# Jeffrey Energy Center
# FGD Landfill 1A/1B
# Run-On and Run-Off Control System Plan

Jeffrey Energy Center
25905 Jeffrey Rd.
St. Marys, Kansas

Prepared for:

Evergy Kansas Central, Inc.

SCS ENGINEERS

25221157.00 | October 2021

40 Shuman Blvd, Ste 216
Naperville, IL 60563

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Appendices

# PLAN REVIEW/AMENDMENT LOG

| Date of Review | Reviewer Name | Amendment Required (YES/NO) | Sections Amended and Reason |
|---|---|---|---|
| October 2016 (Revision 0) | CB&I Environmental & Infrastructure, Inc. | N/A | Initial Plan |
| October 2021 (Revision 1) | SCS Engineers | YES | All sections revised / updated as part of the 5-year periodic review process. |
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# PROFESSIONAL ENGINEER CERTIFICATION

I, Richard D. Southorn, hereby certify that this Run-On and Run-Off Control System Plan meets the requirements of 40 CFR §257.81, was prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Kansas.

This plan has been prepared as a periodic update to the initial Run-On and Run-Off Control System Plan that was certified on October 17, 2016.


Richard D. Southorn, PE

License No. PE 25201

Expires 4/30/2023

# 1.0 INTRODUCTION

The FGD Landfill (Landfill) is an existing coal combustion residual (CCR) landfill located at Evergy's Jeffrey Energy Center near St. Marys, Kansas. This Run-on and Run-off Control System Plan (RORO Plan) documents that the Landfill's run-on and run-off control systems for the active portions of the landfill (currently Phases 1A and 1B) meet the applicable requirements of Title 40 Code of Federal Regulations (CFR) §257.81[1] of the CCR Rule.

# 2.0 REGULATORY REQUIREMENTS

40 CFR §257.81 Run-on and run-off controls for CCR landfills.

(a) 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:

(1) 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; and

(2) 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.

(b) 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[1].

(c) Run-on and run-off control system plan

(1) Content of the plan. The owner or operator must prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (4) of this section. These plans must document how the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of this section. Each plan must be supported by appropriate engineering calculations. The owner or operator has completed the initial run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by 40 CFR §257.105(g)(3).

With reference to 40 CFR §257.81(c) above, the Initial RORO Plan was required to be developed no later than October 17, 2016 for existing landfills (40 CFR §257.81(c)(3)(i))[1]. Updates to the RORO Plan are required whenever there is a change in conditions that would substantially affect the written plan in effect (40 CFR §257.81(2)[1], or within five years of the previous plan (40 CFR §257.81(c)(4))[1].

The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the initial and periodic RORO Plans meet the requirements of 40 CFR §257.81[1].

# 3.0 2021 RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

This document has been prepared as the periodic update to the initial RORO Plan. This plan has been developed to reflect run-on and run-off controls that are being used at the facility at the time of this report. As such, this plan replaces the previous RORO Plan. The current run-on and run-off control systems at the Landfill have been reviewed as part of this 2021 Periodic RORO Plan update and have been found to meet the requirements of 40 CFR §257.81(a)[1], as outlined in Section 2.0.

Conveyance features that comprise the run-on and run-off control systems at the Landfill are depicted in **Figure 1**. Storm water calculations supporting the below discussion are included in **Appendices A through C.**

## 3.1 RUN-ON CONTROL SYSTEM

The active portion of Phase 1A/1B of the Landfill is surrounded by a containment berm that is designed to prevent contact water run-off. This containment berm is approximately six feet higher than the surrounding exterior grades at its lowest point. The surrounding grades outside of this berm all slope away from the active area of the Landfill. Inactive areas with final cover outside of the containment berm are not included in this evaluation.

## 3.2 RUN-OFF CONTROL SYSTEM

As mentioned in Section 3.1, a containment berm has been constructed around the entire Phase 1A/1B active disposal area. The active portion of the Landfill ranges between four feet (in the south) and twenty feet (in the north) below the containment berm. The active area is graded to flow to the north. Direct precipitation falling on the active portion of the Landfill (contact water) is fully contained within the berm.

Contact water flows over the surface of the active area and temporarily collects in the north. It is then conveyed through a pipe and discharges into a downchute lined with riprap. The downchute discharges into the South Bypass Ditch, which ultimately drains to Tower Hill Lake. The run-off control system is depicted in **Figure1**.

Tower Hill Lake is located immediately to the northwest of the Landfill and is permitted to receive non-contact water, contact water, and leachate from the JEC, including multiple landfills and surface impoundments under the facility's National Pollutant Discharge Elimination System (NPDES) Permit In accordance with 40 CFR §257.81(b)[1], this is consistent with the surface water requirements under 40 CFR §257.3-3[1].

## 3.3 HYDROLOGIC AND HYDRAULIC ANALYSIS

Engineering calculations to evaluate the run-off control system at the Landfill consist of a hydrologic and hydraulic storm water model prepared using HydroCAD storm water modeling software. Run-on analyses are not applicable because all surrounding areas slope away from the active area of the Landfill. The run-off control system model for the Landfill is provided in **Appendix B.** A regional model evaluating the capacity within Tower Hill Lake is provided in **Appendix C.** Information used to prepare the HydroCAD storm water model is summarized below.

### 3.3.1 Rainfall Data

Rainfall amounts for the 25-year, 24-hour storm were obtained from the Rainfall Intensity Tables for Counties in Kansas (2014) prepared by Kansas Department of Transportation. This document provides rainfall intensities for various durations and recurrence intervals, displayed in rainfall intensity tables for each county in Kansas. The rainfall intensity table applicable to the Landfill is the table prepared for Pottawatomie County (**Appendix A**). The 25-year, 24-hour rainfall amount for the Landfill was determined to be 6.00-inches, based on a rainfall rate of 0.25 inches/hour for 24 hours.

The Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), Technical Release 55 (TR-55) was consulted to determine the appropriate storm water distribution pattern to model the rainfall depth in HydroCAD. According to TR-55[2], the Type-II 24-hour storm distribution is appropriate for all counties located in Kansas.

### 3.3.2 Model Input Parameters

Subcatchment areas (also known as watersheds) were delineated using AutoCAD Civil3D 2020 (AutoCAD) based on topographic divides within the analyzed area. Run-off from each subcatchment area was calculated using the NRCS-SCS Technical Release 20 (TR-20) method that utilizes curve numbers and flow length parameters to calculate storm water run-off. These areas are depicted in **Figure 1**.

For the regional Tower Hill Lake model, the subcatchment area was delineated using the United States Geological Survey (USGS) 7.5-minutre topographic quadrangle map. This subcatchment area is depicted in **Figure 2**.

For the regional Tower Hill Lake model, the subcatchment area was delineated using the United States Geological Survey (USGS) 7.5-minutre topographic quadrangle map. This subcatchment area is depicted in **Figure 2**.

The Curve number (CN) is a parameter used to determine the amount of runoff that will occur from a surface. High CN values indicate that the majority of rainfall will run off with minimal losses. Lower values correspond to an increased ability of rainfall to infiltrate the ground surface, leading to lower run off rates.

A curve number of 91.6 was selected for all areas with surficial FGD material, based on a review of the Hydrologic Evaluation of Landfill Performance (HELP) model completed as part of the 2009 Solid Waste Permit Application.

For Landfill covers associated with the regional Tower Hill Lake model, the soil type and ground cover were considered to select the appropriate curve number using NRCS lookup tables. According to the NRCS Web Soil Survey for Pottawatomie County[3], the predominant soil type within the Jeffrey Energy Center footprint is Hydrologic Soil Group D (HSG-D). HSG-D soils provide the highest curve numbers of all soil types. Therefore, all subcatchment areas have been modeled with this soil type designation.

The land cover applicable for the regional Tower Hill Lake model consists of open space with good grass cover (CN=80) and water surface (CN=98).

The time of concentration, defined as the longest amount of time a waterdrop would take to travel from the headwater of a subcatchment area to its downstream edge was delineated in AutoCAD and entered for the subcatchment in HydroCAD.

