

ADMINISTRATION
PO Box 669
Chouteau, OK 74337
918-256-5545



May 12, 2023

Hillary Young
Chief Engineer
Land Protection Division
Oklahoma Department of Environmental Quality
707 North Robinson
P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

**RE: Periodic Run-On Run-Off Control System Plan
Grand River Dam Authority (GRDA)
Grand River Energy Center (GREC) Landfill
Chouteau, Mayes County, Oklahoma
Solid Waste Permit No. 3549012**

Ms. Young:

We deliver affordable,
reliable **ELECTRICITY**,
with a focus on **EFFICIENCY**
and a commitment to
ENVIRONMENTAL
STEWARDSHIP.

We are dedicated to
ECONOMIC DEVELOPMENT,
providing resources and
supporting economic growth.

Our **EMPLOYEES**
are our greatest asset in
meeting our mission to be an
Oklahoma Agency
of Excellence.



In accordance with Oklahoma Administrative Code (OAC) 252:517-13-2, GRDA is pleased to present the Periodic Run-Off Run-On Control System Plan for the GREC Coal Combustion Residual (CCR) Landfill. OAC 252:517-13-2(c)(4), requires that the plan be updated every five years. This plan was prepared by Black & Veatch on behalf of GRDA.

Please let me know if you have any questions.

Sincerely,

A handwritten signature in blue ink that reads "Michael L. Bednar".

Michael L. Bednar
Manager of Environmental Compliance

FINAL

2023 - PERIODIC RUN-ON RUN-OFF CONTROL SYSTEM PLAN

**GRAND RIVER ENERGY CENTER - CCR LANDFILL
SOLID WASTE PERMIT NO. 3549012**

Chouteau, Oklahoma

**B&V PROJECT NO. 405290
B&V FILE NO. 41.0403**

PREPARED FOR



10 MAY 2023



CERTIFICATION

I certify, as a Professional Engineer in the State of Oklahoma, that the information in this document was assembled under my direct personal charge and that this periodic run-on run-off control system plan meets the applicable requirements of OAC 252:517-13-2. This report is not intended or represented to be suitable for reuse by Grand River Dam Authority or others without specific verification or adaption by the Engineer.



A handwritten signature of "Gary Sommerfeld" in black ink.

Gary Sommerfeld, P.E.
Oklahoma License Number 31996

Date: 10 May 2023

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1.0 INTRODUCTION

This report presents the periodic five-year revision for the run-on and run-off control plan for the Grand River Dam Authority (GRDA) Coal Combustion Residual (CCR) landfill at the Grand River Energy Center (GREC) in Chouteau, Oklahoma.

The previous plan was prepared February 22, 2018, in accordance with Oklahoma Administrative Code (OAC) 252:517-13-2. This periodic revision has been completed in accordance with OAC 252:517-13-2(c)(4) - *Frequency for revising the plan*. The completed plan will be placed with the GREC operating records as required by OAC 252:517-19-1(g)(3).

Preparations for the current plan included a review of the existing run-on and run-off plan, site visits that coincided with the annual landfill inspections, and discussion with the power facility's environmental compliance personnel.

