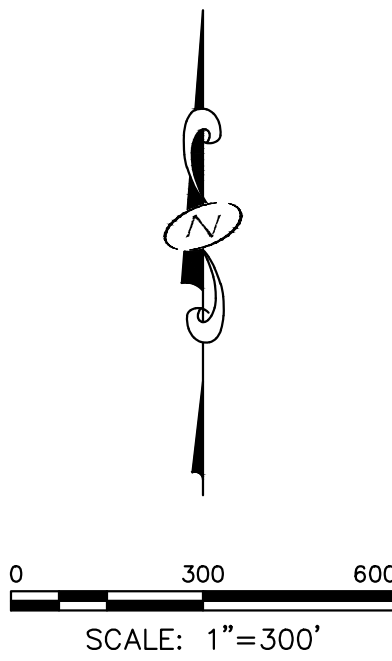
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**LEGEND**  
 MONITORING WELL



REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	BY	CHK	APP	REV	DATE	DESCRIPTION	BY	CHK	APP
							10/6/2016	FILED IN OWNER'S OPERATING RECORD		AM	DS	JP



J.H. CAMPBELL ASH STORAGE FACILITY

**EXISTING CONDITIONS**  
 SITE PLAN

SCALE	1" = 300'	DRAWING NO.	FIGURE	UNIT#
JOB	1654923		2	A



**APPENDIX A  
RAINFALL DATA**



**NOAA Atlas 14, Volume 8, Version 2**  
**Location name: West Olive, Michigan, US\***  
**Latitude: 42.9081°, Longitude: -86.1972°**  
**Elevation: 606 ft\***  
 \* source: Google Maps



**POINT PRECIPITATION FREQUENCY ESTIMATES**

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

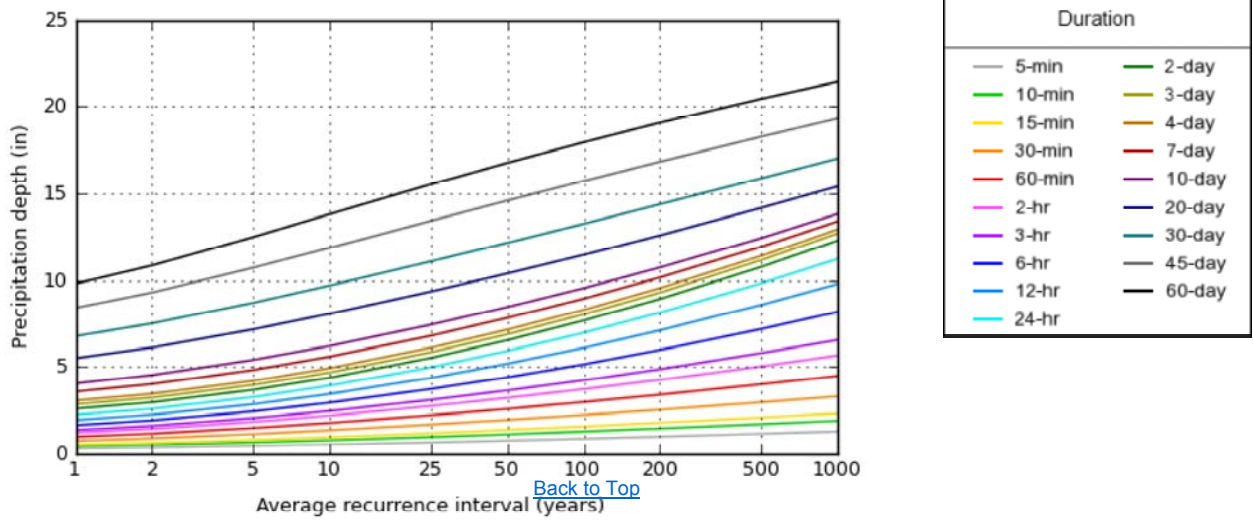
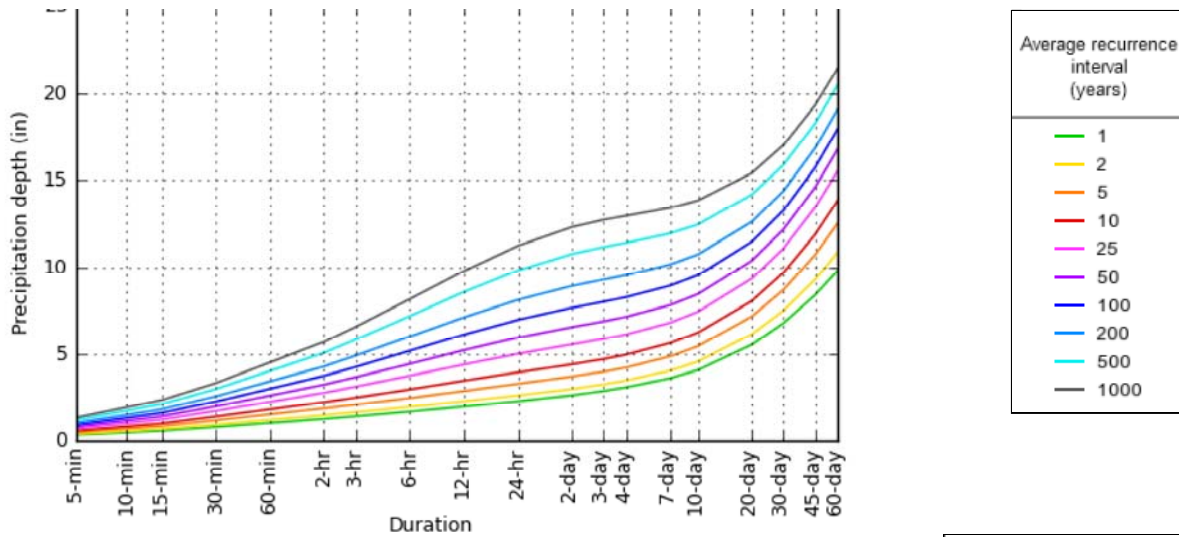
**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.307 (0.251-0.382)	0.362 (0.296-0.451)	0.459 (0.373-0.572)	0.544 (0.440-0.682)	0.671 (0.526-0.877)	0.776 (0.591-1.03)	0.886 (0.650-1.20)	1.01 (0.704-1.39)	1.17 (0.786-1.66)	1.30 (0.848-1.87)
10-min	0.450 (0.368-0.560)	0.531 (0.433-0.661)	0.671 (0.546-0.838)	0.797 (0.644-0.999)	0.982 (0.771-1.28)	1.14 (0.866-1.50)	1.30 (0.952-1.75)	1.47 (1.03-2.04)	1.71 (1.15-2.44)	1.91 (1.24-2.74)
15-min	0.549 (0.449-0.683)	0.647 (0.528-0.806)	0.819 (0.666-1.02)	0.972 (0.786-1.22)	1.20 (0.940-1.57)	1.39 (1.06-1.83)	1.58 (1.16-2.14)	1.79 (1.26-2.49)	2.09 (1.40-2.97)	2.33 (1.51-3.34)
30-min	0.768 (0.628-0.955)	0.907 (0.741-1.13)	1.15 (0.937-1.44)	1.37 (1.11-1.72)	1.69 (1.33-2.21)	1.96 (1.49-2.59)	2.24 (1.64-3.03)	2.54 (1.78-3.52)	2.96 (1.99-4.22)	3.30 (2.15-4.74)
60-min	0.999 (0.817-1.24)	1.18 (0.962-1.47)	1.50 (1.22-1.87)	1.79 (1.44-2.24)	2.22 (1.75-2.92)	2.59 (1.98-3.43)	2.98 (2.19-4.03)	3.40 (2.39-4.72)	4.00 (2.69-5.69)	4.48 (2.91-6.43)
2-hr	1.23 (1.01-1.52)	1.45 (1.19-1.79)	1.84 (1.51-2.28)	2.20 (1.80-2.74)	2.75 (2.18-3.58)	3.21 (2.48-4.23)	3.71 (2.75-4.99)	4.26 (3.01-5.87)	5.03 (3.41-7.11)	5.66 (3.71-8.05)
3-hr	1.38 (1.14-1.69)	1.62 (1.34-1.99)	2.06 (1.70-2.53)	2.47 (2.02-3.05)	3.10 (2.48-4.03)	3.64 (2.82-4.77)	4.23 (3.15-5.67)	4.87 (3.46-6.69)	5.79 (3.94-8.16)	6.54 (4.31-9.27)
6-hr	1.66 (1.38-2.01)	1.93 (1.61-2.34)	2.45 (2.03-2.98)	2.94 (2.43-3.60)	3.72 (3.01-4.81)	4.40 (3.44-5.73)	5.14 (3.87-6.86)	5.97 (4.29-8.16)	7.17 (4.93-10.0)	8.15 (5.41-11.5)
12-hr	1.95 (1.64-2.34)	2.26 (1.90-2.71)	2.85 (2.39-3.44)	3.44 (2.86-4.16)	4.36 (3.56-5.61)	5.18 (4.09-6.70)	6.08 (4.62-8.05)	7.09 (5.14-9.63)	8.56 (5.94-11.9)	9.78 (6.54-13.6)
24-hr	2.26 (1.91-2.68)	2.60 (2.20-3.09)	3.26 (2.75-3.89)	3.92 (3.28-4.70)	4.97 (4.09-6.34)	5.91 (4.71-7.58)	6.95 (5.32-9.12)	8.11 (5.93-10.9)	9.82 (6.87-13.6)	11.2 (7.58-15.5)
2-day	2.60 (2.23-3.07)	2.96 (2.53-3.49)	3.67 (3.13-4.34)	4.38 (3.70-5.20)	5.51 (4.58-6.96)	6.53 (5.24-8.29)	7.65 (5.91-9.96)	8.91 (6.57-11.9)	10.8 (7.60-14.7)	12.3 (8.37-16.9)
3-day	2.86 (2.45-3.34)	3.23 (2.77-3.78)	3.96 (3.38-4.65)	4.68 (3.97-5.52)	5.83 (4.86-7.31)	6.86 (5.54-8.66)	8.01 (6.21-10.4)	9.29 (6.88-12.3)	11.2 (7.91-15.2)	12.7 (8.69-17.4)
4-day	3.06 (2.64-3.57)	3.45 (2.97-4.02)	4.20 (3.60-4.91)	4.93 (4.20-5.79)	6.09 (5.09-7.59)	7.13 (5.77-8.95)	8.27 (6.43-10.6)	9.54 (7.09-12.6)	11.4 (8.11-15.5)	13.0 (8.88-17.6)
7-day	3.58 (3.10-4.13)	4.01 (3.48-4.64)	4.82 (4.16-5.59)	5.59 (4.79-6.51)	6.78 (5.68-8.31)	7.80 (6.34-9.68)	8.93 (6.98-11.3)	10.2 (7.58-13.3)	11.9 (8.54-16.0)	13.4 (9.25-18.1)
10-day	4.05 (3.53-4.65)	4.53 (3.94-5.21)	5.40 (4.68-6.23)	6.20 (5.34-7.18)	7.41 (6.21-9.00)	8.44 (6.87-10.4)	9.54 (7.48-12.0)	10.7 (8.04-13.9)	12.4 (8.92-16.6)	13.8 (9.59-18.6)
20-day	5.50 (4.83-6.25)	6.11 (5.36-6.95)	7.15 (6.25-8.16)	8.05 (6.99-9.23)	9.34 (7.85-11.1)	10.4 (8.50-12.5)	11.5 (9.04-14.2)	12.6 (9.49-16.1)	14.2 (10.2-18.6)	15.4 (10.8-20.6)
30-day	6.76 (5.97-7.64)	7.49 (6.61-8.47)	8.69 (7.64-9.86)	9.69 (8.47-11.1)	11.1 (9.34-13.0)	12.2 (10.0-14.6)	13.3 (10.5-16.3)	14.4 (10.9-18.2)	15.9 (11.5-20.7)	17.0 (12.0-22.6)
45-day	8.39 (7.45-9.43)	9.29 (8.23-10.4)	10.7 (9.47-12.1)	11.9 (10.4-13.5)	13.4 (11.3-15.6)	14.6 (12.0-17.3)	15.7 (12.5-19.1)	16.8 (12.7-21.1)	18.3 (13.2-23.6)	19.3 (13.6-25.5)
60-day	9.80 (8.73-11.0)	10.9 (9.66-12.2)	12.5 (11.1-14.0)	13.8 (12.2-15.6)	15.5 (13.1-17.9)	16.8 (13.8-19.7)	17.9 (14.3-21.7)	19.1 (14.5-23.8)	20.4 (14.9-26.3)	21.4 (15.2-28.2)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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**PF graphical**