### 3.3.3 Conveyance Features

Direct precipitation falling on the active portion of the Landfill collects within the containment berm system and discharges to Tower Hill Lake through a pipe, rip-rap lined downchute, and the South Bypass Ditch. The downchute is comprised of two segments: an upslope temporary leg that connects to the second segment, a permanent downchute. The temporary downchute leg will ultimately be removed once Phases 1C and 1D are constructed and the permanent downchute can be extended upslope. Key attributes used in the Landfill run-off HydroCAD model for each conveyance feature are summarized below:

- Perimeter Berm System and Active Disposal Area (HydroCAD Node - P1AB)
  - Modeled with incremental detention volume using minor and major contour intervals
- Discharge Pipe (HydroCAD Node - P1AB)
  - 24-in. diameter, high-density polyethylene (HDPE) pipe from Perimeter Berm System to the Temporary Downchute.
- Temporary Downchute (HydroCAD Node - TD1AB)
  - 2-ft. deep v-notch channel with 2H:1V sideslopes.
  - Ditch lining designated as 1-ft. diameter riprap.
- Permanent Downchute (HydroCAD Node - D1AB)
  - 2-ft. deep channel, 10-ft. bottom width with 3H:1V sideslopes.
  - Ditch lining designated as 1-ft. diameter riprap.
- South Bypass Ditch (HydroCAD Node - SBD)
  - Modeled as "Link" that directly connects the flow from the Permanent Ditch to Tower Hill Lake.

These conveyance paths are modeled in HydroCAD to demonstrate the run-on control system is appropriately sized to accommodate the 25-year, 24-hour storm event.

Tower Hill Lake is designed to serve as the run-off control pond for the Landfill and other portions of the Jeffrey Energy Center. Tower Hill Lake was modeled with incremental detention volume defined by contour intervals between the normal water elevation (approximate elevation 1,146.0 ft. MSL) to the lowest elevation of the perimeter berm (approximate elevation 1,166.0 ft. MSL). Tower Hill Lake is modeled to demonstrate the run-off control system is appropriately sized to accommodate total discharge rate from the Landfill for the 25-year, 24-hour storm event.

## 3.4 RESULTS AND CONCLUSIONS

The surrounding grades proximate to Phases 1A and 1B all slope away from the active area of the landfill. Therefore, there is no potential for storm water run-on to enter the active area of the landfill. Therefore, the landfill meets the requirements of 40 CFR §257.81(a)(1)[1].

The HydroCAD storm water model of the Landfill was developed to evaluate whether the peak flow run-off from the 25-year, 24-hour storm event could be accommodated without overtopping the run-off control systems.

Landfill Run-Off Control System

The Landfill run-off control system is designed and constructed to divert contact water in a controlled manner to Tower Hill Lake. Based on the results of the HydroCAD storm water model, the run-off control system was determined to accommodate the 25-year, 24-hour storm event without overtopping and meets the requirements of 40 CFR §257.81(a)(2)[1]. The peak depth and freeboard remaining within each conveyance feature is summarized below:

| Table 2 – Conveyance Feature Sizing | | |
|---|---|---|
| Conveyance Feature Designation | Peak Depth (feet) | Freeboard (feet) |
| Perimeter Berm System | 1.65 (north area) | 18.35 (relative to high water level location) |
| Discharge Pipe | 1.65 | 0.35 |
| Temporary Downchute | 1.12 | 0.88 |
| Permanent Downchute | 0.27 | 1.73 |

Based on the results from the regional HydroCAD model, Tower Hill Lake is designed to collect and control the water volume resulting from the 25-year, 24-hour storm event for the Landfill and other portions of the Jeffrey Energy Center without overtopping. The peak depth and freeboard remaining within Tower Hill Lake is summarized below:

| Table 2 – Tower Hill Lake Capacity | | |
|---|---|---|
| Peak Rise in Water Elevation (feet) | Available Freeboard (feet) | Remaining Capacity (acre-feet) |
| 2.70 | 17.30 | 2,804,237.85 |

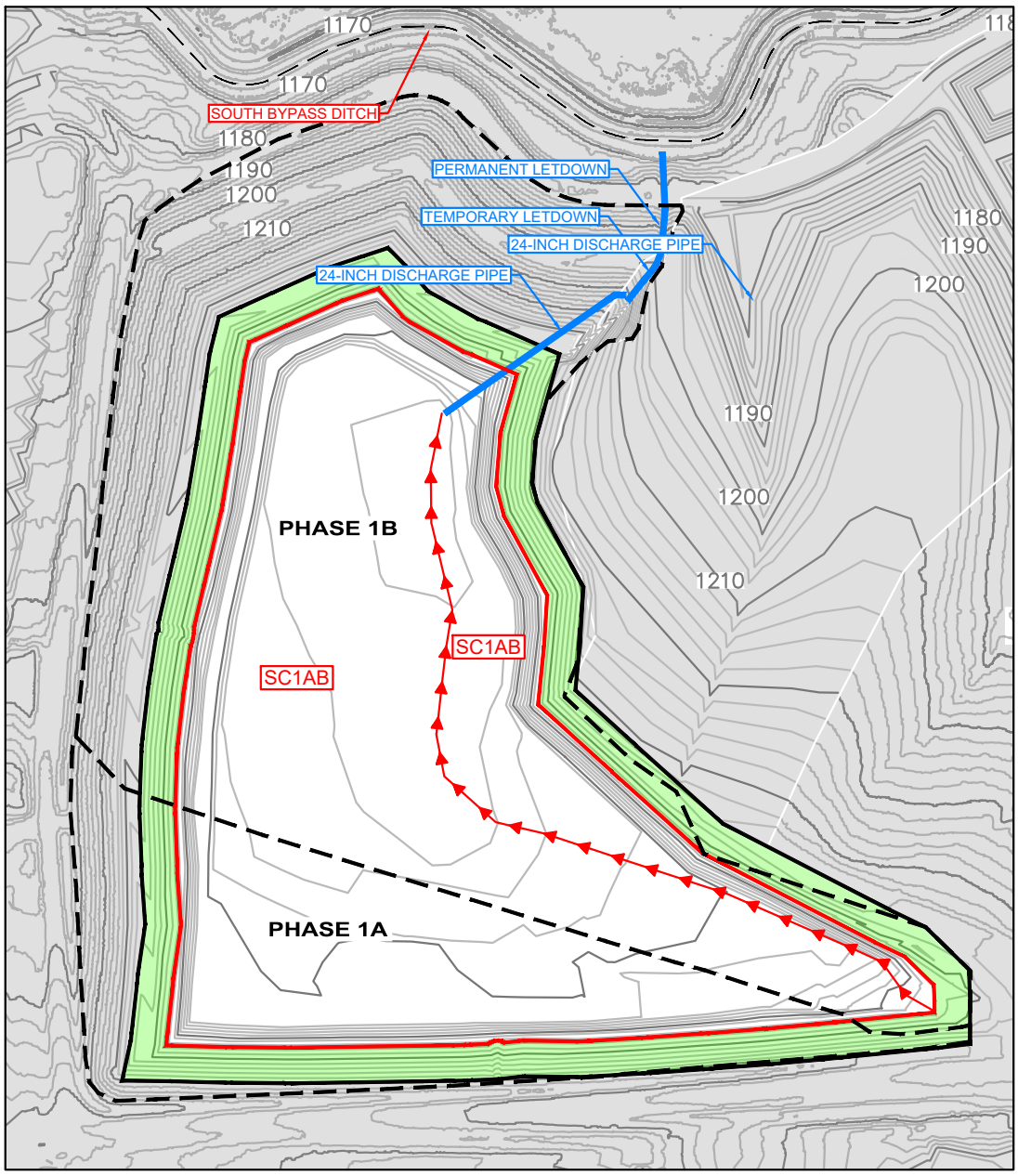
# 4.0 CERTIFICATIONS

Richard D. Southorn, a licensed Professional Engineer in the State of Kansas, has overseen the preparation of this Run-On and Run-Off Control System Plan. A certification statement in accordance with 40 CFR §257.81(c)(5)[1] is provided on **Page iii** of this plan.

