Coal Combustion Residuals Landfill

Run-on and Run-off Control System Plan

Antelope Valley Station Landfill

Prepared for
Basin Electric Power Cooperative

October 2021

234 West Century Avenue
Bismarck, ND 58503
701.255.5460
www.barr.com

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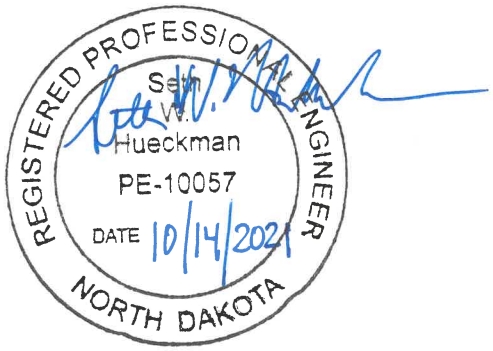
Certifications

I hereby certify that I have or my agent has examined the facility and, being familiar with the provisions of 40 CFR 257 Subpart D, attest that this Coal Combustion Residuals landfill run-on and run-off control system plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards and the requirements of 40 CFR § 257.81. I certify that the plan is adequate for this facility and that procedures for recordkeeping and reporting have been established.



Seth W. Hueckman
Barr Engineering Co.
ND Registration Number PE-10057

Dated this 14th day of October 2021

Seth W. Hueckman

Digitally signed by Seth W. Hueckman
Date: 2021.10.14 08:46:26 -05'00'

1 Introduction

Antelope Valley Station (AVS) is a lignite coal-fired power plant consisting of two units that generate about 900 megawatts (MW) combined. The power plant, owned and operated by Basin Electric Power Cooperative (Basin Electric), is located approximately eight miles northwest of Beulah in Mercer County, North Dakota. Coal ash from AVS is disposed at the Section 7 Landfill, regulated as a coal combustion residuals (CCR) landfill under Permit No. 0160 issued by the North Dakota Department of Environmental Quality (NDDEQ). CCR management is subject to Federal Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments per 40 CFR 257 Subpart D. This CCR run-on and run-off control system plan has been developed to satisfy the requirements described in 40 CFR § 257.81, run-on and run-off controls for CCR landfills, as they apply to AVS's Landfill.

The existing landfill was first permitted by the North Dakota Department of Health, now NDDEQ, for solid waste disposal in 1995. The existing landfill currently consists of four cells, Cells 1-4. The first phase of liner construction was completed in 1996 with ash placement beginning the same year. The fourth and final phase of the existing landfill liner construction was completed in 2015. A lined sump was constructed within Cells 1-4 in 2008 for the purpose of capturing run-off water within the landfill.

Partial sequential closure has been conducted on areas of the existing landfill that had been filled to final grade, with closure construction occurring in 2003, 2011, 2014, and 2016. Approximately 52 acres of the existing landfill is currently active; including Cell 4 and portions of Cell 1, Cell 2, and Cell 3. Approximately 51 acres of the 103-acre CCR landfill footprint for Cells 1-4 have been closed using an engineered earthen cover system approved by the NDDEQ.

Construction of a lateral expansion is scheduled for 2022. The lateral expansion will include a composite liner constructed with a compacted clay liner overlain by a 60-mil high density polyethylene (HDPE) geomembrane liner. The lateral expansion will consist of four additional landfill cells, Cells 5-8, totaling approximately 128 acres. The existing landfill and lateral expansion are considered to be one CCR unit (Cells 1-8). This run-on and run-off control system plan has been developed to satisfy the requirements described in 40 CFR § 257.81, run-on and run-off controls for CCR landfills.

2 Objectives

Per 40 CFR § 257.81, the owner of an existing or new CCR landfill or any lateral expansion of a CCR landfill is required to design, construct, operate, and maintain a run-on and run-off control system.

In order to fulfill these objectives, the run-on and run-off control system plan must:

- provide documentation that the run-on control system adequately manages flow onto the active portion of the CCR unit during and following the peak discharge from a 25-year, 24-hour storm;
- provide documentation that the run-off control system adequately collects and controls at least the water volume from a 25-year, 24-hour storm;

- define recordkeeping requirements;
- define reporting requirements; and
- include a certification from a qualified professional engineer.

3 Run-on Control System

The purpose of a run-on control system is to prevent surface water from outside the lined CCR storage area from flowing onto the active landfill area. Site grading and existing topography near the landfill prevents surface drainage run-on onto the active portion of the CCR unit for events up to and exceeding a 25-year, 24-hour storm. Figure 1 shows that the proposed landfill perimeter dikes are elevated above the surrounding topography and that the surrounding area drains away from the landfill, with arrows added to illustrate surface drainage outside of the landfill.