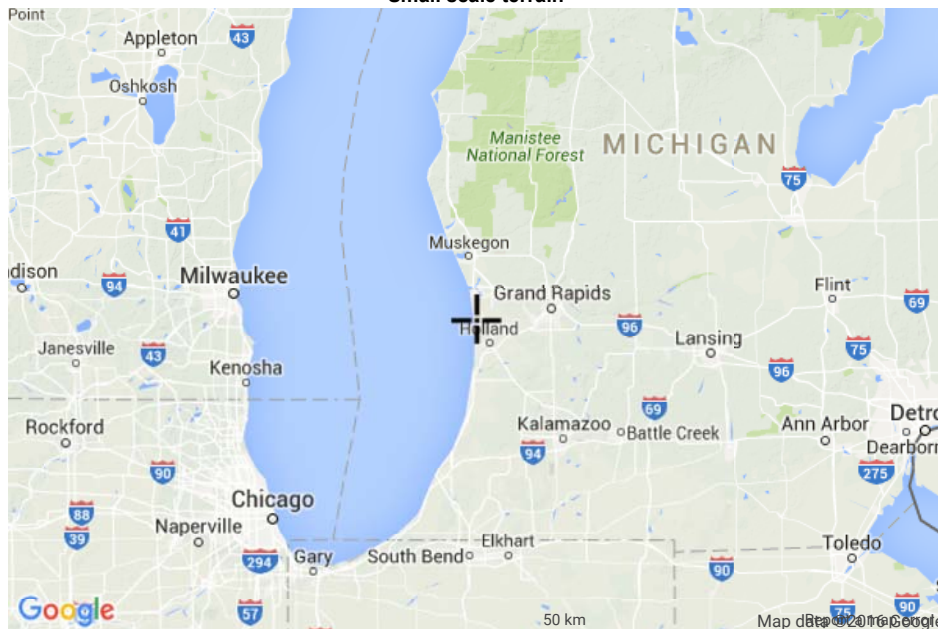
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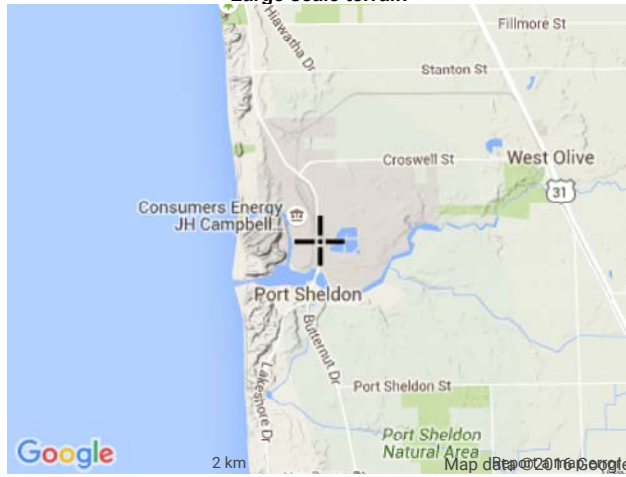
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**Small scale terrain**