# 5.0 REFERENCES


1. U.S. Environmental Protection Agency, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments, Title 40 Code of Federal Regulations Part §257. Federal Register 80, Subpart D, dated April 17, 2015, as revised.
2. USDA Natural Resources Conservation Service, Technical Release 55, dated June 1986.
3. USDA Natural Resources Conservation Service, Web Soil Survey for Pottawatomie County https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm, dated 2021.

# Figures




EXISTING SITE TOPOGRAPHY DEVELOPED BY PROFESSIONAL ENGINEERING CONSULTANTS (PEC) IN DECEMBER 2020

LEGEND

- ACTIVE AREA SUBCATCHMENT BOUNDARY
- APPROXIMATE PHASE BOUNDARY
- SOUTH BYPASS DITCH
- WATER CONVEYANCE FEATURE LOCATION
- TIME OF CONCENTRATION FLOW PATH
- CONTAINMENT BERM

300 0 300

SCALE: 1" = 300'

| | | | |
|---|---|---|---|
| CLIENT | evergy | SITE | JEFFREY ENERGY CENTER<br>ST. MARYS, KS |
| | | | RUN-ON RUN-OFF PLAN<br>SUBCATCHMENT DELINEATION |

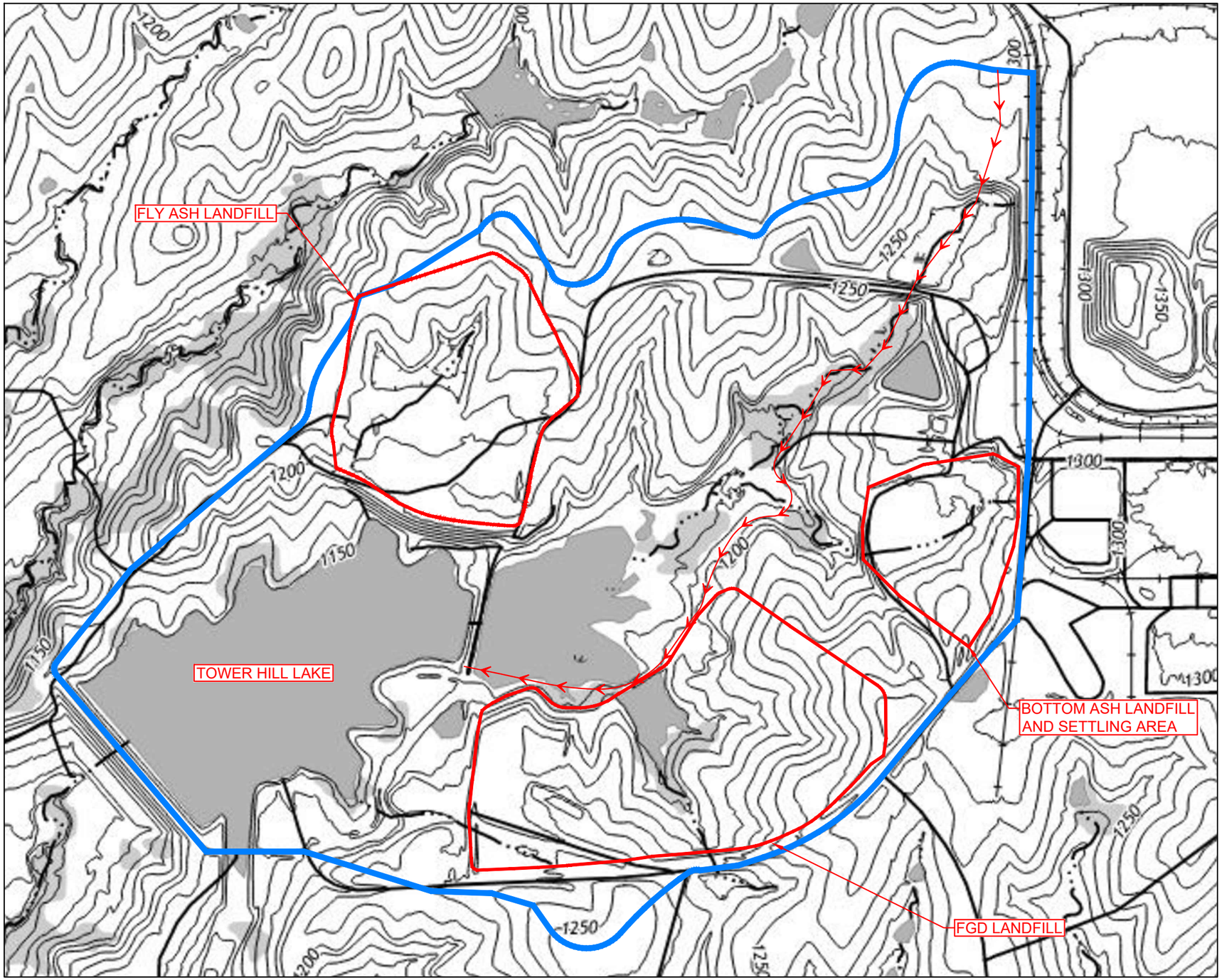
| | | | |
|---|---|---|---|
| PROJECT NO. | 25221157 | DRAWN BY: | NV |
| DRAWN: | 08/26/2021 | CHECKED BY: | SJL |
| REVISED: | 09/22/2021 | APPROVED BY: | RDS |

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

FIGURE
1 OF 2

I:\25221157.00\Drawings\Site Layout-HydroCAD (JEC RORO).dwg, 9/24/2021 8:17:13 AM




LEGEND

- CCR UNIT BOUNDARY
- WATERSHED BOUNDARY
- TIME OF CONCENTRATION

NOTES:

1. FIGURE ADAPTED FROM USGS 7.5–MINUTE TOPOGRAPHIC QUADRANGLE FROM EMMETT AND LECLEDE, KS (2018).
2. ALL BOUNDARIES ARE APPROXIMATE.

N

1000 0 1000

SCALE: 1" = 1000'

| | | | |
|---|---|---|---|
| PROJECT NO. | 25221157 | DRAWN BY: | SJL |
| DRAWN: | 08/26/2021 | CHECKED BY: | RDS |
| REVISED: | | APPROVED BY: | |

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CLIENT: evergy

SITE: JEFFREY ENERGY CENTER
ST. MARYS, KS

JEFFREY ENERGY CENTER
REGIONAL CONTROL SYSTEM
TOWER HILL LAKE

FIGURE
2 OF 2

# Appendices

| | |
|---|---|
| Appendix A | Rainfall Intensity Table for Kansas Counties |
| Appendix B | FGD Landfill 1A/1B Run-On and Run-Off Control System – HydroCAD Output Files |
| Appendix C | Regional Control System Tower Hill Lake – HydroCAD Output Files |

# Appendix A Rainfall Intensity Table for Kansas Counties

# MEMO

Kansas
Department of Transportation
*Bureau of Road Design*

**ROAD MEMORANDUM NO. 16-03**

DATE: September 2, 2016

SUBJECT: *Rainfall Intensity Tables*

The publication, *Rainfall Intensity Tables for Counties in Kansas*, dated June 1997, has recently be updated and replaced by *Rainfall Intensity Tables for Counties in Kansas (2014)*.

The new tables were developed from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Volume 8 (Perica et al. 2013) which was recently released by the National Weather Service (NWS) Hydro Meteorological Design Studies Center. The new tables provide rainfall intensities for durations from 5 minutes to 24 hours and various recurrence intervals from 1-500 years.

The *Rainfall Intensity Tables for Counties in Kansas (2014)* supersede the previous rainfall tables based on TP-40 and HYDRO-35 (McEnroe 1997). The new rainfall tables are available on the Kansas Department of Transportation's (KDOT) website at http://kart.ksdot.org.

If you have any questions, please contact John Hobelman at (785) 368-8791.