2.0 DESCRIPTION OF LANDFILL

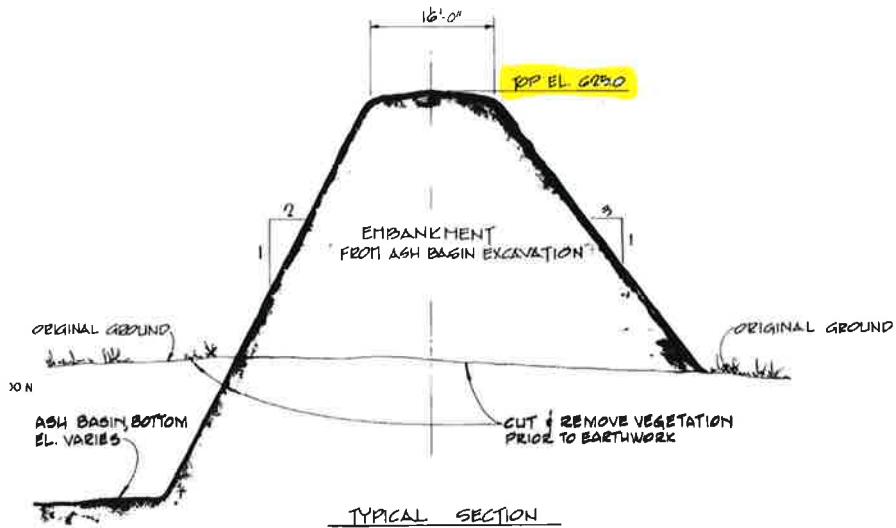
2.1 GENERAL DESIGN INFORMATION

The GREC power plant is located east of Chouteau within Mayes County, in northeastern Oklahoma. It was designed with a 490-MW Unit that was commissioned in 1981. The facility expanded operations in 1985 with a second unit rated at 520 MW. Unit 2 has a dry Flue Gas Desulfurization(FGD) scrubber for control of sulfur emissions.

The GREC landfill was permitted in 1979 as a Non-Hazardous Industrial Waste Landfill that is allowed to accept fly ash, bottom ash and spent powdered activated carbon used to control flue gas emissions, generated at the GREC facility. The original permitted landfill consisted of 116 acres, of which only 47 acres have been utilized for placement of CCR materials.

In October 2017, a request to modify the existing landfill permit was submitted to DEQ. The modification requested a reduction in landfill permit area from 116 acres to 67 acres. The request for permit modification has been approved by DEQ. The original drawings for the landfill were completed in 1979 by Holway-United. The drawings show the embankments surrounding the landfill were constructed to Elevation 625 with a 16-foot wide top and 2 Horizontal to 1 Vertical side slopes, see Figure 2-1. Soil materials from inside the landfill excavation area were used to construct the embankments.

The landfill was designed so that all surface water drainage is routed around the landfill area and into a series of permitted Class III industrial wastewater treatment impoundments regulated under an Oklahoma Pollutant Discharge Elimination System (OPDES) permit OK0035149. The industrial wastewater system consists of 11 process water and storm water retention/treatment basins around the western and southern perimeter of the landfill. These surface impoundments provide a total holding capacity of 1,371,521,000 gallons as stated in the facility OPDES permit and receive process water, cooling tower water, and storm water run-off from the landfill, coal pile, and the operational areas of the plant. The discharge is to the Neosho River.

Figure 2-1 Original Design Drawing Cross-Section of Landfill Perimeter Embankment

2.2 OPERATIONS

Disposal operations within the power plant require dump trucks to haul the fly ash and bottom ash from the plant to the landfill. The fly ash haul trucks are loaded from storage silos using dry disposal methods. The haul trucks unload the ash in the landfill area and dozers are used to grade the material into even lifts. A water truck is used to condition the dry ash to aid in grading and prevent fugitive dust. The face of the disposed ash is on the north side of the landfill and the drainage of the exposed ash is toward the north. In general, bottom ash is deposited at the northeast corner of the working face of the landfill area. The bottom ash has occasionally been sold as a beneficial use product; therefore, bottom ash is deposited separately from the fly ash. Bottom ash has a granular/gravel texture and is also dampened with water for fugitive dust control purposes prior to transport. Ash material that has been placed at the planned final grade has been capped with the planned cover soil, topsoil, and seeded with grass.

The current landfill modification of the east perimeter and construction of the new east embankment is partially complete. Partial regrading of the northeast side of the landfill working face has been part of the east embankment construction.

3.0 Run On and Run Off Controls

OAC 252:517-13-2(a) states, "The owner or operator of an existing or new CCR landfill or any 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 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.

OAC 252:57-13-2(b) states the 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 "Discharges".