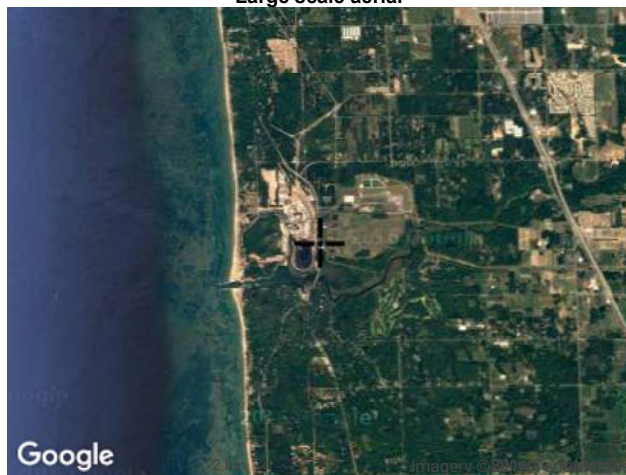
Large scale terrain



Large scale map



Large scale aerial



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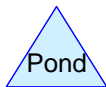
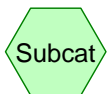
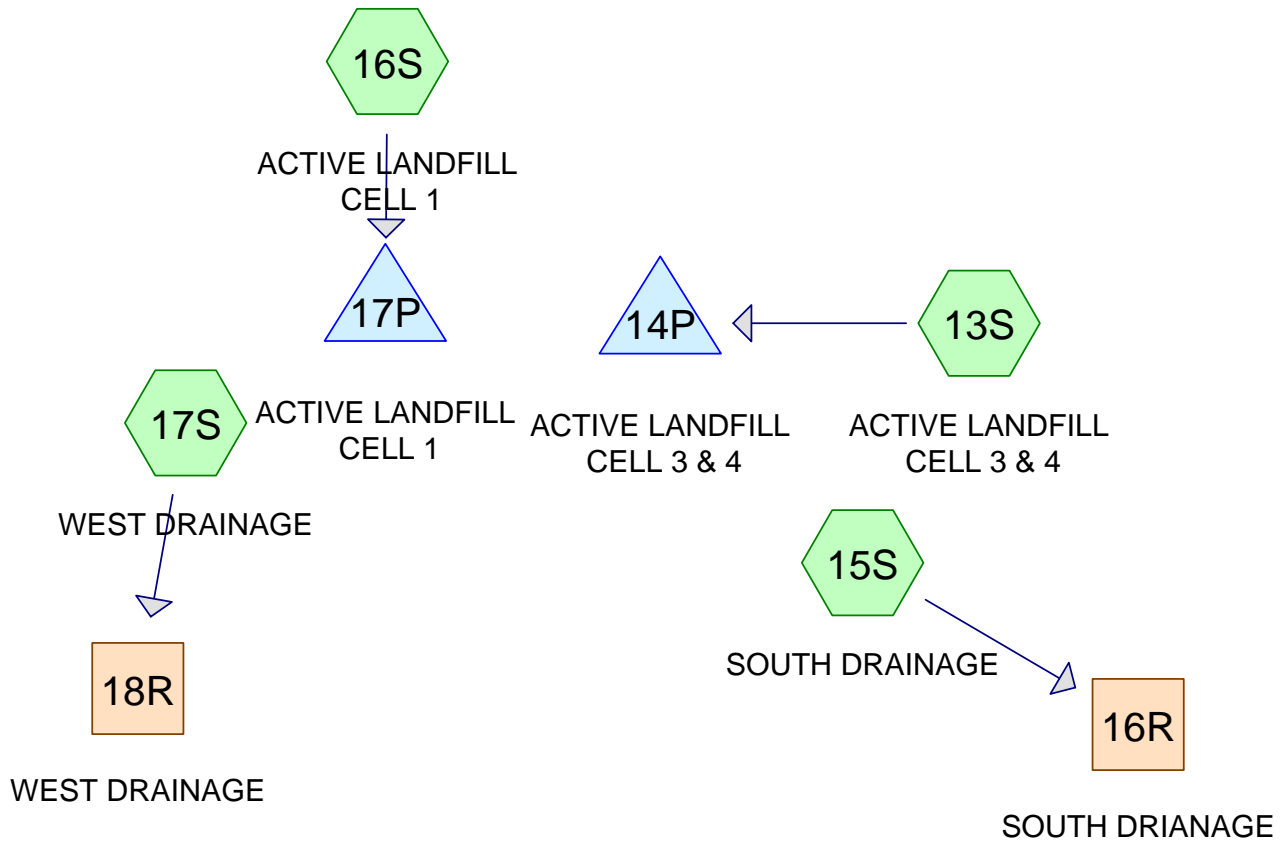
[US Department of Commerce](#)  
[National Oceanic and Atmospheric Administration](#)  
[National Weather Service](#)  
[National Water Center](#)  
1325 East West Highway  
Silver Spring, MD 20910

Questions?: [HDSC.Questions@noaa.gov](mailto:HDSC.Questions@noaa.gov)

[Disclaimer](#)



**APPENDIX B**  
**HYDROLOGIC AND HYDRAULIC MODEL OUTPUT**



## Campbell Landfill

Prepared by Golder Associates, Inc.

HydroCAD® 9.00 s/n 06044 © 2009 HydroCAD Software Solutions LLC

Page 2

### Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
51.610	79	50-75% Grass cover, Fair, HSG C (15S, 17S)
37.980	79	<50% Grass cover, Poor, HSG B (13S, 16S)
<b>89.590</b>		<b>TOTAL AREA</b>

# Campbell Landfill

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HydroCAD® 9.00 s/n 06044 © 2009 HydroCAD Software Solutions LLC

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## Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
37.980	HSG B	13S, 16S
51.610	HSG C	15S, 17S
0.000	HSG D	
0.000	Other	
<b>89.590</b>		<b>TOTAL AREA</b>

## Campbell Landfill

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### Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)
1	14P	608.00	607.88	50.0	0.0024	0.013	8.0	0.0
2	17P	610.00	609.88	50.0	0.0024	0.013	8.0	0.0

**Campbell Landfill**

Type II 24-hr 25-YEAR Rainfall=4.97"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points  
 Runoff by SCS TR-20 method, UH=SCS  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 13S: ACTIVE LANDFILL** Runoff Area=1,052,735 sf 0.00% Impervious Runoff Depth>2.77"  
 Flow Length=562' Slope=0.1493 '/' Tc=3.2 min CN=79 Runoff=127.67 cfs 5.588 af

**Subcatchment 15S: SOUTH DRAINAGE** Runoff Area=729,492 sf 0.00% Impervious Runoff Depth>2.74"  
 Flow Length=948' Slope=0.0032 '/' Tc=55.9 min CN=79 Runoff=26.08 cfs 3.818 af

**Subcatchment 16S: ACTIVE LANDFILL** Runoff Area=601,674 sf 0.00% Impervious Runoff Depth>2.78"  
 Flow Length=286' Slope=0.1493 '/' Tc=2.5 min CN=79 Runoff=73.51 cfs 3.194 af

**Subcatchment 17S: WEST DRAINAGE** Runoff Area=1,518,653 sf 0.00% Impervious Runoff Depth>2.76"  
 Flow Length=544' Slope=0.0074 '/' Tc=26.7 min CN=79 Runoff=90.33 cfs 8.011 af

**Reach 16R: SOUTH DRAINAGE** Avg. Depth=0.81' Max Vel=2.41 fps Inflow=26.08 cfs 3.818 af  
 n=0.030 L=4,956.0' S=0.0040 '/' Capacity=2,681.96 cfs Outflow=18.75 cfs 3.657 af

**Reach 18R: WEST DRAINAGE** Avg. Depth=2.91' Max Vel=2.56 fps Inflow=90.33 cfs 8.011 af  
 n=0.030 L=1,868.0' S=0.0013 '/' Capacity=78.12 cfs Outflow=72.85 cfs 7.899 af

**Pond 14P: ACTIVE LANDFILL CELL 3 &** Peak Elev=609.09' Storage=204,287 cf Inflow=127.67 cfs 5.588 af  
 8.0" Round Culvert n=0.013 L=50.0' S=0.0024 '/' Outflow=0.96 cfs 0.898 af

**Pond 17P: ACTIVE LANDFILL CELL 1** Peak Elev=613.92' Storage=77,223 cf Inflow=73.51 cfs 3.194 af  
 8.0" Round Culvert n=0.013 L=50.0' S=0.0024 '/' Outflow=2.40 cfs 2.383 af

**Total Runoff Area = 89.590 ac Runoff Volume = 20.611 af Average Runoff Depth = 2.76"**  
**100.00% Pervious = 89.590 ac 0.00% Impervious = 0.000 ac**

**Campbell Landfill**

Type II 24-hr 25-YEAR Rainfall=4.97"

Prepared by Golder Associates, Inc.