Scott W. King, P.E., Chief
Bureau of Road Design

SWK:js
By e-mail: American Council of Engineering Companies
Federal Highway Administration
Kansas Contractors Association (kca@ink.org)
Active Consultants
Director of Engineering & Design
Director of Operations
District Engineers
Area Engineers
Chief, Bureau of Local Projects
Chief, Bureau of Right of Way
Chief, Bureau of Transportation Safety & Technology
Chief, Bureau of Construction & Materials
Chief, Bureau of Maintenance
Chief, Bureau of Structures and Geotechnical Services
Road Design/Squad Leaders
Coordinating Section

# Rainfall Intensity Tables for Counties in Kansas


**(December, 2014 Edition)**

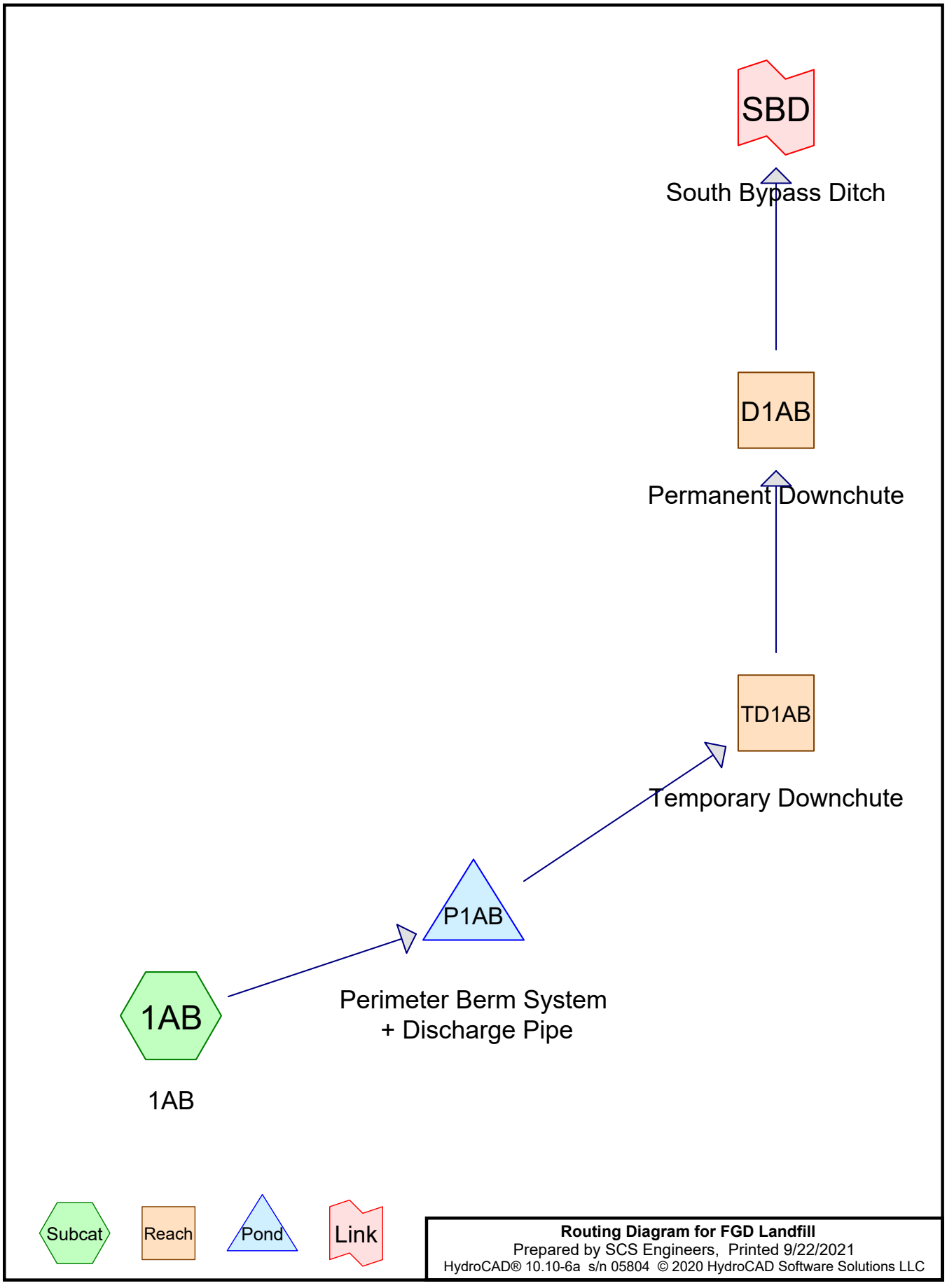
RAINFALL INTENSITY TABLE

POTTAWATOMIE COUNTY, KANSAS

This table contains average rainfall intensities in inches per hour.

| DURATION | AVERAGE RECURRENCE INTERVAL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (H:M) | 1 yr | 2 yr | 5 yr | 10 yr | 25 yr | 50 yr | 100 yr | 200 yr | 500 yr |
| 3:15 | 0.58 | 0.68 | 0.87 | 1.03 | 1.27 | 1.47 | 1.68 | 1.91 | 2.22 |
| 3:30 | 0.55 | 0.65 | 0.82 | 0.98 | 1.21 | 1.40 | 1.59 | 1.81 | 2.11 |
| 3:45 | 0.52 | 0.61 | 0.78 | 0.93 | 1.15 | 1.33 | 1.52 | 1.72 | 2.00 |
| 4:00 | 0.49 | 0.58 | 0.74 | 0.88 | 1.09 | 1.26 | 1.44 | 1.64 | 1.91 |
| 4:15 | 0.47 | 0.56 | 0.71 | 0.84 | 1.04 | 1.21 | 1.38 | 1.56 | 1.82 |
| 4:30 | 0.45 | 0.53 | 0.68 | 0.81 | 1.00 | 1.16 | 1.32 | 1.50 | 1.74 |
| 4:45 | 0.43 | 0.51 | 0.65 | 0.78 | 0.96 | 1.11 | 1.27 | 1.44 | 1.67 |
| 5:00 | 0.42 | 0.49 | 0.63 | 0.74 | 0.92 | 1.06 | 1.22 | 1.38 | 1.61 |
| 5:15 | 0.40 | 0.47 | 0.60 | 0.72 | 0.89 | 1.02 | 1.17 | 1.33 | 1.54 |
| 5:30 | 0.39 | 0.46 | 0.58 | 0.69 | 0.85 | 0.99 | 1.13 | 1.28 | 1.49 |
| 5:45 | 0.37 | 0.44 | 0.56 | 0.67 | 0.82 | 0.95 | 1.09 | 1.23 | 1.43 |
| 6:00 | 0.36 | 0.43 | 0.54 | 0.64 | 0.80 | 0.92 | 1.05 | 1.19 | 1.38 |
| 6:30 | 0.34 | 0.40 | 0.51 | 0.61 | 0.75 | 0.86 | 0.99 | 1.12 | 1.30 |
| 7:00 | 0.32 | 0.38 | 0.48 | 0.57 | 0.70 | 0.81 | 0.93 | 1.05 | 1.22 |
| 7:30 | 0.30 | 0.36 | 0.46 | 0.54 | 0.67 | 0.77 | 0.88 | 0.99 | 1.15 |
| 8:00 | 0.29 | 0.34 | 0.43 | 0.51 | 0.63 | 0.73 | 0.83 | 0.94 | 1.09 |
| 8:30 | 0.27 | 0.32 | 0.41 | 0.49 | 0.60 | 0.70 | 0.79 | 0.90 | 1.04 |
| 9:00 | 0.26 | 0.31 | 0.39 | 0.47 | 0.57 | 0.66 | 0.76 | 0.85 | 0.99 |
| 9:30 | 0.25 | 0.30 | 0.38 | 0.45 | 0.55 | 0.63 | 0.72 | 0.81 | 0.94 |
| 10:00 | 0.24 | 0.28 | 0.36 | 0.43 | 0.53 | 0.61 | 0.69 | 0.78 | 0.90 |
| 10:30 | 0.23 | 0.27 | 0.35 | 0.41 | 0.50 | 0.58 | 0.66 | 0.75 | 0.86 |
| 11:00 | 0.22 | 0.26 | 0.33 | 0.40 | 0.49 | 0.56 | 0.64 | 0.72 | 0.83 |
| 11:30 | 0.21 | 0.25 | 0.32 | 0.38 | 0.47 | 0.54 | 0.61 | 0.69 | 0.80 |
| 12:00 | 0.21 | 0.24 | 0.31 | 0.37 | 0.45 | 0.52 | 0.59 | 0.66 | 0.77 |
| 13:00 | 0.19 | 0.23 | 0.29 | 0.34 | 0.42 | 0.48 | 0.55 | 0.62 | 0.72 |
| 14:00 | 0.18 | 0.22 | 0.27 | 0.32 | 0.39 | 0.45 | 0.51 | 0.58 | 0.67 |
| 15:00 | 0.17 | 0.20 | 0.26 | 0.30 | 0.37 | 0.43 | 0.48 | 0.55 | 0.63 |
| 16:00 | 0.16 | 0.19 | 0.24 | 0.29 | 0.35 | 0.40 | 0.46 | 0.52 | 0.59 |
| 17:00 | 0.16 | 0.18 | 0.23 | 0.27 | 0.33 | 0.38 | 0.43 | 0.49 | 0.56 |
| 18:00 | 0.15 | 0.18 | 0.22 | 0.26 | 0.32 | 0.36 | 0.41 | 0.46 | 0.53 |
| 19:00 | 0.14 | 0.17 | 0.21 | 0.25 | 0.30 | 0.35 | 0.39 | 0.44 | 0.51 |
| 20:00 | 0.14 | 0.16 | 0.20 | 0.24 | 0.29 | 0.33 | 0.37 | 0.42 | 0.49 |
| 21:00 | 0.13 | 0.15 | 0.19 | 0.23 | 0.28 | 0.32 | 0.36 | 0.40 | 0.46 |
| 22:00 | 0.13 | 0.15 | 0.19 | 0.22 | 0.27 | 0.30 | 0.34 | 0.39 | 0.45 |
| 23:00 | 0.12 | 0.14 | 0.18 | 0.21 | 0.26 | 0.29 | 0.33 | 0.37 | 0.43 |
| 24:00 | 0.12 | 0.14 | 0.17 | 0.20 | 0.25 | 0.28 | 0.32 | 0.36 | 0.41 |

