Hugo CCR Landfill
Run-On and Run-Off Control

Western Farmers Electric Cooperative

Project No. 142180

Revision 1
January 28, 2022

Hugo CCR Landfill
Run-On and Run-Off Control

Prepared for

Western Farmers Electric Cooperative
Project No. 142180
Hugo, Oklahoma

Revision 1
January 28, 2022

Prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

INDEX AND CERTIFICATION

Western Farmers Electric Cooperative
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Certification

I hereby certify, as a Professional Engineer in the state of Oklahoma, that the information in this Document and Appendix was assembled under my direct personal charge. I am a "Qualified Professional Engineer" as defined by 40 C.F.R. § 257.53 and OAC 252:517-1-3 by the fact that I have the technical knowledge and experience to make the specific technical certifications set forth herein. This Control Plan meets the requirements of 40 C.F.R. § 257.81 and OAC 252:517-13-2. This Control Plan is not intended or represented to be suitable for reuse by Western Farmers Electric Cooperative or others without specific verification or adaptation by the Engineer.

Digitally signed by Alexander, Kendra E
Date: 2022.01.31 12:18:01-06'00'

Kendra E. Alexander P.E. (No. 30065)

Date: ______________________________

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LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
BMcD	Burns & McDonnell
CCR	Coal Combustion Residual
C.F.R.	Code of Federal Regulations
CFS	Cubic Feet Per Second
EPA	United States Environmental Protection Agency
ESP	Electrostatic Precipitator
NAD	North American Datum
NAVD 88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
OAC	Oklahoma Administrative Code
ODEQ	Oklahoma Department of Environmental Quality
OPDES	Oklahoma Pollution Discharge Elimination System
Plant	WFEC Hugo Power Plant
RCRA	Resource Conservation and Recovery Act
WFEC	Western Farmers Electric Cooperative

1.0 INTRODUCTION

Burns & McDonnell (BMcD) has compiled information and prepared this Run-on and Run-off Control System Plan (Control Plan) for the existing CCR Landfill, designated CCR Unit 1 at the Western Farmers Electric Cooperative (WFEC) Hugo Power Plant (Plant). The purpose of this Control Plan is to comply with the United States Environmental Protection Agency's (EPA) Coal Combustion Residual Rule (CCR Rule), and the rules enforced by the Oklahoma Department of Environmental Quality (ODEQ).

On April 17, 2015, the EPA published the CCR Rule relating to the disposal of coal combustion residual (CCR) materials generated at electric utilities' coal-fired units. The CCR Rule was promulgated pursuant to the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. §§ 6901 *et seq*.), using the Subtitle D approach and is found in 40 C.F.R. § 257.50 *et seq*. Additionally, ODEQ adopted counterpart regulations to the CCR Rule effective September 15, 2016, which are found at Oklahoma Administrative Code (OAC) 252:517. Effective July 30, 2018, the EPA approved Oklahoma's permit program for the management of CCR. As such, the Oklahoma CCR state permit program allows ODEQ to enforce rules related to CCR activities in non-Indian Country, issue permits, enforce violations, and operate while subject to the Federal CCR Rule.

The owner or operator of a CCR Landfill subject to the CCR Rule must prepare a Run-on and Run-off Control System Plan in accordance with OAC 252:517-13-2. This Control Plan provides the documentation and engineering calculations for the Landfill at the Plant. The Control Plan must contain the following in accordance with OAC 252:514-13-2:

- Documentation of how the run-on and run-off control systems have been designed and constructed to meet the following requirements:
  - A run-on control system to prevent flow onto the active portion of the Landfill during peak discharge from a 24-hour, 25-year storm; and
  - A run-off control 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.
- Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under OAC 252:517-13-6.
- Supporting engineering calculations for the plan.
- Certification by a qualified professional engineer.

The following run-on and run-off control system terms are defined per the CCR Rule:

- Active Portion – Portion of the Landfill that has received or is receiving CCR or non-CCR waste and has not completed closure in accordance with OAC 252:517-15-7.
- Run-off – Any rainwater, leachate, or other liquid that drains over land from any part of a CCR landfill or lateral expansion of a CCR landfill.
- Run-on – Any rainwater, leachate, or other liquid that drains over land onto any part of a CCR landfill or lateral expansion of a CCR landfill.

2.0 EXISTING CONDITIONS

The Plant is a single, coal-fired unit rated at 450 MW. The Plant is located south of Highway US-70, west of the Town of Fort Towson, Oklahoma, and is owned and operated by WFEC. Bottom ash is available for beneficial reuse and managed in the Landfill. Fly ash and economizer ash generated by the Plant are beneficially reused and are managed in the CCR 1 (Landfill) as described below.

Fly ash is pneumatically transported from the electrostatic precipitator (ESP) and stored temporarily in silos during normal operations. Fly ash is unloaded directly from the silo and sold for beneficial use. The remaining portion of the fly ash is placed in the Landfill where it is managed or later excavated for sale for beneficial use. Water is used for dust control and fly ash is conditioned with water as needed during unloading.

The Landfill is a special waste landfill registered with the State of Oklahoma. The Landfill is located on the west side of the Plant and is divided into two cells “A” to the North and “B” to the South. See Figure 2-1 for a Site Plan.

Figure 2-1. Overall Site Plan

Since material is sent to the Landfill in a dry condition, and no other plant runoff streams are sent to the Landfill, the only source of water to the Landfill is the stormwater runoff that falls directly within the watershed of the Landfill. This water is collected in low areas at the east side of Cell B and at the north side of Cell A of the Landfill and pumped to impoundment F08 permitted under OPDES OK0035327.

2.1 Project Mapping

After reviewing historical site plan maps, previous inspection reports, surveys, and surface imagery, the site plan and grading has not appeared to have changed to the extent that would increase run-on or run-off from the active portion of the Landfill. Therefore, the aerial survey performed in 2016 is adequate to review the existing Operating Plan.

2.1.1 Aerial Survey

An aerial survey was performed in January 2016 by Survey and Aerial Mapping, LLC. The aerial survey included topography, planimetric features, and orthoimagery.

2.1.2 Vertical Datum

Mapping sources referenced were in the North American Vertical Datum of 1988 (NAVD 88).

2.1.3 Horizontal Coordinate System

North American Datum (NAD) 1983 State Plane Oklahoma South 3502 (U.S. feet) coordinate system was utilized as the basis for mapping and modeling efforts.