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**Summary for Subcatchment 13S: ACTIVE LANDFILL CELL 3 & 4**

Runoff = 127.67 cfs @ 11.94 hrs, Volume= 5.588 af, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-YEAR Rainfall=4.97"

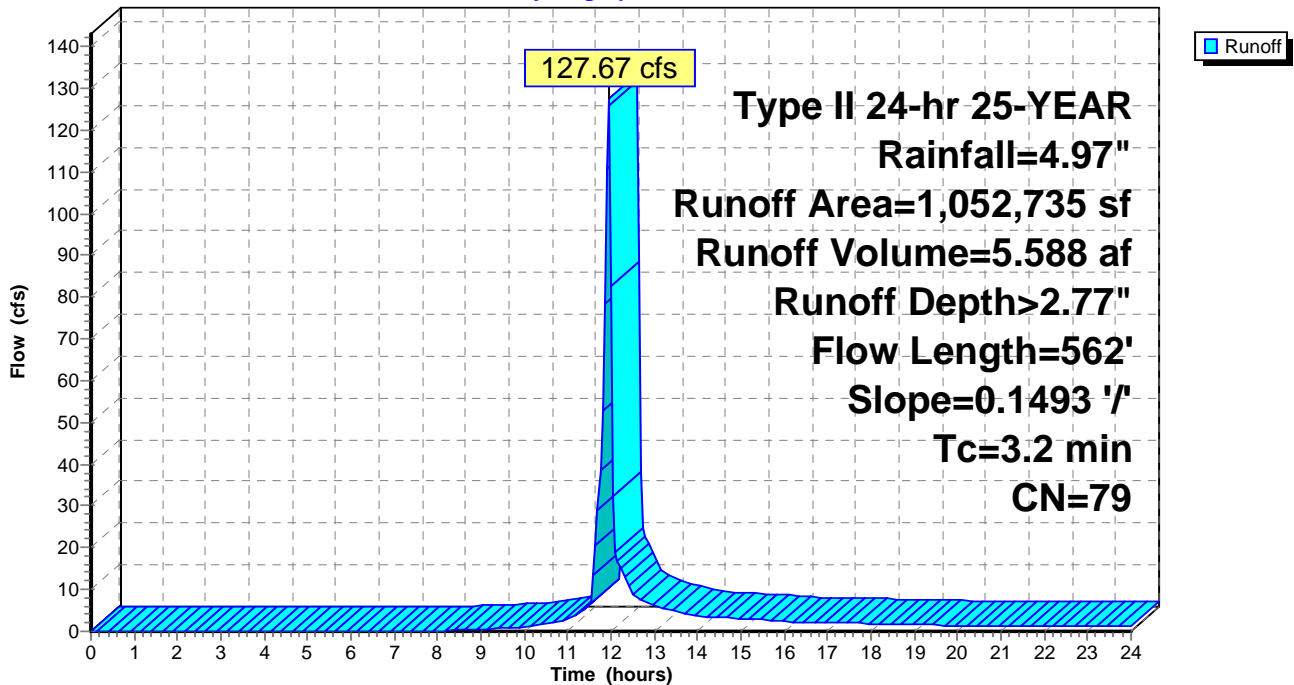
Area (sf)	CN	Description
1,052,735	79	<50% Grass cover, Poor, HSG B
1,052,735		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.1493	0.83		<b>Sheet Flow,</b> Fallow n= 0.050 P2= 2.60"
1.2	462	0.1493	6.22		<b>Shallow Concentrated Flow,</b> Unpaved Kv= 16.1 fps
3.2	562	Total			

**Subcatchment 13S: ACTIVE LANDFILL CELL 3 & 4**

Hydrograph



**Summary for Subcatchment 15S: SOUTH DRAINAGE**

Runoff = 26.08 cfs @ 12.58 hrs, Volume= 3.818 af, Depth> 2.74"

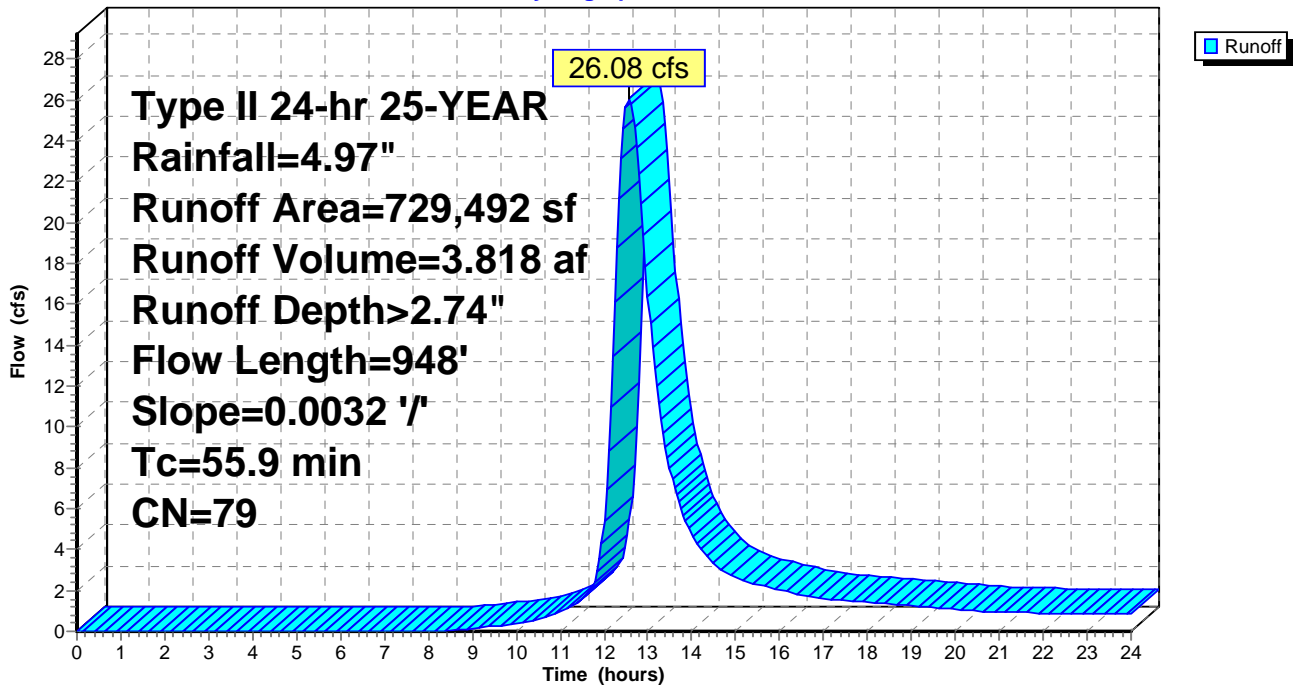
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-YEAR Rainfall=4.97"

Area (sf)	CN	Description
729,492	79	50-75% Grass cover, Fair, HSG C
729,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.2	100	0.0032	0.08		<b>Sheet Flow,</b> Range n= 0.130 P2= 2.60"
35.7	848	0.0032	0.40		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
55.9	948	Total			

**Subcatchment 15S: SOUTH DRAINAGE**

Hydrograph





**Summary for Subcatchment 16S: ACTIVE LANDFILL CELL 1**

Runoff = 73.51 cfs @ 11.93 hrs, Volume= 3.194 af, Depth> 2.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-YEAR Rainfall=4.97"

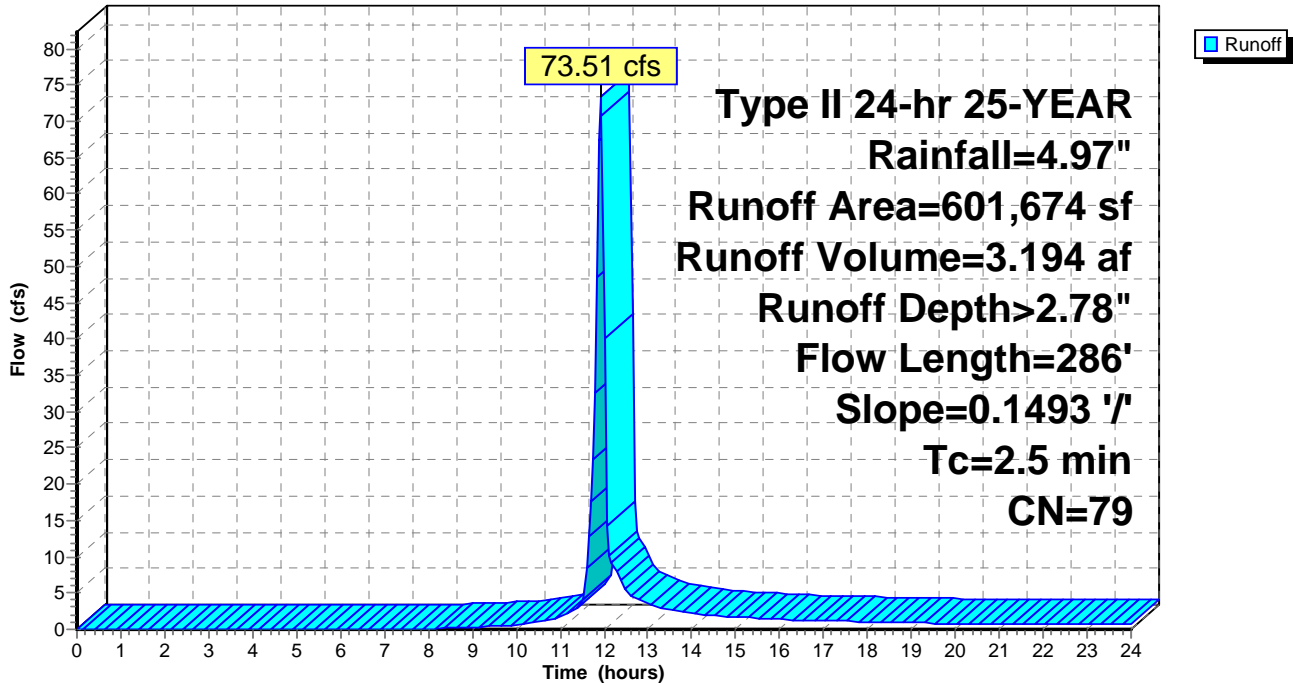
Area (sf)	CN	Description
601,674	79	<50% Grass cover, Poor, HSG B
601,674		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.1493	0.83		<b>Sheet Flow,</b> Fallow n= 0.050 P2= 2.60"
0.5	186	0.1493	6.22		<b>Shallow Concentrated Flow,</b> Unpaved Kv= 16.1 fps
2.5	286	Total			