The closed portions of the landfill are graded to direct surface run-off to the nearest edge of the landfill, and then offsite to surrounding existing drainage systems.

4 Run-off Control System

The purpose of a run-off control system is to prevent water that has come into contact with ash from draining offsite. All ash contact surface water will be contained within the lined areas of the landfill and leachate pond. Ash-contact water generated from Cells 1-4 is controlled within the lined limits of the existing landfill through installation of ditches from active landfill areas to the existing lined sump within the landfill. The ash-contact water and leachate generated from Cells 5-8 will also be controlled within the lined limits of the landfill. Surface run-off will be intercepted in perimeter ditches and directed into the leachate collection system as described in this section and as illustrated on Figure 1. While the systems described in this plan will be used to control contact water run-off, site conditions at any given time during landfill develop may vary somewhat from the general layouts shown in this plan; however, AVS will implement control systems to manage contact surface water run-off consistent with this plan.

Site hydrology and hydraulics were modeled using HydroCAD Version 10.00-16 and Soil Conservation Service (SCS) methods. The design storm for the run-off control system is the 25-year, 24-hour storm event, which has a rainfall depth of 3.62 inches (reference: NOAA Atlas 14). Hydrology calculations are included in Appendix A.

Precipitation events typically produce minimal observed surface run-off from the approximately 52 acres of active landfill in Cells 1-4. Instead, water rapidly infiltrates and is stored in the dry ash until it evaporates or is bound to the ash mass through chemical reaction. For larger precipitation events, like the 25-year, 24-hour design storm, some surface run-off within the active landfill area is expected. Water draining from the surface of landfill Cells 1-4 is directed to the lined landfill sump within the landfill limits by the installation of ditches. Based on the design rainfall event, the lined sump has been designed to provide a minimum of 13,000 cubic yards to store the run-off captured from the approximately 52 acres of active landfill in Cells 1-4. The existing lined sump has a capacity of approximately 24,353 cubic yards with an

additional 2 feet of freeboard (Basin, 2016) and therefore has sufficient capacity to contain the design storm event.

For Cells 5-8, run-off from the surface of the active landfill will generally flow to the north, east and west perimeters. An interior perimeter ditch within the landfill and around the edge of the active face will be maintained to intercept ash-contact water and keep it from draining outside the lined limits of the landfill. Water that reaches the perimeter ditches will infiltrate into the drainage layer. The interior perimeter ditch length has an estimated length of 3,500 feet, which includes the total length of the west, north, and east sides of a typical expansion cell. The cross-sectional flow area of the interior perimeter ditch needs to be a minimum of 60 square feet to store the run-off captured from the 60 acres of open area (maximum open area) from Cells 5-8 until the water infiltrates into the drainage layer. A minimum ditch depth of 5 feet with 3 horizontal to 1 vertical (3H:1V) side slopes has been calculated to provide the required storage.

Water in the drainage layer will drain to and will be collected in leachate pipes that, in turn, drain to leachate sumps. The leachate collected in the sumps is then pumped to the leachate pond on the west side of the landfill expansion area. The leachate pond is designed to evaporate all ash-contact water and leachate generated from a 60-acre (maximum) active ash landfill area. It also accommodates back-to-back-to-back 100-year storms (Barr, 2021) in addition to the ash-contact water and leachate.

5 Recordkeeping & Reporting

According to 40 CFR § 257.81(c)(2), Basin Electric will 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. Additionally, Basin Electric will prepare periodic updates to the plan every five years (minimum).

Basin Electric will maintain a copy of the most recent version of the run-on and run-off control system plan in the facility's operating record in accordance with 40 CFR § 257.105, Recordkeeping Requirements, and the plan will be made publicly available on the Basin Electric CCR web site in compliance with 40 CFR § 257.107, Publicly Accessible Internet Site Requirements. Notification will be sent to State Director (solidwaste@nd.gov) in compliance with 40 CFR § 257.106, Notification Requirements.