3.0 RUN-ON AND RUN-OFF CONTROL SYSTEM

3.1 Run-on Control System

The run-on control system consists of a berm and perimeter ditches around the Landfill. The berm around the perimeter of the Landfill is at approximate elevation 515'. The existing grade to the north, east, and south of the Landfill is lower, ranging from elevation 514' to 495'. In general, stormwater runoff drains away from the Landfill on the north, east and south sides of the Landfill. A depiction of the general stormwater flow direction and the Run-On Control System is shown in Figure 3-1.

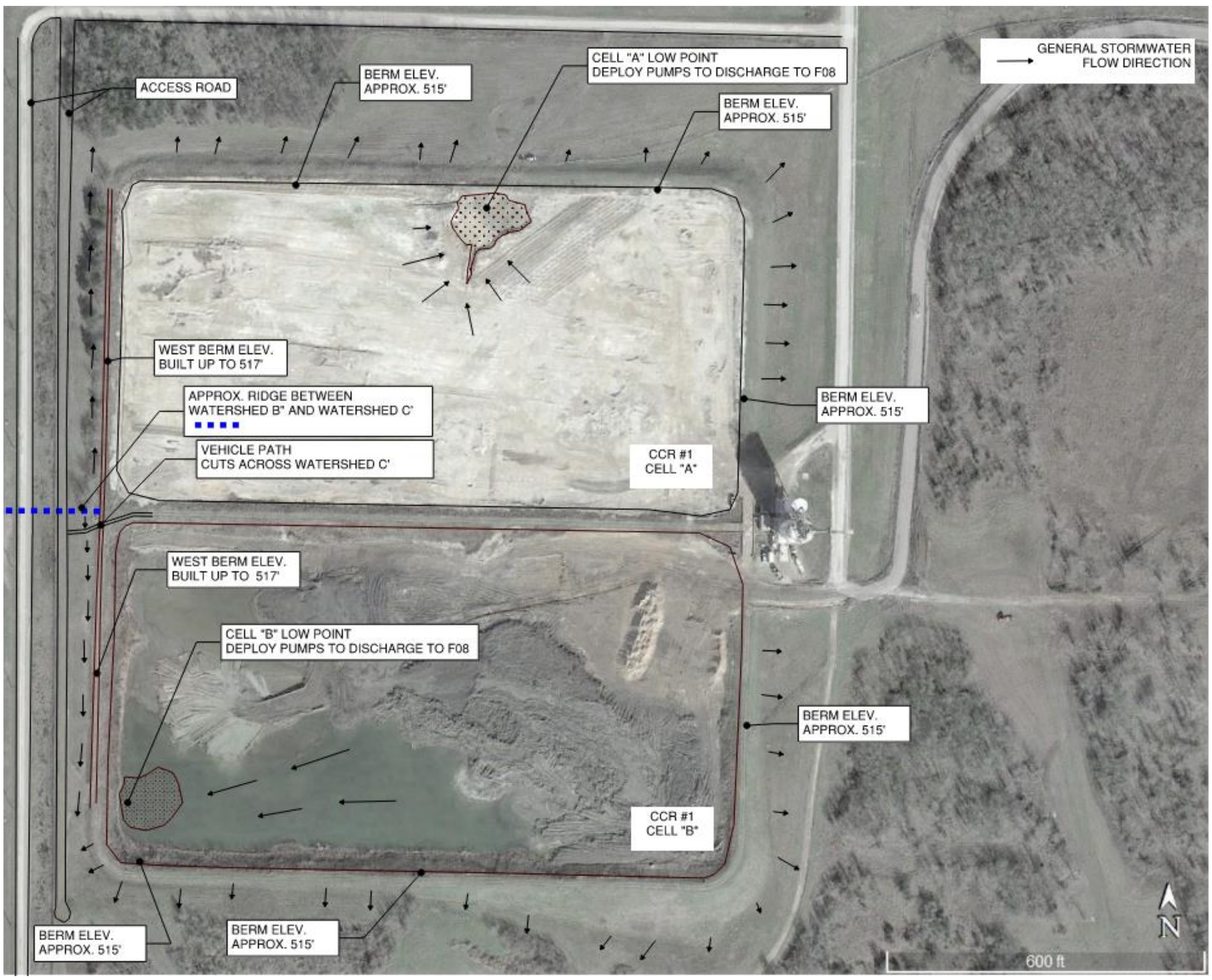


Figure 3-1. Run-On System Overview

The grade on the west side of the Landfill is higher than the berm around the Landfill: starting at elevation 525' and sloping down towards the Landfill. The berm on the west side of the Landfill has been built up to elevations as high as 517'. There is a perimeter ditch between the plant access road and the western berm of the Landfill. This ditch directs water away from the Landfill, where it can drain to the north or south.

A vehicle path, identified in Figure 3-1, runs west and east between the Landfill cells, ultimately dividing the western perimeter ditch in half. Given that the west side of the Landfill is higher than the adjacent berm, the vehicle path creates a low point thus allowing runoff from the perimeter access road to reach the active portion of the landfill. To meet the OAC CCR Rules, it is recommended that the small section of the roadway be built up to the berm elevation so that water flows into the perimeter ditches rather than into the Landfill. Details for this recommendation are provided in Appendix C.

3.2 Run-Off Control System

The run-off control system consists of contouring the ash to direct runoff to the low spot in each cell of the Landfill. The water is collected at the low spots and pumped to F08 in compliance with the current OPDES permit referenced in Section 2.0.

3.3 Run-on and Run-off System Criteria

3.3.1 Capacity Criteria

OAC. § 252.81 (a)(1) and (a)(2) state the following:

> *"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."*

4.0 HYDROLOGIC AND HYDRAULIC CAPACITY

4.1 Calculation Approach

The NOAA Atlas 14 precipitation frequency estimates were last updated in 2013; therefore, no change in the 2016 precipitation inputs was required. To simulate the peak flow of the design storm run-on and volume resulting from the design storm run-off, a hydrologic and hydraulic model created in 2016 was updated. Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) was used to generate this model. HEC-HMS is software developed by the U.S. Army Corps of Engineers for the evaluation of watersheds and hydrologic processes. The HEC-HMS model breaks down the hydrologic and hydraulic processes into a precipitation model, a runoff model, and other hydraulic elements, such as culverts, storage ponds, and pumps. The detailed calculation and model description are in Appendix A.

In addition to calculating the peak discharge, Bentley FlowMaster software was used to validate the known capacities of the perimeter ditches. The outputs for the perimeter ditch profiles for the design storm are in Appendix B.