**Subcatchment 16S: ACTIVE LANDFILL CELL 1**

Hydrograph



**Summary for Subcatchment 17S: WEST DRAINAGE**

Runoff = 90.33 cfs @ 12.21 hrs, Volume= 8.011 af, Depth> 2.76"

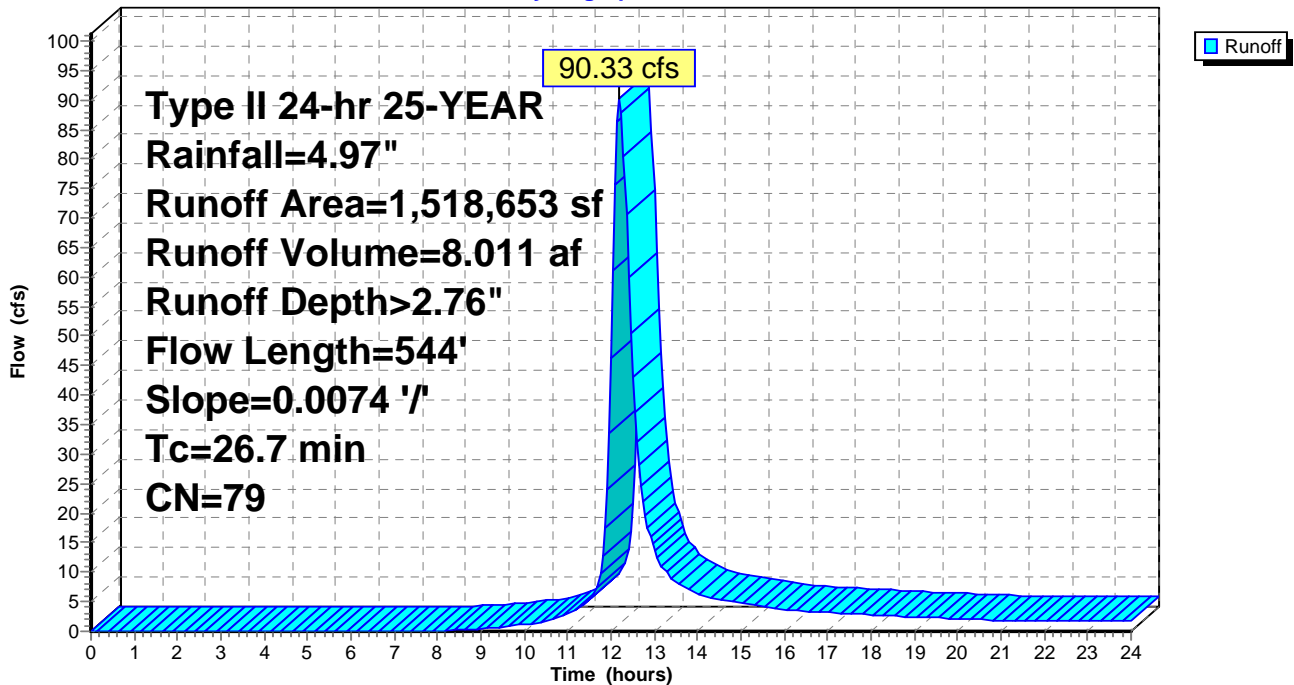
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Type II 24-hr 25-YEAR Rainfall=4.97"

Area (sf)	CN	Description
1,518,653	79	50-75% Grass cover, Fair, HSG C
1,518,653		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.4	100	0.0074	0.12		<b>Sheet Flow,</b> Range n= 0.130 P2= 2.60"
12.3	444	0.0074	0.60		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
26.7	544	Total			

**Subcatchment 17S: WEST DRAINAGE**

Hydrograph



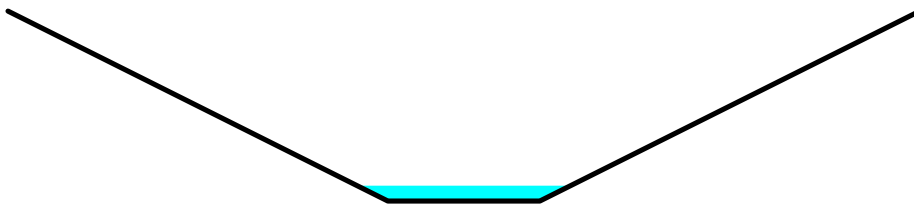
### Summary for Reach 16R: SOUTH DRIANAGE

Inflow Area = 16.747 ac, 0.00% Impervious, Inflow Depth > 2.74" for 25-YEAR event  
 Inflow = 26.08 cfs @ 12.58 hrs, Volume= 3.818 af  
 Outflow = 18.75 cfs @ 13.49 hrs, Volume= 3.657 af, Atten= 28%, Lag= 54.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Max. Velocity= 2.41 fps, Min. Travel Time= 34.3 min  
 Avg. Velocity = 1.08 fps, Avg. Travel Time= 76.7 min

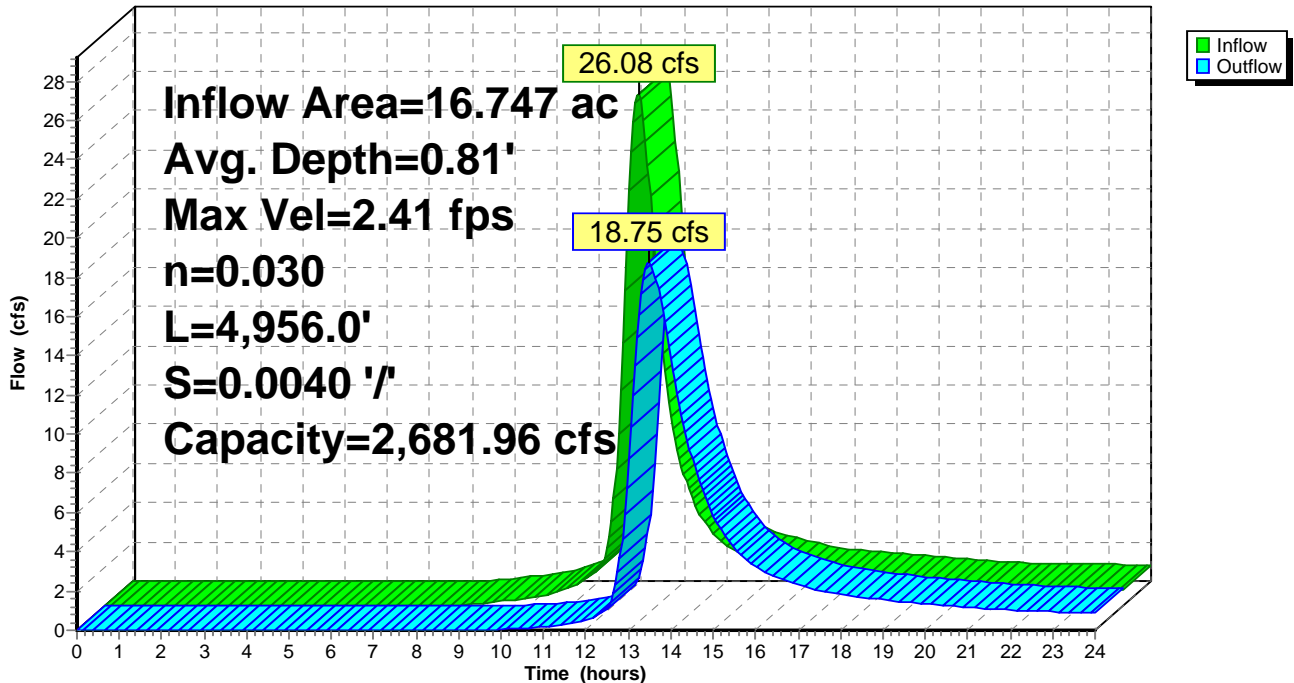
Peak Storage= 38,604 cf @ 12.92 hrs, Average Depth at Peak Storage= 0.81'  
 Bank-Full Depth= 10.00', Capacity at Bank-Full= 2,681.96 cfs