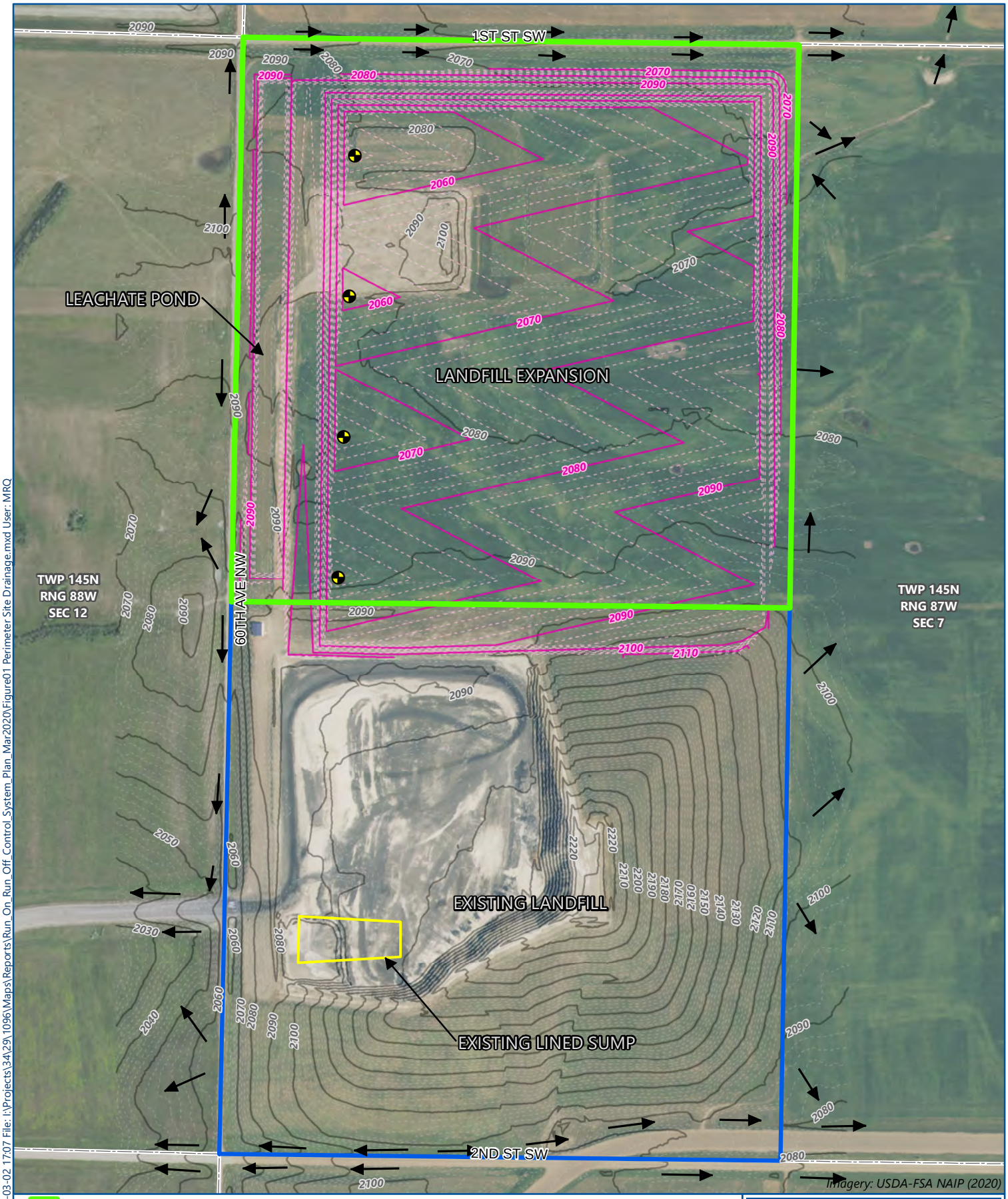
6 References

Barr, 2021. Engineering Report, Lateral Landfill Expansion Antelope Valley Station, March 2021

Basin, 2016. Coal Combustion Residual Landfill Run-On and Run-Off Control Plan, Basin Electric Power Cooperative Antelope Valley Station, October 2016

NOAA Atlas 14 Point Precipitation Frequency Estimates: North Dakota. National Weather Service. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=nd. Accessed December 18, 2020

Figures



Landfill Expansion
Existing Landfill Limits
Public Land Survey Section
Leachate Collection Sump
Existing Lined Sump
Flow Direction
Existing 10-foot Contour
Existing 2-foot Contour
Proposed 10-foot Contour
Proposed 2-foot Contour

Note: Elevations are in the NGVD29 datum.