3.1 Run On Controls

The landfill perimeter embankment prevents run-on to the landfill. Stormwater drainage toward the embankment occurs on the north and east side of the landfill. A stormwater pond located northeast of the landfill captures drainage from the east and southeast portions of the plant. The drainage area on the northeast and east of the landfill is controlled by the perimeter berm. (See Figure 3-1)

Figure 3-1 Run-On Areas and Drainage Direction



The north side run-on surface water drainage grades toward the east and toward south at the planned discharge location located on the southeast corner of the originally permitted landfill footprint. The drainage area outside of the northwest corner of the landfill is much smaller and the drainage is collected within the coal pile runoff features.

The perimeter embankment provides sufficient protection that prevent the 24-hour, 25-year storm from run-on to the active and closed portions of the landfill. Drainage calculations are provided in Appendix A.

The drainage direction on the west and south sides of the perimeter embankment are away from the landfill. Drainage on the west slopes toward the process water ponds and then to the natural drainage at the southwest. Drainage on the south slopes toward the south and the borrow source ponds that are part of the natural drainage. The 24-hour, 25-year storm event drains away from the closed portions of the landfill on the west and south.

3.2 Run-Off Controls

Run-off is controlled at the active face of the landfill and at the closed/capped areas. Run-off from the active north face of the landfill is prevented by the perimeter embankment. Precipitation does not run-off beyond the inside of the perimeter embankment. The active face is continually graded to drain toward the north and does not run-off across closed porions of the cap.

The currently capped portions of the landfill are on the west slope, south slope, and the south half at the final fill elevation (See Figure 3-1). The capped portions have been constucted with the planned closure cap soil material, topsoil, and seeded. Precipitation on the capped portions that run-off the landfill do not contact the coal combustion residual materials.

All areas of the landfill control run-off from the 24-hour, 25-year storm event. Two letdown structures are planned for preventing erosion due to run-off from the final closure. A letdown structure on the east directs capped closure runoff in the direction of the originally planned discharge location. A letdown structure at the northeast directs runoff toward the FGD pond. The letdown structures are planned to be rock bedding or similar erosion protection surfacing. (See Figure 3-2). The letdown structures meet the requirements for run-off from the design storm event.

3-2 Closure Design Run-Off Features

4.0 Amendments and Revisions

GRDA may amend or revise the written run-on and run-off control plan to meet changes in the power plant operations or as necessary for landfill beneficial re-use. The regulation for revisions is provided in OAC 252:517-13-2(c)(2).

The run-on and run-off control plan is scheduled for the next periodic revision in 2028 as directed by OAC 252:517-13-2(c)(4). The plan is to be prepared on a five-year periodic basis and will be placed in the power plants operating record.

5.0 References

The following references were used to develop the periodic revision to the run-on and run-off control plan.

- a. Grand River Dam Authority (GRDA) 490-MW Coal Fired Generating Station Ash Disposal Permit Application, Chouteau, Oklahoma; 22 August 1979.
- b. Oklahoma Administrative Code (OAC). Chapter 517. Disposal of Coal Combustion Residuals from Electric Utilities, Effective 15 September 2018
- c. Bottom Ash Surface Impoundment Hazard Potential Classification Assessment, prepared by Black & Veatch, October 2016.
- d. Closure Plan for GRDA Landfill – Grand River Energy Center, by A & M Engineering and Environmental Services, Inc, 22 February 2018.
- e. Quality Assurance and Quality Control Plan for GRDA Landfill – Grand River Energy Center, by A & M Environmental Services, 13 September 2019.
- f. Run-on and Run-Off Control Plan for Grand River Dam Authority Landfill, by A & M Engineering and Environmental Services, Inc. 22 Februay 2018.