8.00' x 10.00' deep channel, n= 0.030  
 Side Slope Z-value= 2.0 '/' Top Width= 48.00'  
 Length= 4,956.0' Slope= 0.0040 '/'  
 Inlet Invert= 610.00', Outlet Invert= 590.00'

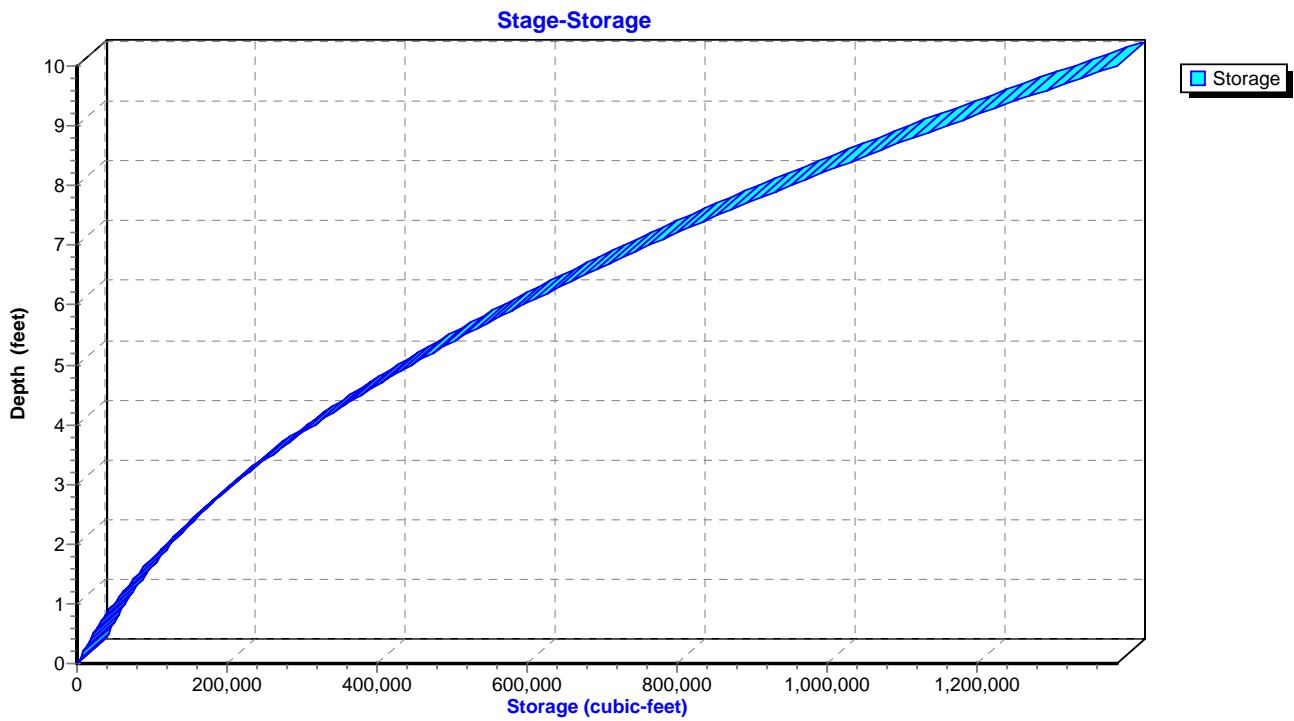


### Reach 16R: SOUTH DRIANAGE

Hydrograph



### Reach 16R: SOUTH DRIANAGE



### Summary for Reach 18R: WEST DRAINAGE

Inflow Area = 34.863 ac, 0.00% Impervious, Inflow Depth > 2.76" for 25-YEAR event  
Inflow = 90.33 cfs @ 12.21 hrs, Volume= 8.011 af  
Outflow = 72.85 cfs @ 12.54 hrs, Volume= 7.899 af, Atten= 19%, Lag= 20.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Max. Velocity= 2.56 fps, Min. Travel Time= 12.2 min  
Avg. Velocity = 1.03 fps, Avg. Travel Time= 30.3 min

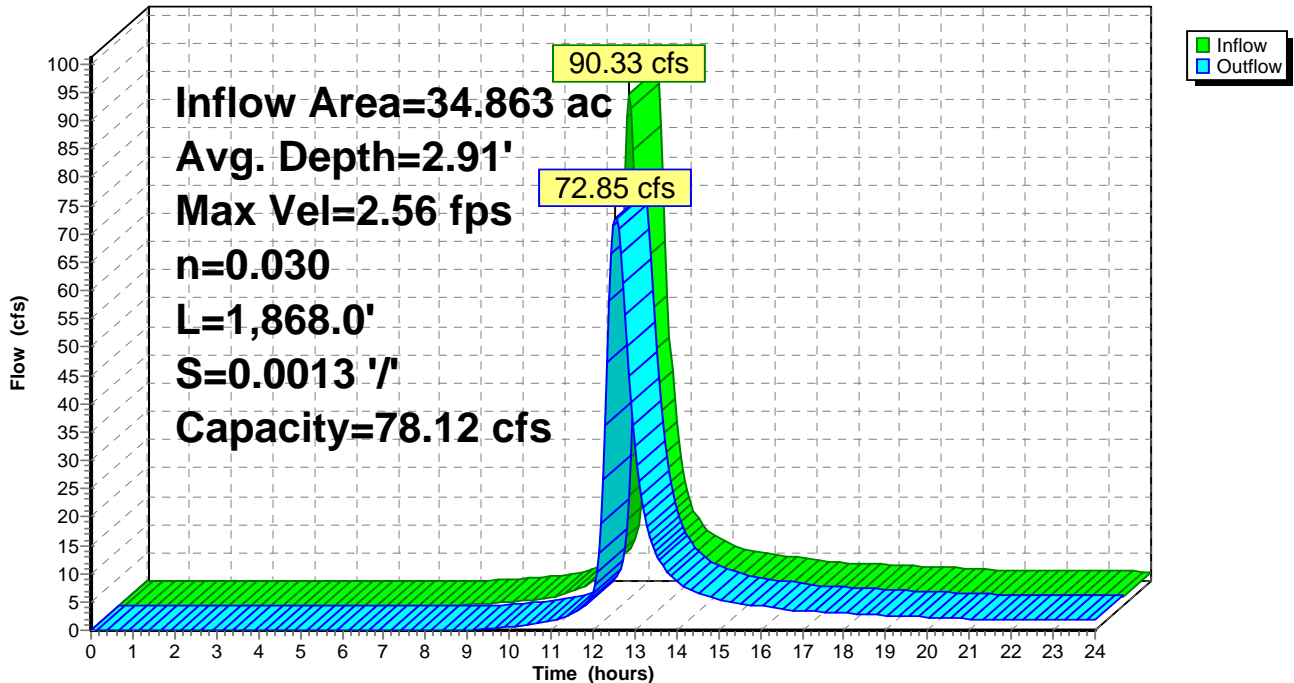
Peak Storage= 53,255 cf @ 12.34 hrs, Average Depth at Peak Storage= 2.91'  
Bank-Full Depth= 3.00', Capacity at Bank-Full= 78.12 cfs

4.00' x 3.00' deep channel, n= 0.030  
Side Slope Z-value= 2.0 '/' Top Width= 16.00'  
Length= 1,868.0' Slope= 0.0013 '/'  
Inlet Invert= 606.00', Outlet Invert= 603.50'