# Appendix B FGD Landfill 1A/1B Run-On and Run-Off Control System – HydroCAD Output Files


SBD
South Bypass Ditch
D1AB
Permanent Downchute
TD1AB
Temporary Downchute
P1AB
Perimeter Berm System
+ Discharge Pipe
1AB
1AB
Subcat
Reach
Pond
Link
Routing Diagram for FGD Landfill
Prepared by SCS Engineers, Printed 9/22/2021
HydroCAD® 10.10-6a s/n 05804 © 2020 HydroCAD Software Solutions LLC

## Summary for Subcatchment 1AB: 1AB

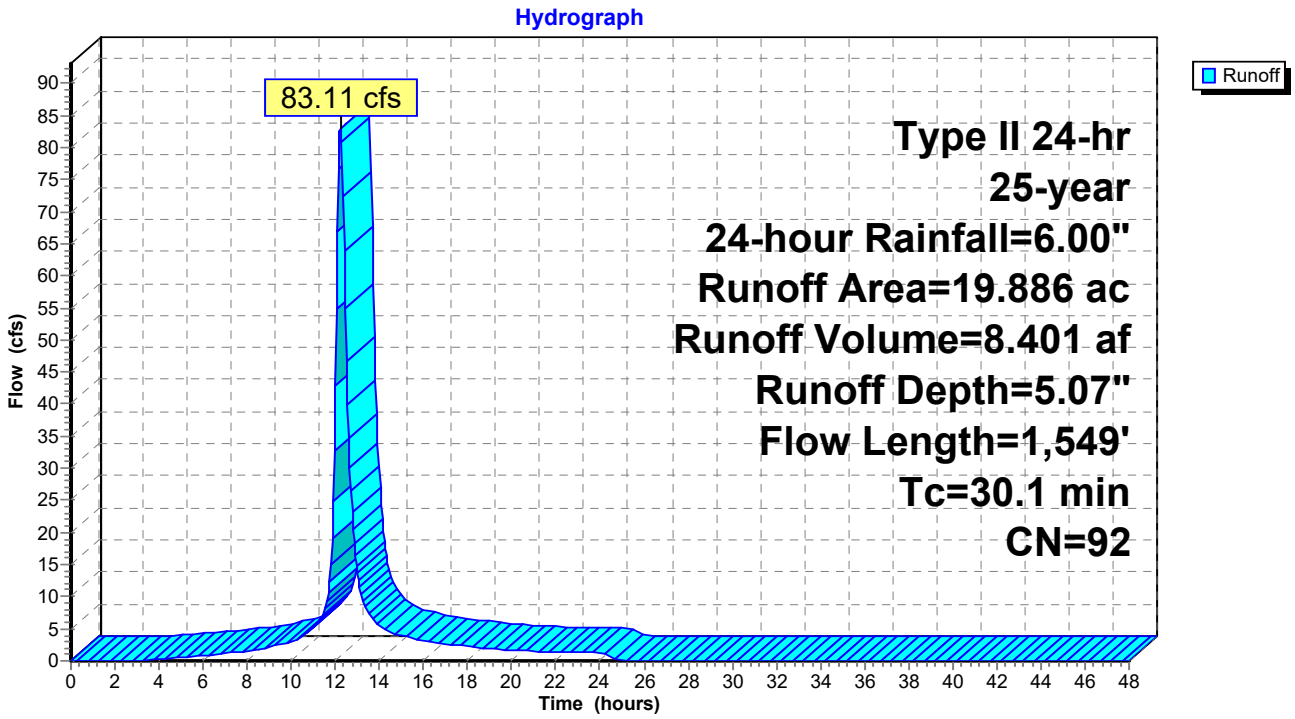
Runoff = 83.11 cfs @ 12.23 hrs, Volume= 8.401 af, Depth= 5.07"
Routed to Pond P1AB : Perimeter Berm System + Discharge Pipe

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=6.00"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 19.886 | 92 | CCR Material, HSG-D |
| | 19.886 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.1 | 100 | 0.0367 | 0.54 | | **Sheet Flow,** Fallow n= 0.050 P2= 3.36" |
| 27.0 | 1,449 | 0.0080 | 0.89 | | **Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps |
| 30.1 | 1,549 | Total | | | |

## Subcatchment 1AB: 1AB



## Summary for Reach D1AB: Permanent Downchute

Inflow Area = 19.886 ac, 0.00% Impervious, Inflow Depth > 4.95" for 25-year, 24-hour event
Inflow = 9.52 cfs @ 13.27 hrs, Volume= 8.211 af
Outflow = 9.52 cfs @ 13.29 hrs, Volume= 8.210 af, Atten= 0%, Lag= 1.3 min
Routed to Link SBD : South Bypass Ditch

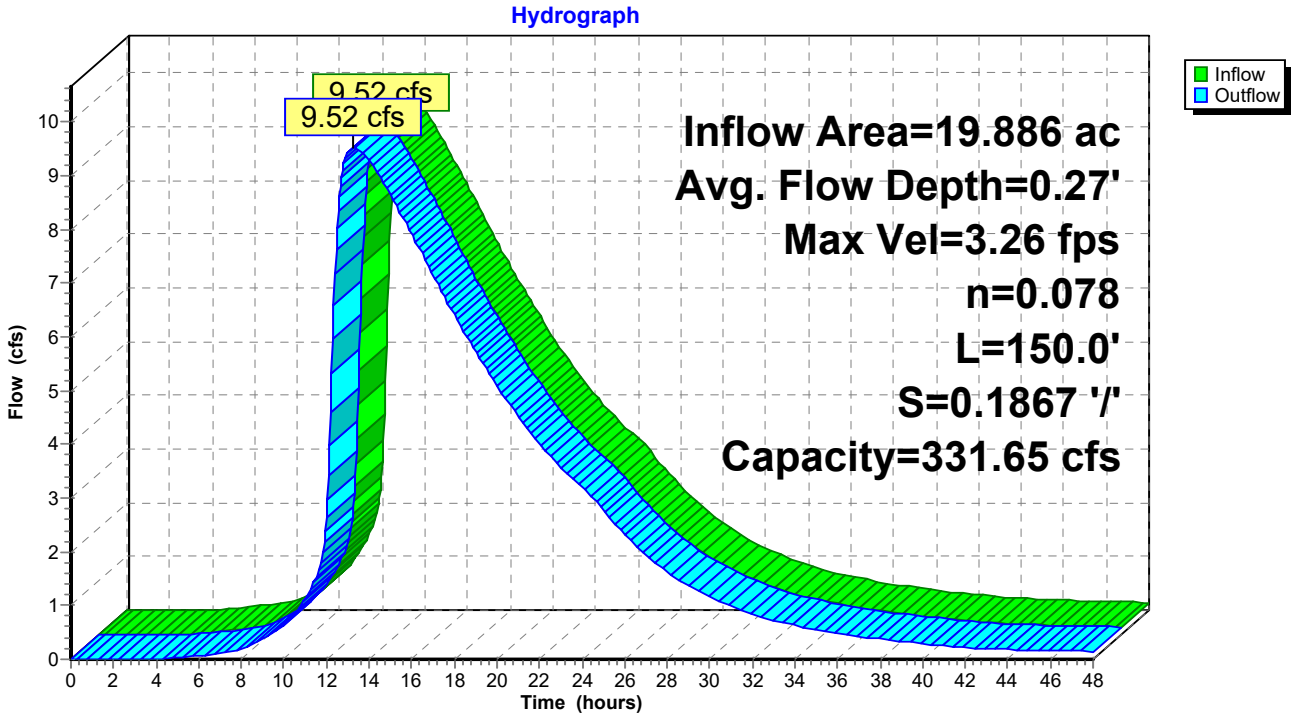
Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.26 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 1.6 min