The run-on/run-off design event for this Control Plan, as indicated in OAC 252:517-13-2 (a)(1) and (a)(2), is the 24-hour, 25-year storm. The precipitation depth used for the run-on and run-off is 7.55 inches. This precipitation data was acquired from the National Weather Service (NOAA, 2017). The point precipitation location (Station Valliant 3 W), where the precipitation values are derived for, is shown in Figure 4-1. The table of rainfall depths for various frequencies and durations is presented in Figure 4-2. This precipitation depth was used in conjunction with the SCS Type II rainfall temporal distribution to develop a rainfall curve for the 24-hour, 25-year event.

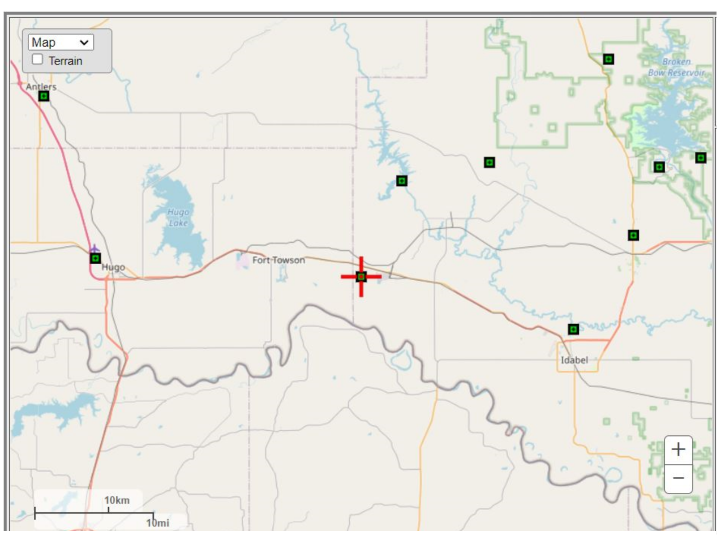


Figure 4-1. Point Precipitation Locator

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.468** (0.377-0.582)	**0.534** (0.430-0.665)	**0.644** (0.517-0.803)	**0.737** (0.590-0.920)	**0.867** (0.680-1.10)	**0.969** (0.748-1.24)	**1.07** (0.811-1.39)	**1.18** (0.868-1.54)	**1.32** (0.949-1.75)	**1.44** (1.01-1.91)
10-min	**0.685** (0.552-0.853)	**0.782** (0.629-0.974)	**0.943** (0.757-1.18)	**1.08** (0.863-1.35)	**1.27** (0.996-1.61)	**1.42** (1.10-1.81)	**1.57** (1.19-2.03)	**1.73** (1.27-2.26)	**1.94** (1.39-2.57)	**2.10** (1.48-2.80)
15-min	**0.836** (0.673-1.04)	**0.954** (0.767-1.19)	**1.15** (0.923-1.43)	**1.32** (1.05-1.64)	**1.55** (1.21-1.97)	**1.73** (1.34-2.21)	**1.92** (1.45-2.47)	**2.11** (1.55-2.75)	**2.37** (1.70-3.13)	**2.56** (1.81-3.41)
30-min	**1.23** (0.986-1.52)	**1.40** (1.13-1.74)	**1.69** (1.36-2.11)	**1.94** (1.55-2.42)	**2.28** (1.79-2.89)	**2.55** (1.97-3.25)	**2.82** (2.13-3.64)	**3.10** (2.28-4.05)	**3.48** (2.50-4.61)	**3.77** (2.66-5.02)
60-min	**1.62** (1.31-2.02)	**1.86** (1.49-2.31)	**2.25** (1.80-2.80)	**2.58** (2.06-3.22)	**3.05** (2.39-3.88)	**3.42** (2.65-4.37)	**3.81** (2.88-4.92)	**4.21** (3.10-5.50)	**4.75** (3.41-6.29)	**5.17** (3.64-6.88)
2-hr	**2.02** (1.64-2.49)	**2.31** (1.88-2.85)	**2.80** (2.27-3.45)	**3.22** (2.60-3.98)	**3.82** (3.03-4.81)	**4.30** (3.35-5.44)	**4.79** (3.65-6.14)	**5.31** (3.94-6.89)	**6.01** (4.34-7.90)	**6.56** (4.65-8.67)
3-hr	**2.27** (1.86-2.78)	**2.60** (2.12-3.18)	**3.15** (2.57-3.86)	**3.63** (2.95-4.46)	**4.32** (3.45-5.43)	**4.88** (3.83-6.16)	**5.46** (4.19-6.97)	**6.08** (4.53-7.85)	**6.92** (5.03-9.07)	**7.59** (5.40-9.98)
6-hr	**2.76** (2.28-3.34)	**3.14** (2.60-3.81)	**3.81** (3.14-4.62)	**4.39** (3.61-5.35)	**5.26** (4.25-6.55)	**5.96** (4.73-7.47)	**6.71** (5.19-8.50)	**7.50** (5.64-9.63)	**8.60** (6.30-11.2)	**9.48** (6.79-12.4)
12-hr	**3.31** (2.77-3.97)	**3.76** (3.14-4.52)	**4.56** (3.80-5.48)	**5.26** (4.37-6.34)	**6.31** (5.15-7.80)	**7.17** (5.75-8.90)	**8.08** (6.32-10.2)	**9.06** (6.88-11.5)	**10.4** (7.69-13.5)	**11.5** (8.31-14.9)
24-hr	**3.89** (3.28-4.62)	**4.45** (3.76-5.29)	**5.43** (4.57-6.45)	**6.29** (5.27-7.49)	**7.55** (6.21-9.22)	**8.57** (6.93-10.5)	**9.66** (7.61-12.0)	**10.8** (8.26-13.6)	**12.4** (9.21-15.9)	**13.7** (9.93-17.6)
2-day	**4.49** (3.83-5.28)	**5.20** (4.43-6.11)	**6.40** (5.44-7.53)	**7.43** (6.29-8.76)	**8.91** (7.39-10.8)	**10.1** (8.22-12.3)	**11.3** (8.99-13.9)	**12.6** (9.71-15.8)	**14.4** (10.7-18.2)	**15.8** (11.5-20.1)
3-day	**4.93** (4.23-5.75)	**5.68** (4.88-6.63)	**6.96** (5.96-8.14)	**8.06** (6.86-9.44)	**9.62** (8.02-11.5)	**10.9** (8.89-13.1)	**12.2** (9.69-14.9)	**13.5** (10.4-16.8)	**15.3** (11.5-19.3)	**16.8** (12.3-21.3)
4-day	**5.27** (4.54-6.12)	**6.05** (5.22-7.03)	**7.37** (6.34-8.58)	**8.50** (7.28-9.92)	**10.1** (8.47-12.1)	**11.4** (9.36-13.7)	**12.7** (10.2-15.5)	**14.1** (10.9-17.4)	**16.0** (12.0-20.1)	**17.5** (12.8-22.1)
7-day	**6.06** (5.27-6.98)	**6.91** (6.01-7.96)	**8.33** (7.22-9.61)	**9.54** (8.24-11.0)	**11.3** (9.49-13.3)	**12.6** (10.4-15.0)	**14.0** (11.3-16.9)	**15.5** (12.1-19.0)	**17.4** (13.2-21.7)	**19.0** (14.0-23.8)
10-day	**6.77** (5.92-7.75)	**7.66** (6.70-8.78)	**9.15** (7.98-10.5)	**10.4** (9.04-12.0)	**12.2** (10.3-14.3)	**13.6** (11.3-16.1)	**15.0** (12.1-18.0)	**16.5** (12.9-20.1)	**18.5** (14.0-22.9)	**20.0** (14.9-25.1)
20-day	**8.94** (7.92-10.1)	**9.95** (8.80-11.3)	**11.6** (10.2-13.2)	**13.0** (11.4-14.8)	**14.9** (12.7-17.2)	**16.3** (13.7-19.1)	**17.8** (14.5-21.1)	**19.3** (15.2-23.3)	**21.2** (16.2-26.1)	**22.7** (17.0-28.2)
30-day	**10.8** (9.61-12.1)	**12.0** (10.6-13.5)	**13.8** (12.3-15.6)	**15.4** (13.6-17.4)	**17.4** (14.9-20.0)	**19.0** (16.0-22.0)	**20.5** (16.8-24.1)	**22.0** (17.4-26.3)	**23.9** (18.3-29.2)	**25.4** (19.0-31.3)
45-day	**13.1** (11.8-14.7)	**14.6** (13.1-16.3)	**16.9** (15.1-18.9)	**18.7** (16.6-21.0)	**21.1** (18.1-24.0)	**22.8** (19.3-26.2)	**24.4** (20.1-28.5)	**26.0** (20.6-30.9)	**28.0** (21.5-33.8)	**29.3** (22.1-36.1)
60-day	**15.1** (13.6-16.8)	**16.9** (15.2-18.8)	**19.6** (17.6-21.9)	**21.7** (19.4-24.3)	**24.5** (21.1-27.6)	**26.4** (22.4-30.2)	**28.2** (23.2-32.7)	**29.9** (23.8-35.3)	**31.9** (24.5-38.4)	**33.2** (25.1-40.7)