N 0 600 Feet

BARR

PERIMETER SITE DRAINAGE
Basin Electric Power Cooperative
Antelope Valley Station Landfill
Mercer County, North Dakota

FIGURE 1

Barr Footer: ArcGIS 10.7.1, 2021-03-02 17:07 File: I:\Projects\34\29\1096\Maps\Reports\Run_On_Run_Off_Control_System_Plan_Mar2020\Figure01 Perimeter Site Drainage.mxd User: MRQ

Appendix A

HydroCAD Report

Basin Run-on/Run-off Calculations (Cell 1-4 Lined Sump Required Capacity)

Item	Quantity	Notes:
Open Area (ac) =	52	
Open Area (ft^2) =	2,265,120	
P = 25-yr/24-hr Total Rainfall (in) =	3.62	
SCS Curve Number for Ash =	81.6	This is the same curve number used in HELP modeling
S =	2.25	
Q (inches) =	1.85	
Q (ft) =	0.154	
Total Runoff Volume (ft^3) =	349,499	
Total Runoff Volume (yd^3) =	**12,944**	

Direct Runoff Calculation: $Q = (P-0.2S)^2/(P+0.8S)$

Q = Direct Runoff in Inches

P = Total Storm Rainfall in Inches

S = 1000/CN - 10

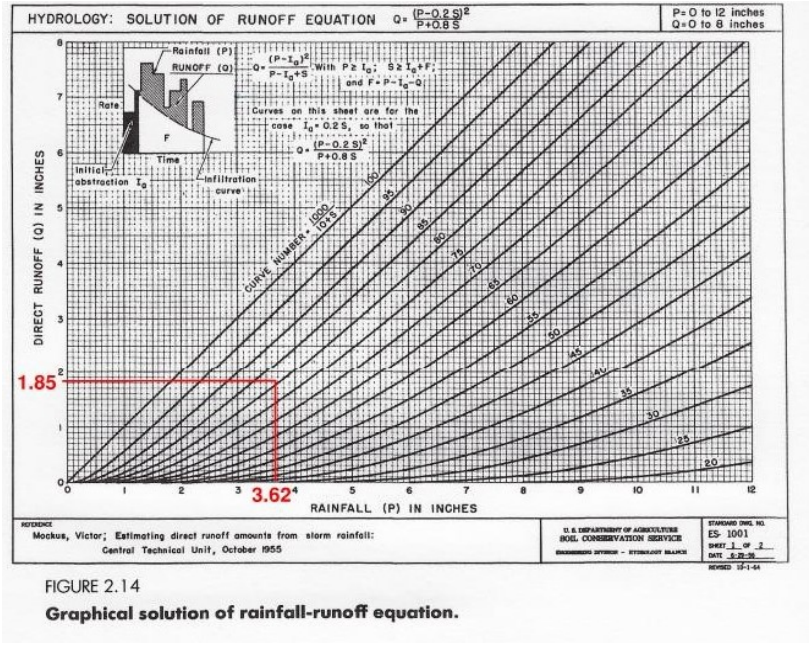


FIGURE 2.14

Graphical solution of rainfall-runoff equation.

Basin Run-on/Run-off Calculations (Cell 5-8 Interior Perimeter Ditch Required Capacity)

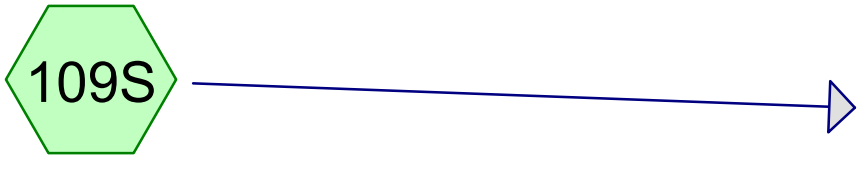
Total Runoff Volume and Drainage Layer Infiltration Computations

Item	Quantity	Notes:
Area (ac) =	60	
Ash Curve Number =	**82**	Note: Used 81.6 from HELP model and HydroCAD rounded to 82
Time of Concentration (min) =	8.6	Note: Used 100' length for sheet flow at a land slope of 4%, Used 560' and 4% shallow concentrated flow component
Total Runoff Volume (acre-feet) =	9.411	
Total Runoff Volume (cubic feet) =	409,942	
Interior Perimeter Ditch Length (ft) =	3,500	
Channel Depth (ft) =	5	
Channel Sideslopes (H:V) =	3:1	
Channel Inlet Invert El (ft) =	2,090.0	
Channel Outlet Invert El (ft) =	2,086.6	
Channel Slope % =	0.1	
Slope Length with Exposed Sand Layer (ft)	5.83	
Exposed Sand Layer Surface Area (ft^2)	20,405	
Sand Drainage Layer Infiltration (Referred to as Exfiltration Rate in HydroCAD (cfs)) =	**6.69**	Note: This is assumed as the hydraulic conductivity of the sand layer ($k = 1 \times 10^{-2}$ cm/s) multiplied by the exposed leachate collection system sand layer surface area in the in the channel.