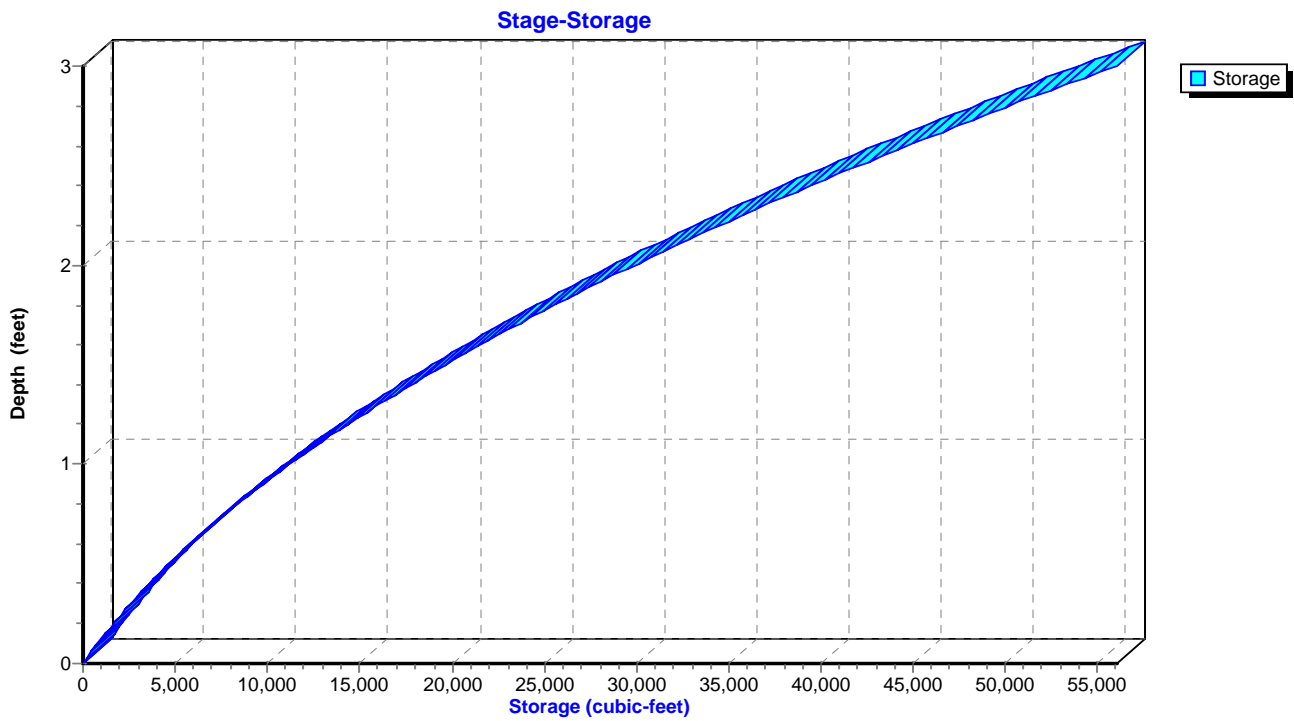


### Reach 18R: WEST DRAINAGE

Hydrograph



### Reach 18R: WEST DRAINAGE



**Summary for Pond 14P: ACTIVE LANDFILL CELL 3 & 4**

Inflow Area = 24.167 ac, 0.00% Impervious, Inflow Depth > 2.77" for 25-YEAR event  
 Inflow = 127.67 cfs @ 11.94 hrs, Volume= 5.588 af  
 Outflow = 0.96 cfs @ 24.00 hrs, Volume= 0.898 af, Atten= 99%, Lag= 723.7 min  
 Primary = 0.96 cfs @ 24.00 hrs, Volume= 0.898 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Peak Elev= 609.09' @ 24.00 hrs Surf.Area= 233,193 sf Storage= 204,287 cf

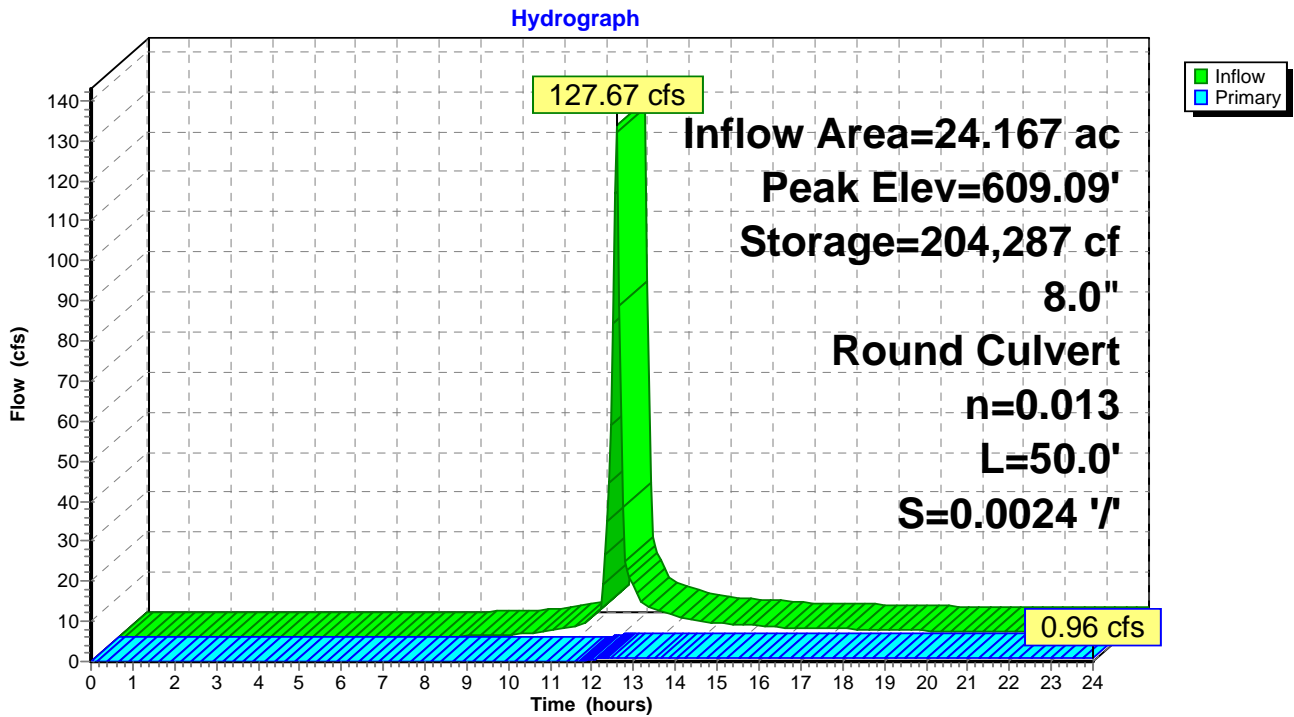
Plug-Flow detention time= 420.1 min calculated for 0.898 af (16% of inflow)  
 Center-of-Mass det. time= 273.0 min ( 1,091.7 - 818.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	608.00'	761,213 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
608.00	143,183	0	0
610.00	309,015	452,198	452,198
611.00	309,015	309,015	761,213

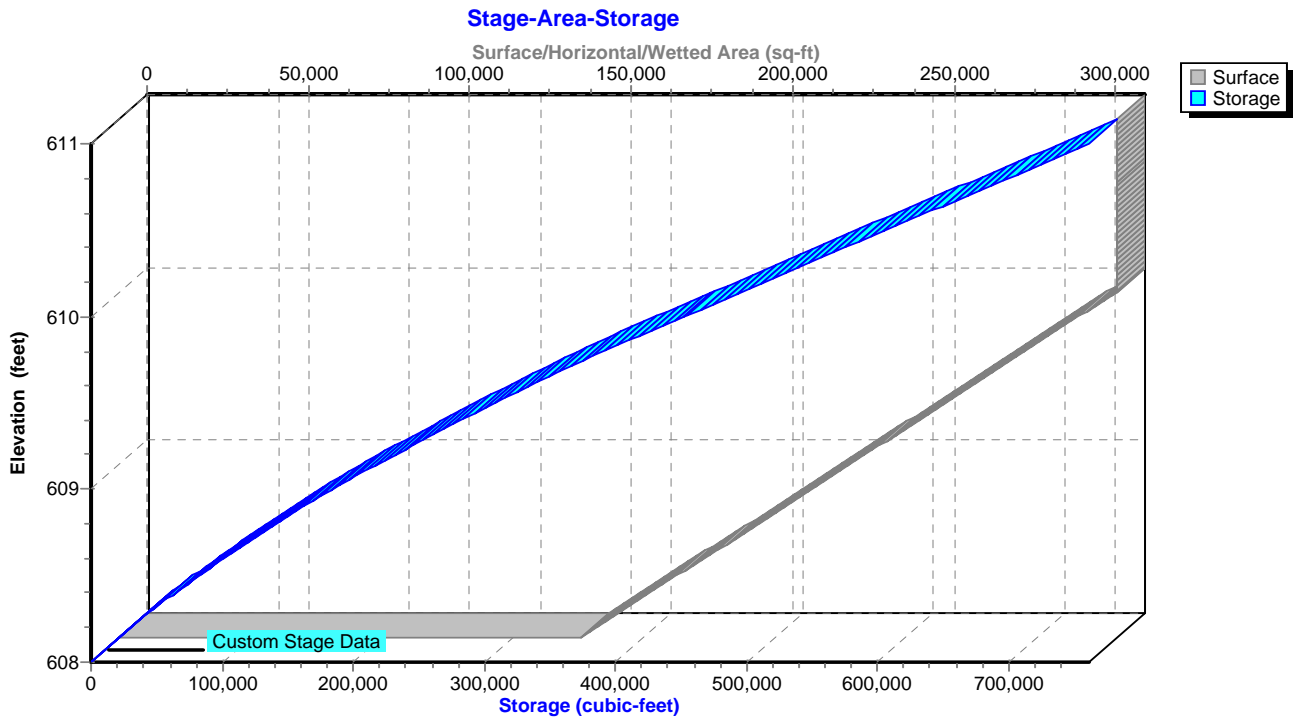
Device	Routing	Invert	Outlet Devices
#1	Primary	608.00'	<b>8.0" Round Culvert</b> L= 50.0' CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 607.88' S= 0.0024 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

**Primary OutFlow** Max=0.96 cfs @ 24.00 hrs HW=609.09' (Free Discharge)  
 ↑1=Culvert (Barrel Controls 0.96 cfs @ 2.75 fps)

### Pond 14P: ACTIVE LANDFILL CELL 3 & 4



### Pond 14P: ACTIVE LANDFILL CELL 3 & 4





**Campbell Landfill**

Type II 24-hr 25-YEAR Rainfall=4.97"

Prepared by Golder Associates, Inc.