[1] 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.

Figure 4-2. Precipitation Point Frequency Estimates Valliant 3 W Station

4.2 Watershed Delineation and Hydrologic Characteristics

The Plant watersheds were delineated using the mapping sources as discussed in Section 2.1 and are shown in Figure 4-3. Watersheds D (Cell A) and E (Cell B) represent the interior portion of the Landfill. Watershed B is the area that runs off to the north, and around the Landfill. Only a small portion of Watershed B contributes to the ditches on the west side of the Landfill, and so Watershed B was further divided into Watershed B' and Watershed B" to evaluate the capacity of the ditch along the north half of the west side of the landfill. Watershed C drains the area west of the southern half of the Landfill. Watershed C was subdivided into Watershed C' to evaluate the capacity of the ditch along the west side of the Landfill Cell “B”. Properties of the watershed were determined using the topographical and planimetric features from the mapping. These properties were used to build the HEC-HMS model. The engineering calculation utilizing the HEC-HMS Model is included in Appendix A.

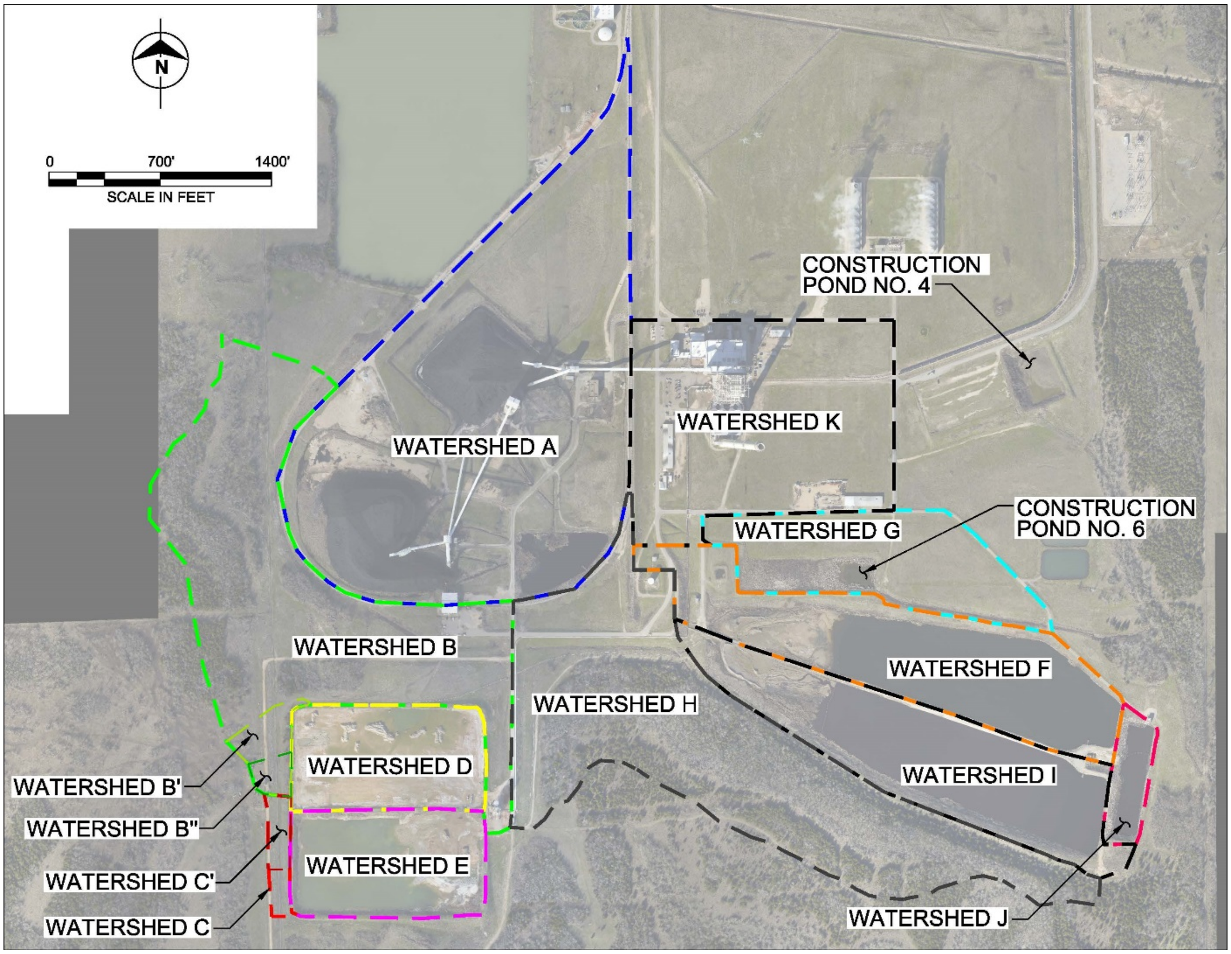


Figure 4-3. Plant Watershed Boundaries

4.3 Site Visit Hydraulic Review Findings

On December 28, 2021, a site walk was conducted around the perimeter of the Landfill to validate the current Operating Plan. It was found that the upper portion of the western perimeter ditch in Watershed C’ slopes to the South, with the potential to allow stormwater to enter the Landfill. This is due to a vehicular path cutting across Watershed C’. Field measurements were taken along Watershed C’ south of the vehicular path to determine a geometry for approximately 50-ft of channel. While the survey data indicates an irregular shape, the most apparent geometry was an irregular trapezoidal channel with a bottom width between three to four feet, a top width of 13-feet, and a depth of one-foot in the shallower areas near the access road.

5.0 RESULTS

5.1 Summary

The peak flows from Watersheds B', B", C, and C', estimated via hydrographs generated in HEC-HMS, were input into Bentley FlowMaster. The peak flows generated from HEC-HMS are shown below in Table 5-1. Results indicate that the peak runoff from the 24-hour 25-year return storm would not overtop the ditches at the locations checked. The runoff hydrographs from Watersheds D and E were also developed in HEC-HMS. The results indicated the volume of runoff would be contained within the Landfill, until such time the Plant were to pump the water to F08. For the next review cycle in 2026, it is recommended that a new Plant topographical survey be collected if the Operating Plan changes due to fly ash or bottom ash handling in the Landfill.

Table 5-1. Summarized Results from HEC-HMS Simulation

HEC-HMS Hydraulic Element	Peak Discharge (cfs)	Volume (inches)
North Cell Low Point	0.0	0
South Cell Low Point	0.0	0
Watershed B'	14.9	5.13
Watershed B"	6.1	5.13
Watershed C	11.6	5.14
Watershed C"	7.7	5.14
Watershed D	133.5	4.64
Watershed E	139.1	4.64

5.2 Operating Plan

To meet the requirements of OAC:252-13-2(a)(1) and prevent flow onto the active portion of the Landfill during the peak discharge from the design storm, the Plant should maintain the system of perimeter ditches and berms, which direct stormwater runoff away from the Landfill. In addition, to continue to meet direct stormwater runoff away from the Landfill, the following is recommended and detailed in Appendix C:

1. Remove debris from the ditch located in Watershed B'.
2. Return the berm on the Western side of the Landfill to a high point elevation of 517' where the vehicle path (Referenced on Figure 3-1) crosses Watershed C'.
3. Return the small section of ditch adjacent to the Western Berm of Cell "B" of the Landfill to its original geometry that has been disturbed by vehicular traffic.

To meet the requirements of OAC:252-13-2(a)(2) and collect and control the water volume of the design storm, the Plant should continue to utilize low areas of the Landfill to collect runoff within the Landfill. The runoff collected in the low areas of the Landfill should be sent to the F08 after the design storm event.

To meet the requirements of OAC:252-13-2 and discharge in accordance with OAC:252:606, the Plant should continue to utilize the current equipment and methods to comply with the OPDES permit.

5.3 Conclusion

In following the Operating Plan identified in Section 5.2, the run-on and run-off control system for the Landfill is designed, constructed, operated, and maintained to: (1) prevent flow onto the active portion of the Landfill during the peak discharge from a 24-hour, 25-year storm, and (2) collect and control at least the water volume resulting from a 24-hour, 25-year storm. Runoff from the active portion of the Landfill is handled in accordance with the surface water requirements of OAC:517-13-2.

6.0 REVIEW AND REVISIONS

The Control Plan will be placed in the Plant's Operating Record in accordance with the CCR Rule. Pursuant to the CCR Rule, if there is a significant change to any information compiled in the Control Plan, the relevant information will be updated, and the revised document will be placed in the Plant's Operating Record with notice and public accessibility as required by the CCR Rule. A record of revisions made to this document is included in Section 7.0.

7.0 RECORD OF REVISIONS

Revision Number	Date	Revisions Made	By Whom
0	10/16/2016	Initial Issue	Burns & McDonnell
1	1/28/2022	Operating Plan Update	Burns & McDonnell

APPENDIX A – 142180-C-001

Client : WFEC
Project Name : Run On Run Off
Project Number :142180

WORKSHEET TITLE:	Run-on and run-off	**CALCULATION NO.:**	142180-C-001
CREATED DATE:	1/21/2022	**REVISION:**	0
REVISED BY:	K. Alexander	**REVIEWED BY:**	
OBJECTIVE:	Provide calculations to demonstrate the hydrologic run-on and run-off per **OAC 252:517**		

REFERENCES:

1 Lindeburg, M. **(2015)**. *Civil engineering reference manual for the PE exam 15th Edition.* Belmont, CA: Professional Publications, Inc.

2 Sanja Perica, Deborah Martin, Sarah Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin (2013). NOAA Atlas Volume 8 Version 2.0, Precipitation-Frequency Atlas of the United States, Midwestern States (Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, Wisconsin) NOAA, National Weather Service, Silver Spring, MD.

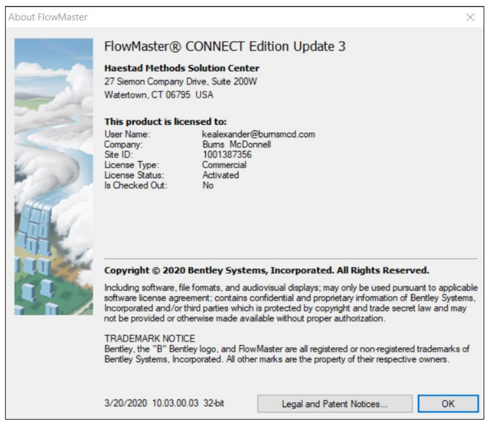
3 Cox, D., Chu, T., Ruane, R. (February 1979). *Characterization of coal pile drainage* (EPA-600/7-79-051). Washington, DC: US Environment Protection Agency

4 Web Soil Survey

5 Cronshey, R. et al. (June 1986). *Urban hydrology for small watersheds* (TR-55). Washington, DC: US Department of Agriculture.