Note: HydroCAD was used to calculate runoff volume minus exfiltration and then hand computations below were used to size interior perimeter ditch.

Item	Quantity	Notes:
Runoff Volume Minus Exfiltration (acre-feet) =	4.806	
Runoff Volume Minus Exfiltration (cubic feet) =	209,349	
Perimeter Ditch Length (ft) =	3,500	
Required Ditch Cross Section Area (ft^2) =	**59.8**	This was computed by taking the runoff volume minus exfiltration divided by the perimeter ditch length.
Channel Bottom Width (ft) =	0	
Channel Depth (ft) =	5	
Channel Sideslopes (H:V) =	3:1	
Designed Channel Cross-Section Area (ft^2) =	**75**	
Total Ditch Storage Capacity (cubic feet) =	**262,500**	
Remaining Ditch Capacity During 25-Year Storm (cubic feet) =	**53,151**	This was computed by taking the total ditch storage capacity minus the 25-year/24-hour runoff volume minus exfiltration (runoff that drains into leachate collection system drainage layer)

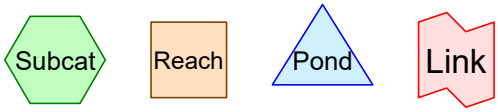
HydroCAD used to calculate runoff volumes for sizing Cells 5-8 interior perimeter ditch system



Proposed - 60 Acre Open Footprint (Exposed Ash) - HELP CN

Proposed Interior Perimeter Ditch - Store Runoff from Ash Footprint

Note: Interior ditch geometry shown in this HydroCAD model was arbitrarily selected and is not consistent with the designed ditch geometry. The purpose of developing this model was to calculate the volume of runoff the interior perimeter ditch must store from a 25-year/24-hour precipitation event.



Routing Diagram for Basin SW-Interior Perimeter Ditch
Prepared by Barr Engineering Co., Printed 1/22/2021

Summary for Subcatchment 109S: Proposed - 60 Acre Open Footprint (Exposed Ash) - HELP CN

Runoff = 180.53 cfs @ 12.00 hrs, Volume= 9.411 af, Depth= 1.88"

Total Runoff Volume from 25-yr/24-hr Storm

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-yr Rainfall=3.62"

	Area (ac)	CN	Description
*	60.000	82	HELP Model CN
	60.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	100	0.0400	0.43		**Sheet Flow, Sheet flow towards ditch - max 100'** Fallow n= 0.050 P2= 2.01"
4.7	560	0.0400	2.00		**Shallow Concentrated Flow, Shallow concentrated flow toward ex** Nearly Bare & Untilled Kv= 10.0 fps
8.6	660	Total			

Events for Subcatchment 109S: Proposed - 60 Acre Open Footprint (Exposed Ash) - HELP CN

Event	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
25-yr	**180.53**	**9.411**	**1.88**

Summary for Reach 110R: Proposed Interior Perimeter Ditch - Store Runoff from Ash Footprint

Inflow Area = 60.000 ac, 0.00% Impervious, Inflow Depth = 0.96" for 25-yr event
Inflow = 173.84 cfs @ 12.00 hrs, Volume= 4.806 af, Incl. 6.69 cfs Inflow Loss
Outflow = 79.93 cfs @ 12.12 hrs, Volume= 4.806 af, Atten= 54%, Lag= 7.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.71 fps, Min. Travel Time= 21.5 min
Avg. Velocity = 0.38 fps, Avg. Travel Time= 153.4 min

Peak Storage= 102,901 cf @ 12.12 hrs
Average Depth at Peak Storage= 2.53'
Bank-Full Depth= 4.00' Flow Area= 64.0 sf, Capacity= 226.83 cfs

4.00' x 4.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 28.00'
Length= 3,500.0' Slope= 0.0010 '/'
Inlet Invert= 2,090.00', Outlet Invert= 2,086.60'

Runoff Volume from 25-yr/24-hr Storm After Including Drainage Losses into Exposed Leachate Collection System Sand Layer

Note: Interior ditch geometry shown in this HydroCAD model was arbitrarily selected and is not consistent with the designed ditch geometry. The purpose of developing this model was to calculate the volume of runoff the interior perimeter ditch must store from a 25-year/24-hour precipitation event. Results shown above including ditch velocities, average depth, and other flow results should not be considered accurate.