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**Summary for Pond 17P: ACTIVE LANDFILL CELL 1**

Inflow Area = 13.813 ac, 0.00% Impervious, Inflow Depth > 2.78" for 25-YEAR event  
 Inflow = 73.51 cfs @ 11.93 hrs, Volume= 3.194 af  
 Outflow = 2.40 cfs @ 13.76 hrs, Volume= 2.383 af, Atten= 97%, Lag= 109.6 min  
 Primary = 2.40 cfs @ 13.76 hrs, Volume= 2.383 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Peak Elev= 613.92' @ 13.76 hrs Surf.Area= 41,365 sf Storage= 77,223 cf

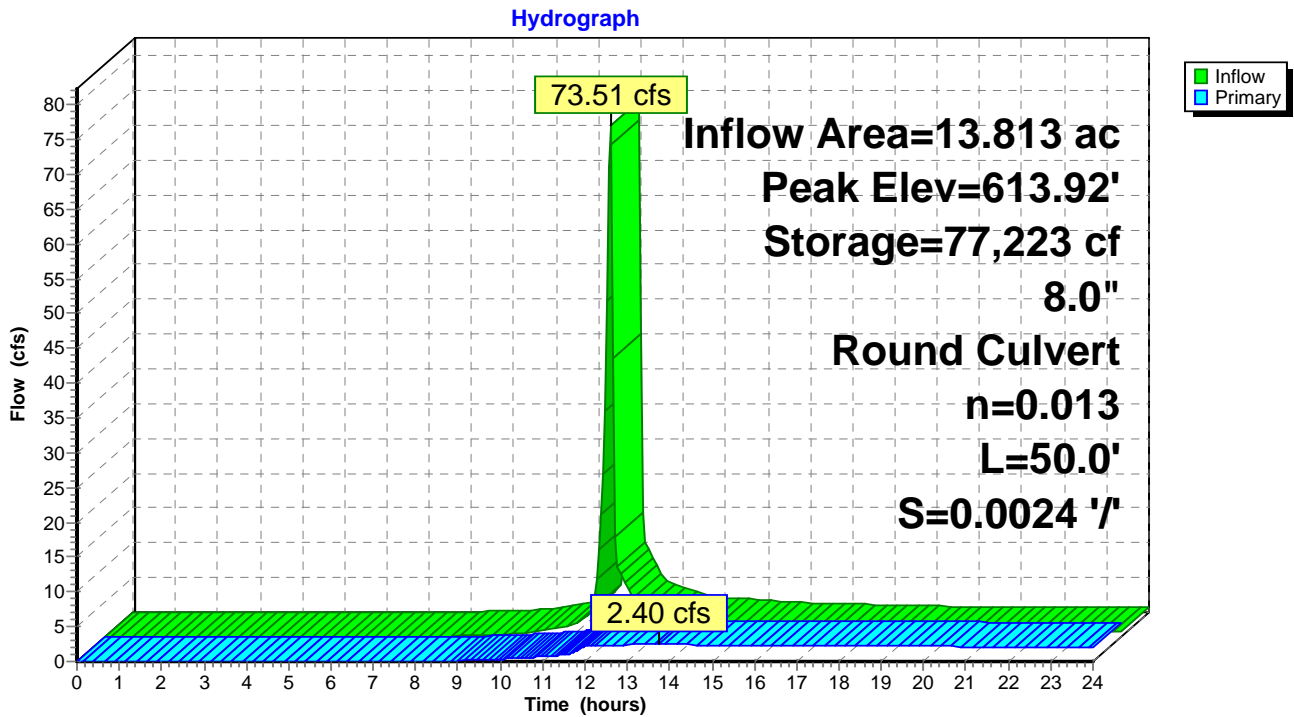
Plug-Flow detention time= 316.2 min calculated for 2.378 af (74% of inflow)  
 Center-of-Mass det. time= 222.0 min ( 1,040.3 - 818.2 )

Volume	Invert	Avail.Storage	Storage Description
#1	610.00'	80,584 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
610.00	355	0	0
612.00	18,963	19,318	19,318
614.00	42,303	61,266	80,584

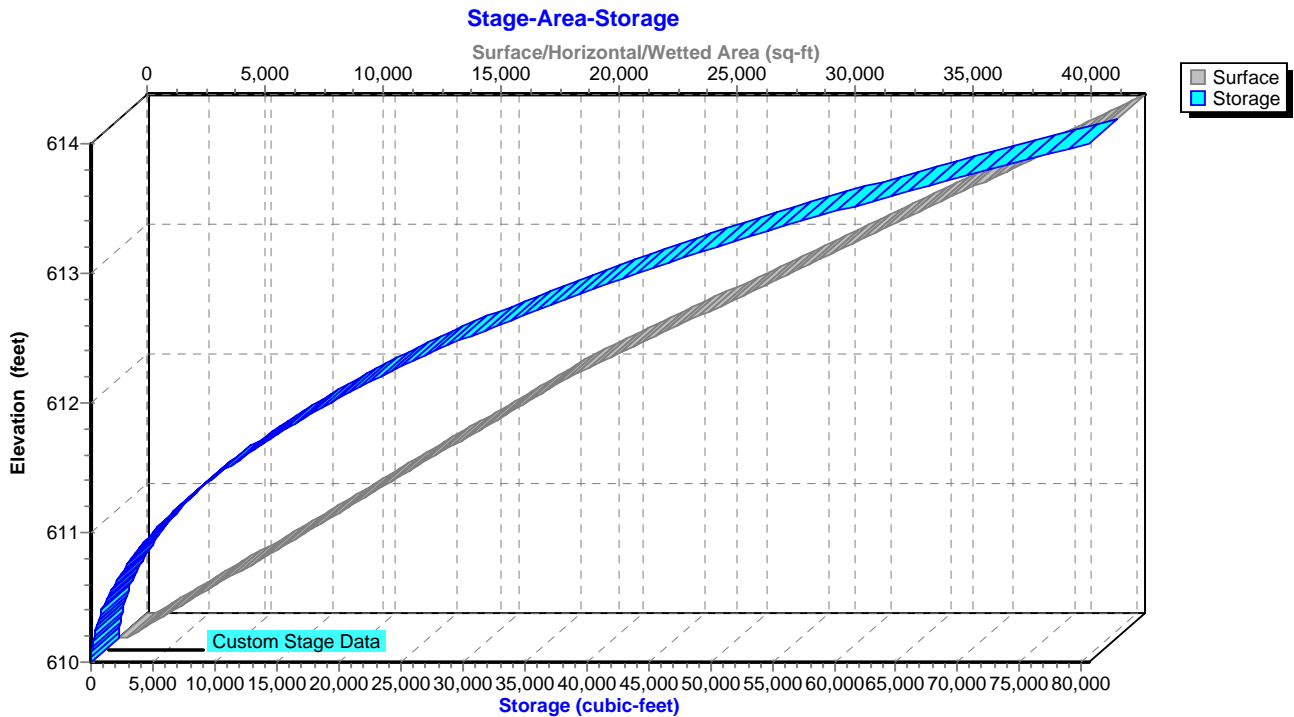
Device	Routing	Invert	Outlet Devices
#1	Primary	610.00'	<b>8.0" Round Culvert</b> L= 50.0' CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 609.88' S= 0.0024 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

**Primary OutFlow** Max=2.40 cfs @ 13.76 hrs HW=613.92' (Free Discharge)  
 ↑1=Culvert (Barrel Controls 2.40 cfs @ 6.88 fps)

### Pond 17P: ACTIVE LANDFILL CELL 1



### Pond 17P: ACTIVE LANDFILL CELL 1



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