SOFTWARE:

1 Hydrologic Modeling System (HEC-HMS)
2 **Bentley FlowMaster**



MODEL:

1 WFEC_2022
ENR\WFEC\142180_WFECHUGORORO\7_Studies\Tech_Consult\Reports\Run On_Run Off\HEC
2 142180 Run-on Run-off.fm8
ENR\WFEC\142180_WFECHUGORORO\7_Studies\Tech_Consult\Reports\Run On_Run Off\FlowMaster

DESIGN INPUT:

1 Per OAC 252.17-13 (a) the design storm is a 24-hour 25-year return storm.
2 Site soil classification is D. — Reference 4
3 Curve Numbers as follows:

	CN	
Coal Pile/CCR	73	Reference 3
Meadow - Mowed for Hay	78	Reference 5

4 There is relatively little impervious area, therefore a single CN will be used, and 10% impervious will be conservatively added.
5 **Assumed** channel velocity is 5 ft/s for calculating Time of Concentration.

EQUATIONS:

1 Sheet Flow Travel Time
$t_{sheet} = 0.007*(nL)^{0.8}/\sqrt{(P_2)}*S_{decimal}^{0.4}$ — Reference 1, p. 20-3, eq. 20.6
2 Shallow Flow Travel Time
$t_{shallow} = L/v$ — Reference 1, p. 20-3, Section 5

Client : WFEC
Project Name : Run On Run Off
Project Number :142180

WORKSHEET TITLE:	Run-on and run-off	**CALCULATION NO.:**	142180-C-001
CREATED DATE:	1/21/2022	**REVISION:**	0
REVISED BY:	K. Alexander	**REVIEWED BY:**	

OBJECTIVE: Provide calculations to demonstrate the hydrologic run-on and run-off per **OAC 252:517**

3 Velocity of Shallow Flow
vshallow =16.1345√(Sdecimal) — Reference 1, p. 20-3, eq. 20.7
4 Channel Flow Travel Time
tchannel = L/v — Reference 1, p. 20-3, Section 5
5 Time of Concentration
tc = tsheet + tshallow + tchannel — Reference 1, p. 20-3, eq. 20.5
6 Soil Water Storage Capacity
S = (1000/CN) -10 — Reference 1, p. **20-17**, eq. 20.43
7 Initial Abstraction
Ia = 0.2*S — Reference 1, p. **20-16**, eq. 20.38

VARIABLES:

1	tlag	lag time, min
2	L	hydraulic length of the watershed, ft
3	S	soil water storage capacity, in
4	Sdecimal	slope, ft/ft
5	CN	curve number, unit less
6	Ia	initial abstraction, in
7	Ad	total drainage area, ac or mi2
8	AT	total area, ac
9	Q	peak runoff rate, cfs
10	vchannel	channel velocity, ft/s
11	vshallow	shallow velocity, ft/s
12	tc	time of concentration, min
13	tsheet	sheet flow travel time, min
14	tshallow	shallow concentrated flow travel time, min
15	tchannel	channel flow travel time, min
16	P2	2yr 24hr rainfall, in
17	n	Manning's roughness coefficient

PROCEDURE:

1 Use topographic mapping and planimetric features to establish the watersheds boundaries and ground surface cover for the plant.
See Figure 1 for watershed boundaries.
See Table 1 for watershed area and summary of ground surface features.

Table 1

Watershed	B'	B''	C	C'	D	E
Area, sf	159,199	56,414	105,492	67,375	798,171	823,814
Area, ac	3.7	1.3	2.4	1.5	18.3	18.9
Area, mi^2	0.005710	0.002024	0.003784	0.002417	0.028630	0.029550
Surfacing	Grass	Grass	Grass	Grass	CCR	CCR
Curve No.	78.0	78.0	78.0	78.0	73.0	73.0
S	2.8	2.8	2.8	2.8	3.7	3.7
Ia	0.56	0.56	0.56	0.56	0.74	0.74

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PROCEDURE (continued):