Peak Storage= 438 cf @ 13.27 hrs
Average Depth at Peak Storage= 0.27' , Surface Width= 11.62'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 331.65 cfs

10.00' x 2.00' deep channel, n= 0.078 Riprap, 12-inch
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 150.0' Slope= 0.1867 '/'
Inlet Invert= 1,198.00', Outlet Invert= 1,170.00'

‡

### Reach D1AB: Permanent Downchute



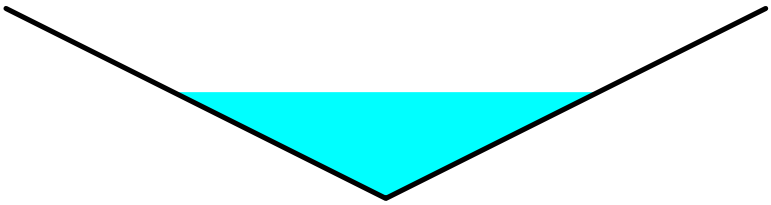
## Summary for Reach TD1AB: Temporary Downchute

Inflow Area = 19.886 ac, 0.00% Impervious, Inflow Depth > 4.96" for 25-year, 24-hour event
Inflow = 9.52 cfs @ 13.25 hrs, Volume= 8.211 af
Outflow = 9.52 cfs @ 13.27 hrs, Volume= 8.211 af, Atten= 0%, Lag= 0.8 min
Routed to Reach D1AB : Permanent Downchute

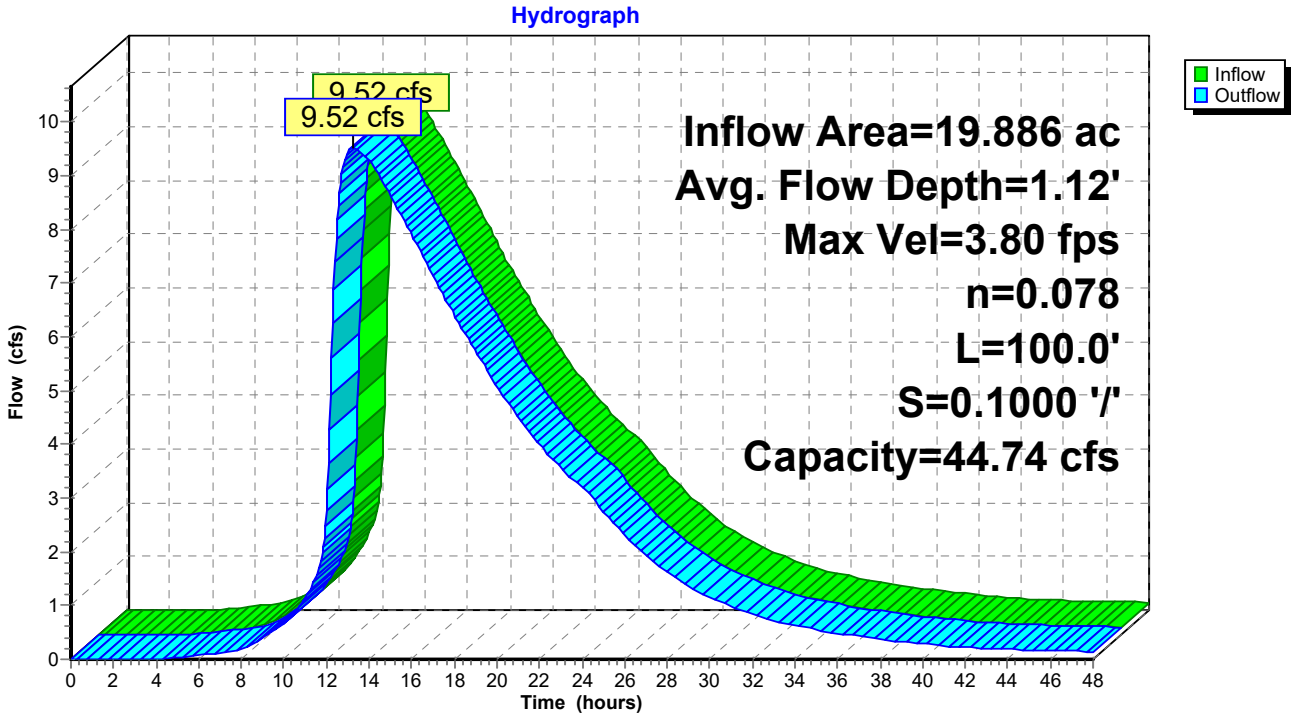
Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.80 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.20 fps, Avg. Travel Time= 0.8 min

Peak Storage= 251 cf @ 13.26 hrs
Average Depth at Peak Storage= 1.12' , Surface Width= 4.48'
Bank-Full Depth= 2.00' Flow Area= 8.0 sf, Capacity= 44.74 cfs

0.00' x 2.00' deep channel, n= 0.078 Riprap, 12-inch
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 100.0' Slope= 0.1000 '/'
Inlet Invert= 1,210.00', Outlet Invert= 1,200.00'



### Reach TD1AB: Temporary Downchute



## Summary for Pond P1AB: Perimeter Berm System + Discharge Pipe

Inflow Area = 19.886 ac, 0.00% Impervious, Inflow Depth = 5.07" for 25-year, 24-hour event
Inflow = 83.11 cfs @ 12.23 hrs, Volume= 8.401 af
Outflow = 9.52 cfs @ 13.25 hrs, Volume= 8.211 af, Atten= 89%, Lag= 61.3 min
Primary = 9.52 cfs @ 13.25 hrs, Volume= 8.211 af
Routed to Reach TD1AB : Temporary Downchute

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,223.65' @ 13.25 hrs Surf.Area= 4.876 ac Storage= 4.898 af

Plug-Flow detention time= 379.1 min calculated for 8.211 af (98% of inflow)
Center-of-Mass det. time= 364.8 min ( 1,160.9 - 796.1 )

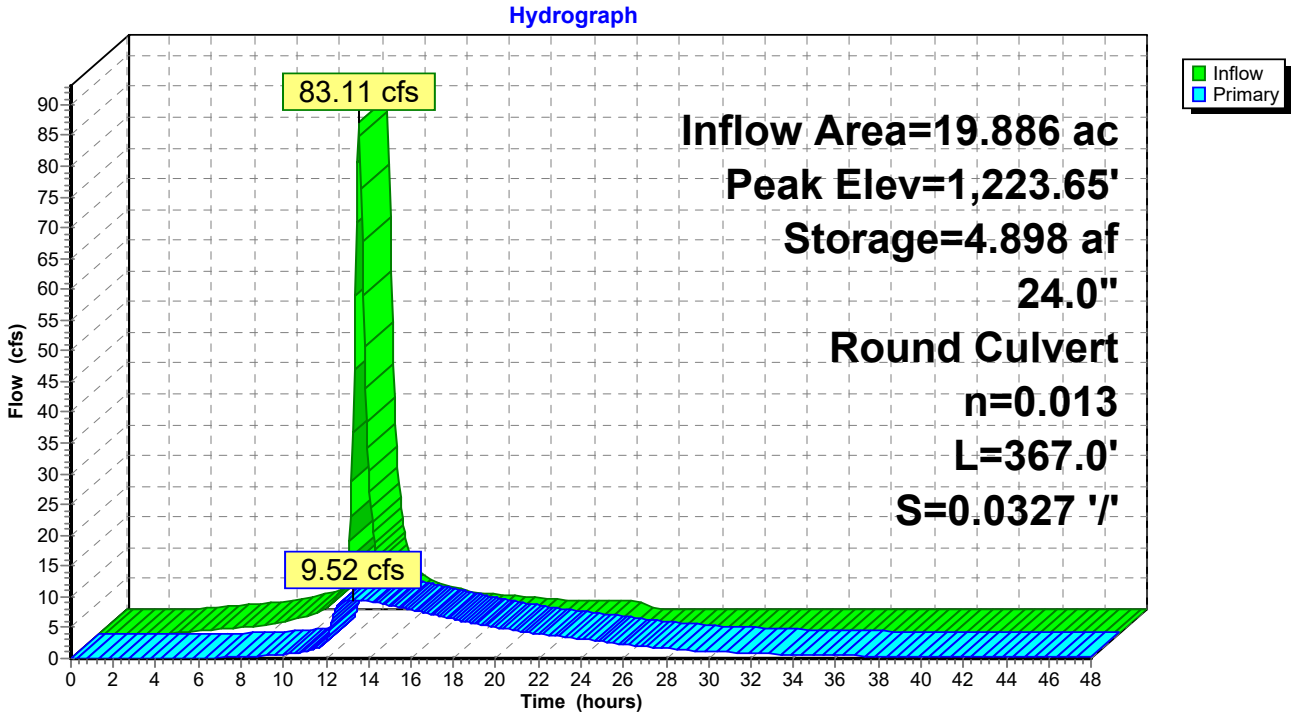
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,222.00' | 268.652 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,222.00 | 1.077 | 0.000 | 0.000 |
| 1,224.00 | 5.695 | 6.772 | 6.772 |
| 1,226.00 | 8.592 | 14.287 | 21.059 |
| 1,228.00 | 10.822 | 19.414 | 40.473 |
| 1,230.00 | 12.859 | 23.681 | 64.154 |
| 1,232.00 | 15.858 | 28.717 | 92.871 |
| 1,234.00 | 16.828 | 32.686 | 125.557 |
| 1,236.00 | 17.373 | 34.201 | 159.758 |
| 1,238.00 | 17.898 | 35.271 | 195.029 |
| 1,240.00 | 18.403 | 36.301 | 231.330 |
| 1,242.00 | 18.919 | 37.322 | 268.652 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,222.00' | **24.0" Round Temp Contact Water Pipe**<br>L= 367.0' CPP, projecting, no headwall, Ke= 0.900<br>Inlet / Outlet Invert= 1,222.00' / 1,210.00' S= 0.0327 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf |

**Primary OutFlow** Max=9.53 cfs @ 13.25 hrs HW=1,223.65' (Free Discharge)
↑—**1=Temp Contact Water Pipe** (Inlet Controls 9.53 cfs @ 3.45 fps)