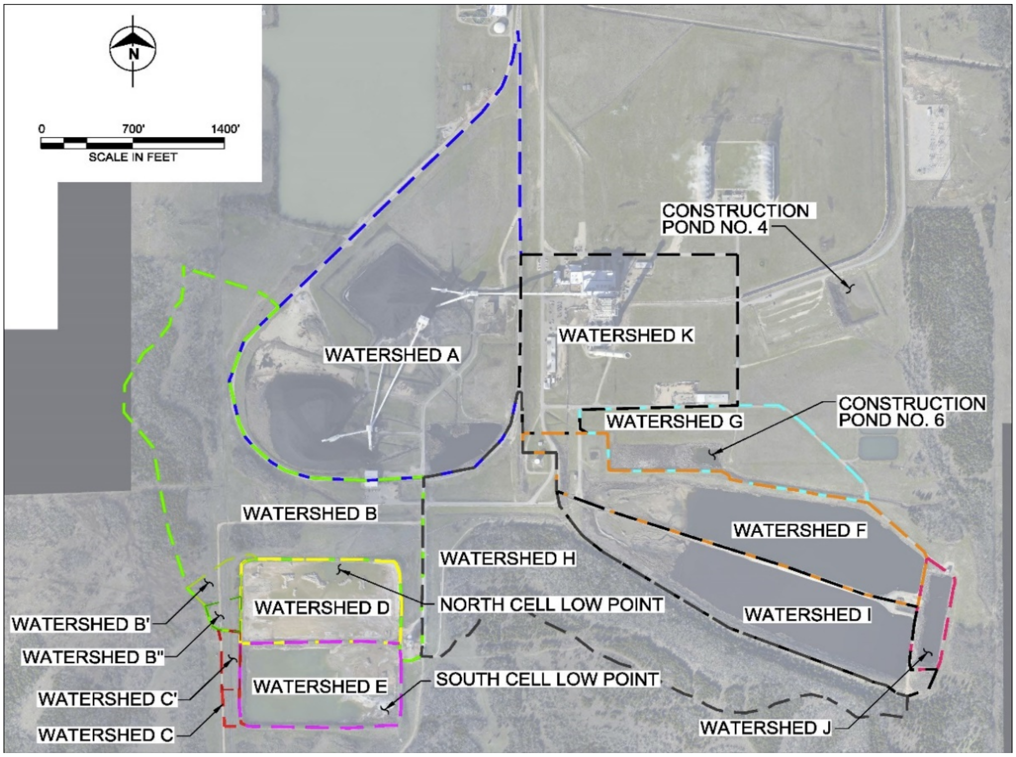

Figure 1 - Watershed Boundaries for Plant

Watershed A drains through the coal pile runoff pond into CCR 3
Watershed B is diverted around the Coal Pile and CCR Landfill into a ditch that goes through Watershed H.
Watershed B' and B'' are sub-watershed of Watershed B. Peak discharges will be calculated for these sub-watersheds to evaluate the ditch's capacity.
Watershed C drains to the south side of the site.
Watershed C' is a sub-watershed of Watershed C. Peak discharges will be calculated for these sub-watersheds to evaluate the ditch's capacity.
Watershed D is the north half of the CCR Landfill which drains to a low point on the north side of the cell.
Watershed E is the south half of the CCR Landfill which drains to a low point on the east side of the cell.
Watershed F drains through various open ditches and pipes to **F08 (Stormwater Pond)**
Watershed G drains to the north side of **F08 (Stormwater Pond)**.
Watershed H drains to the south side of the **closed impoundment**
Watershed I consists of the area immediately around **and** the south of the **closed impoundment**.
Watershed J is the Process Waste Pond.
Watershed K drains the plant to Construction Pond 4.
Watersheds A, F, G, H, I, J, and K do not runoff to the CCR Landfill, and therefore they are excluded from further consideration in this calculation.

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WORKSHEET TITLE: Run-on and run-off **CALCULATION NO.:** 142180-C-001

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REVISED BY: K. Alexander **REVIEWED BY:**

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PROCEDURE (continued):

2 Use topographic features to establish time of concentration.
See Table 2 for summary of time of concentration calculations.

Table 2

	B'	B"	C	C'	D	E	Notes
Sheet							
n	0.150	0.150	0.150	0.150			
L (ft)	150.00	150.00	150.00	150.00			(total < 150ft)
P_2 (in)	4.45	4.45	4.45	4.45			
$S_{decimal}$ (ft/ft)	0.010	0.010	0.017	0.017			
t_{sheet} (hr)	**0.25**	**0.25**	**0.21**	**0.21**			Equation 1
t_{sheet} (min)	**15.16**	**15.16**	**12.26**	**12.26**			Equation 1
Shallow							
L (ft)	157.00	84.00	81.00	81.00			
$S_{decimal}$ (ft/ft)	0.054	0.101	0.068	0.068			
$v_{shallow}$ (fps)	3.75	5.13	4.20	4.20			Equation 3
$t_{shallow}$ (s)	**41.82**	**16.37**	**19.27**	**19.27**			Equation 2
$t_{shallow}$ (m)	**0.70**	**0.27**	**0.32**	**0.32**			Equation 2
Channel							
L (ft)	319.00	0.00	591.00	298.00			
$S_{decimal}$ (ft/ft)	0.0089	0.0044	0.0050	0.0043			
$v_{channel}$ (fps)	5.00	5.00	5.00	5.00			
$t_{channel}$ (s)	**63.80**	**0.00**	**118.20**	**59.60**			Equation 4
$t_{channel}$ (m)	**1.06**	**0.00**	**1.97**	**0.99**			Equation 4
t_c (min)	**16.92**	**15.44**	**14.55**	**13.57**	**0.00**	**0.00**	Equation 5
t_{lag} (min)	**10.15**	**9.26**	**8.73**	**8.14**	**0.00**	**0.00**	

*Rain that falls directly on the Landfill immediately converts to runoff, therefore, there is no time of concentration.

3 Set up North Cell Low Point and South Cell Low Point as Reservoir to model the storage capacity for Run Off.
See Table 3 for Elevation Area data.

Table 3

North Cell Low Point		South Cell Low Point	
Elevation	Area	Elevation	Area
ft	ac	ft	ac
510	8.6737	500	10.1896
511	13.9211	501	11.2516
512	15.9307	502	12.0882
513	16.4192	503	12.5744
514	16.7585	504	13.0548
515	17.0966	505	13.5532

4 Set up Meteorological Model
SCS Storm Type 2
25-year - 24 hours Rainfall 7.55 inches

PROCEDURE (continued):

5 Set up Control Specification.
Use 1 minute to be conservative.

6 Run HEC-HMS.
Graphs of water surface elevation in the North Cell Low Point and South Cell Low Point show the water elevation not over topping.

APPENDIX B – FLOWMASTER CHANNEL OUTPUTS

Client : WFEC
Project Name : Run On Run Off
Project Number :142180

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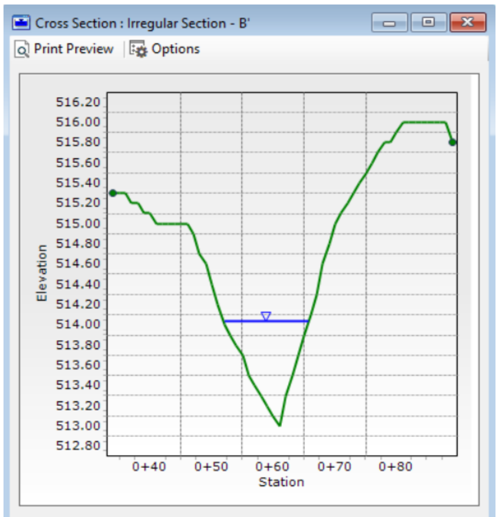
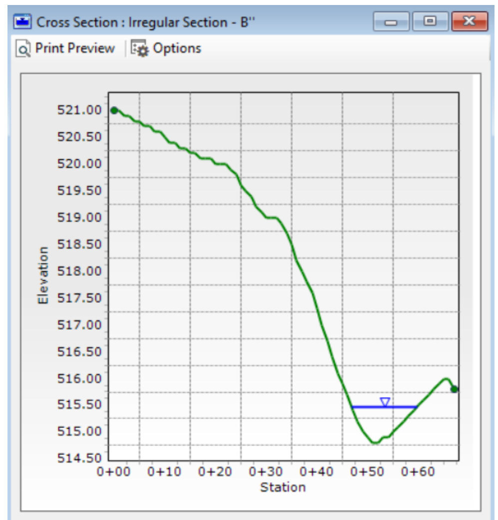
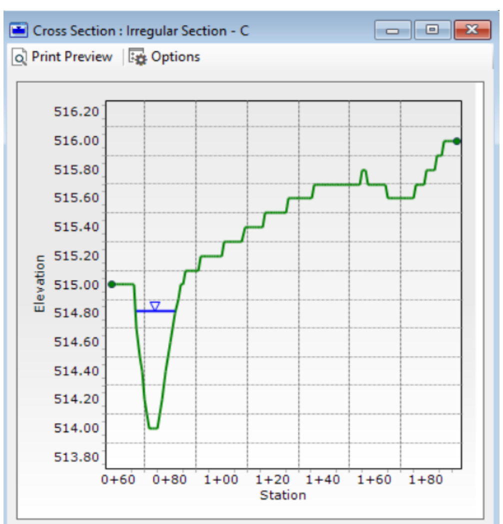
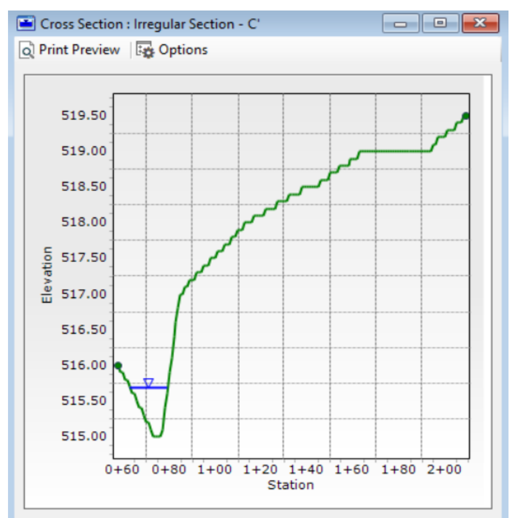
FLOWMASTER CHANNEL OUTPUTS