## Pond P1AB: Perimeter Berm System + Discharge Pipe

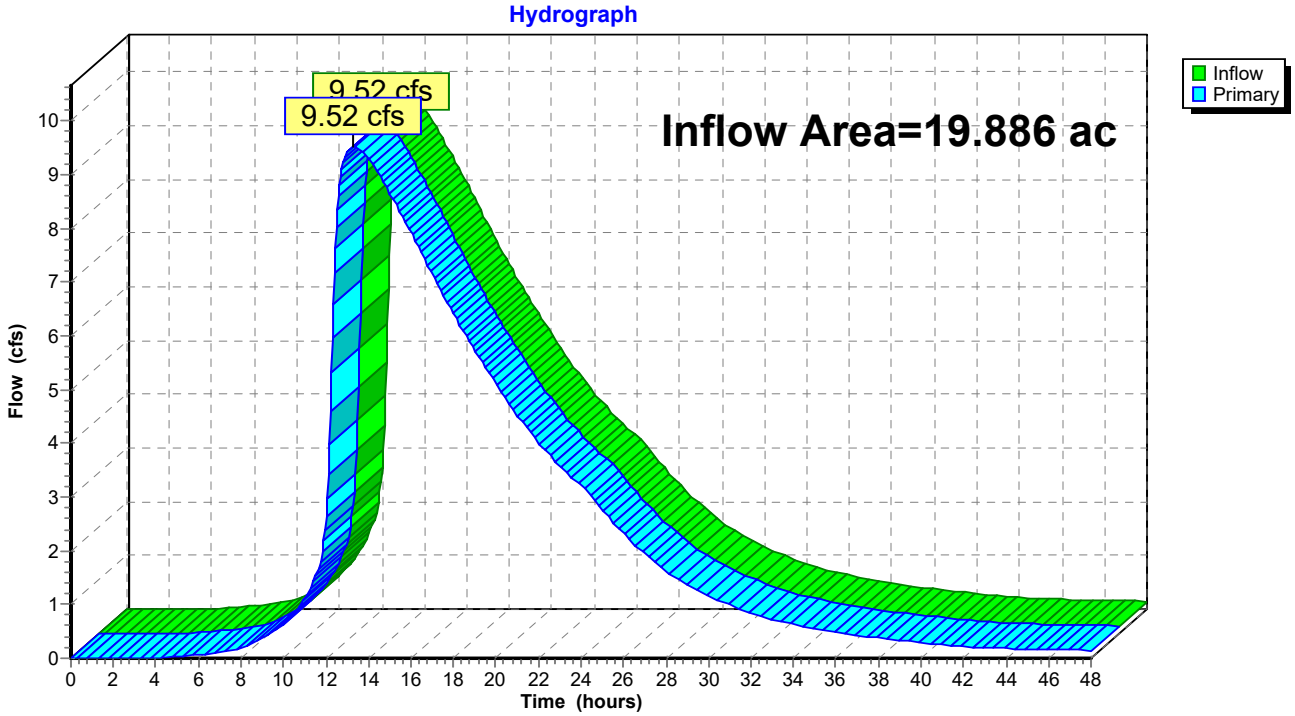


## Summary for Link SBD: South Bypass Ditch

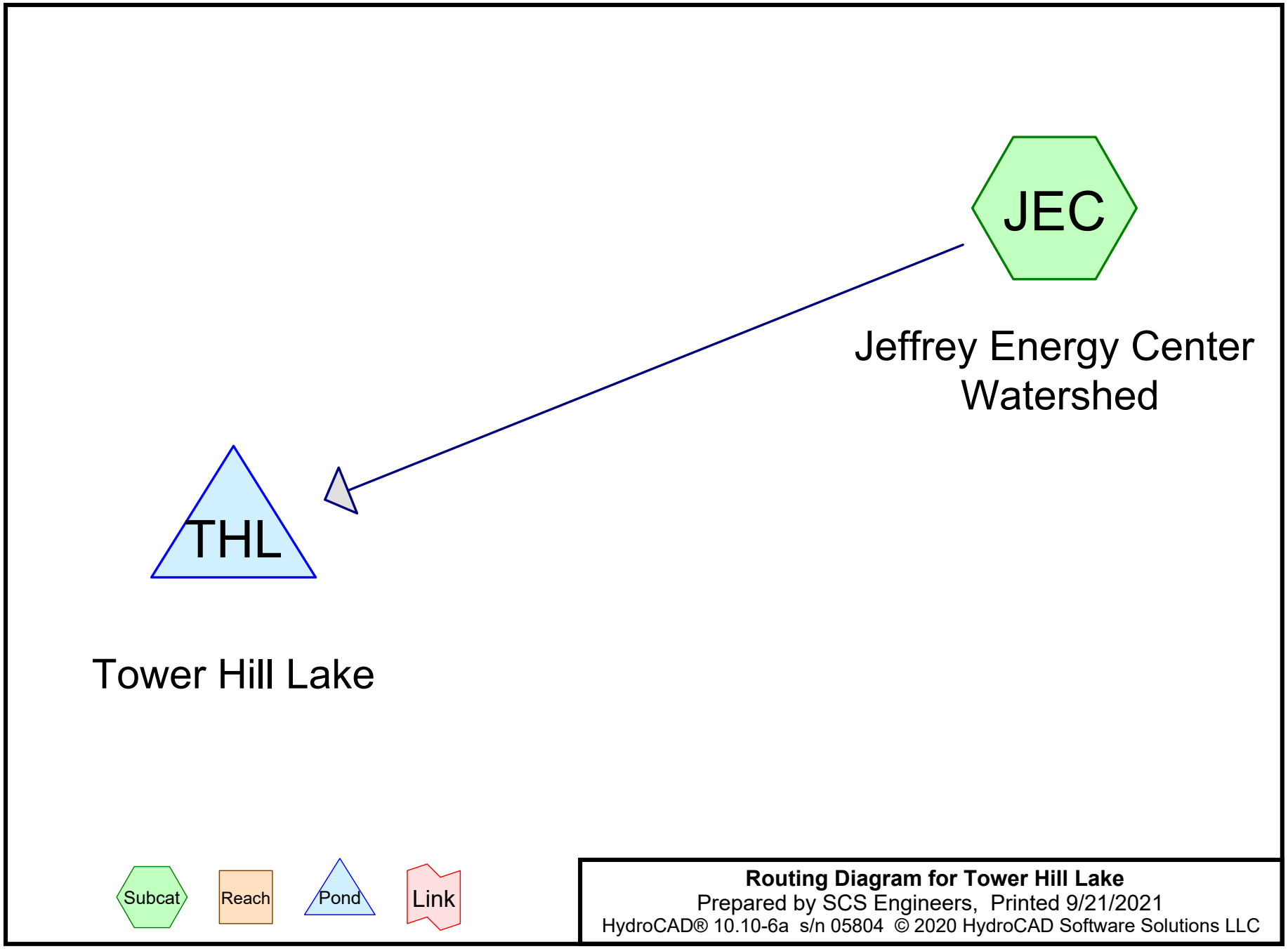
Inflow Area = 19.886 ac, 0.00% Impervious, Inflow Depth > 4.95" for 25-year, 24-hour event
Inflow = 9.52 cfs @ 13.29 hrs, Volume= 8.210 af
Primary = 9.52 cfs @ 13.29 hrs, Volume= 8.210 af, Atten= 0%, Lag= 0.0 min
Routed to nonexistent node THL

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

### Link SBD: South Bypass Ditch



# Appendix C Regional Control System Tower Hill Lake – HydroCAD Output Files




**Routing Diagram for Tower Hill Lake**
Prepared by SCS Engineers, Printed 9/21/2021

## Summary for Subcatchment JEC: Jeffrey Energy Center Watershed

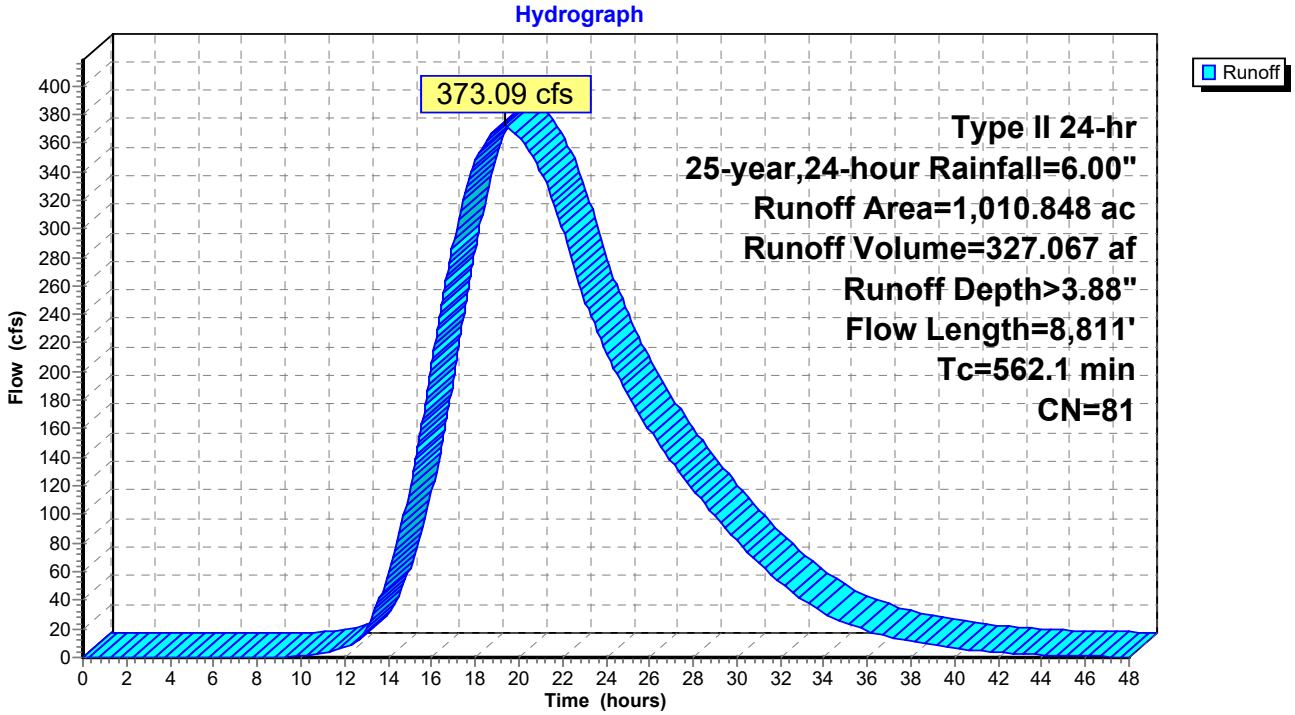
Runoff = 373.09 cfs @ 19.35 hrs, Volume= 327.067 af, Depth> 3.88"
Routed to Pond THL : Tower Hill Lake

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year,24-hour Rainfall=6.00"

| Area (ac) | CN | Description |
|---|---|---|
| 934.496 | 80 | >75% Grass cover, Good, HSG D |
| 76.352 | 98 | Water Surface, 0% imp, HSG D |
| 1,010.848 | 81 | Weighted Average |
| 1,010.848 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.2 | 100 | 0.0400 | 0.23 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 3.36" |
| 13.5 | 1,138 | 0.0400 | 1.40 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 541.4 | 7,573 | 0.1000 | 0.23 | 6.99 | **Channel Flow,** Area= 30.0 sf Perim= 4,737.0' r= 0.01' n= 0.069 Riprap, 6-inch |
| 562.1 | 8,811 | Total | | | |

## Subcatchment JEC: Jeffrey Energy Center Watershed



## Summary for Pond THL: Tower Hill Lake

Inflow Area = 1,010.848 ac, 0.00% Impervious, Inflow Depth > 3.88" for 25-year,24-hour event
Inflow = 373.09 cfs @ 19.35 hrs, Volume= 327.067 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= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,148.70' @ 48.00 hrs Surf.Area= 124.166 ac Storage= 327.058 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 | 1,146.00' | 2,804.565 af | **Custom Stage Data (Prismatic)**Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) |
|---|---|---|---|
| 1,146.00 | 117.180 | 0.000 | 0.000 |
| 1,148.00 | 122.922 | 240.102 | 240.102 |
| 1,150.00 | 126.458 | 249.380 | 489.482 |
| 1,152.00 | 130.703 | 257.161 | 746.643 |
| 1,154.00 | 134.795 | 265.498 | 1,012.141 |
| 1,156.00 | 138.961 | 273.756 | 1,285.897 |
| 1,158.00 | 143.457 | 282.418 | 1,568.315 |
| 1,160.00 | 148.544 | 292.001 | 1,860.316 |
| 1,162.00 | 154.180 | 302.724 | 2,163.040 |
| 1,164.00 | 160.146 | 314.326 | 2,477.366 |
| 1,166.00 | 167.053 | 327.199 | 2,804.565 |

## Pond THL: Tower Hill Lake