Plug peak discharges for B', B'', C and C' from HEC-HMS into Flow Master **and set Length to Channelized Flow Length**
FlowMaster shows the ditches have capacity to carry the 25 year 24 hour peak runoff.



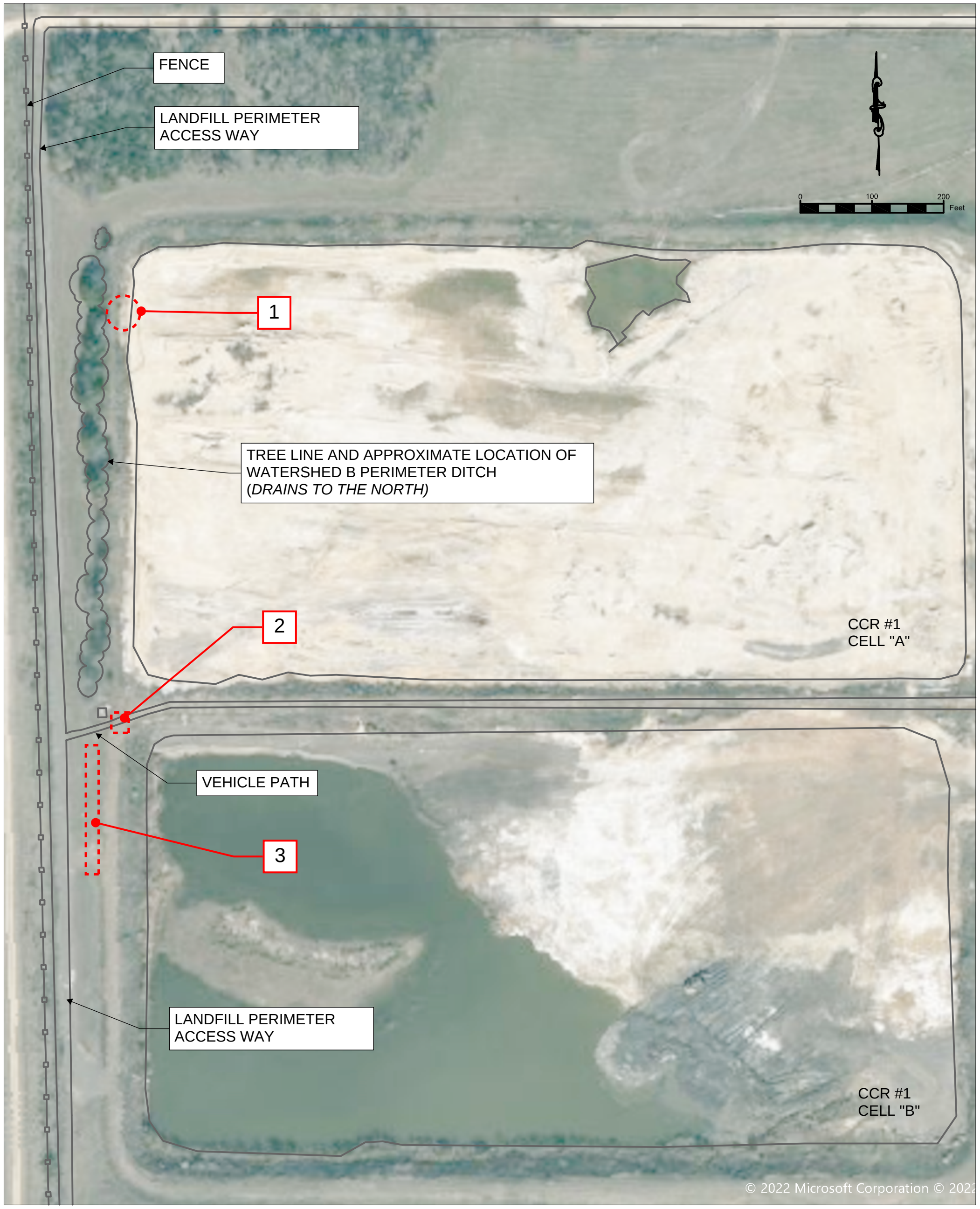






APPENDIX C – OPERATING PLAN RECOMMENDED IMPROVEMENTS

OPERATING PLAN: SUMMARY OF IMPROVEMENTS



COMMENTS

1. During the site walk, debris (tree limbs, mulch, etc.) observed in the flow line of the ditch.

Recommendation:

Remove debris from the ditch located in Watershed B'

2. Vehicle path currently cuts across the berm.

Recommendation:

Perform site grading to raise the berm to elevation 517' where the vehicle path crosses Watershed C'.

3. Disturbance of the perimeter ditch observed during the site walk due to vehicular traffic around the flow line of the ditch.

Recommendation:

Restore length of ditch adjacent to the berm to its original geometry.

project 142180

APPENDIX C
FLOW PREVENTION ACTIVITIES ONTO THE ACTIVE PORTION OF THE LANDFILL
WFEC - HUGO, OK

BURNS McDONNELL

date 1/28/2022

designed K. ALEXANDER

CREATE AMAZING.

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