APPENDIX A

CALCULATIONS

WinTR-55 Current Data Description

--- Identification Data ---

User: B&V Date: 5/5/2023
Project: GRDA Units: English
SubTitle: A1 RUN-OFF Areal Units: Acres
State: Oklahoma
County: Mayes
Filename: C:\Users\lel92886\OneDrive - Black & Veatch\1 Assorted Tasks\GRDA Runoff Report\GRDA_A1 Run-off

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
A1		Outlet	26.18	84	.469

Total area: 26.18 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

B&V

GRDA
A1 RUN-OFF
Mayes County, Oklahoma

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data

Rainfall Distribution Type: Type II

Dimensionless Unit Hydrograph: <standard>

B&V

GRDA
A1 RUN-OFF
Mayes County, Oklahoma

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 25-Yr (cfs)
<hr/>	
SUBAREAS	
A1	116.56
<hr/>	
REACHES	
OUTLET	116.56

B&V

GRDA
A1 RUN-OFF
Mayes County, Oklahoma

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period
	25-Yr (cfs) (hr)
<hr/>	
SUBAREAS	
A1	116.56
	12.16

REACHES

OUTLET	116.56
--------	--------

B&V

GRDA
A1 RUN-OFF
Mayes County, Oklahoma

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
A1	26.18	0.469	84	Outlet	
Total Area: 26.18 (ac)					

B&V

GRDA
A1 RUN-OFF
Mayes County, Oklahoma

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Mannings's Slope (ft/ft)	n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
<hr/>							
A1	SHEET	100	0.2500	0.150			0.053
	SHALLOW	1306	0.0030	0.050			0.411
	CHANNEL	219	0.2500	0.025	4.87	21.49	12.167
							0.005
					Time of Concentration		.469
							<hr/>

B&V

GRDA
A1 RUN-OFF
Mayes County, Oklahoma

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
A1	Open space; grass cover 50% to 75% (fair) Gravel (w/ right-of-way)	D D	25.94 .24	84 91
	Total Area / Weighted Curve Number		26.18	84
			=====	==

WinTR-55 Current Data Description

--- Identification Data ---

User: B&V Date: 5/5/2023
Project: GRDA Units: English
SubTitle: A2 RUN-OFF Areal Units: Acres
State: Oklahoma
County: Mayes
Filename: C:\Users\lel92886\OneDrive - Black & Veatch\1 Assorted Tasks\GRDA Runoff Report\GRDA_A2 Run-off

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
A2		Outlet	22.23	84	.384

Total area: 22.23 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

B&V

GRDA
A2 RUN-OFF
Mayes County, Oklahoma

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data

Rainfall Distribution Type: Type II

Dimensionless Unit Hydrograph: <standard>

B&V

GRDA
A2 RUN-OFF
Mayes County, Oklahoma

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 25-Yr (cfs)
<hr/>	
SUBAREAS	
A2	110.05
<hr/>	
REACHES	
OUTLET	110.05

B&V

GRDA
A2 RUN-OFF
Mayes County, Oklahoma

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period
	25-Yr (cfs)
	(hr)
<hr/>	
SUBAREAS	
A2	110.05 12.12

REACHES

OUTLET	110.05
--------	--------

B&V

GRDA
A2 RUN-OFF
Mayes County, Oklahoma

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
A2	22.23	0.384	84	Outlet	

Total Area: 22.23 (ac)

B&V

GRDA
A2 RUN-OFF
Mayes County, Oklahoma

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Mannings's Slope (ft/ft)	n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
A2							
SHEET	100	0.2500	0.150				0.053
SHALLOW	1117	0.0035	0.050				0.325
CHANNEL	224	0.2500	0.025	4.35	21.33	10.370	0.006

Time of Concentration .384

B&V

GRDA
A2 RUN-OFF
Mayes County, Oklahoma

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
A2	Open space; grass cover 50% to 75% (fair) Gravel (w/ right-of-way)	D D	22.01 .22	84 91
	Total Area / Weighted Curve Number		22.23	84

WinTR-55 Current Data Description

--- Identification Data ---

User: B&V Date: 5/5/2023
Project: GRDA Units: English
SubTitle: RUN-ON W1 Areal Units: Acres
State: Oklahoma
County: Mayes
Filename: C:\Users\lel92886\OneDrive - Black & Veatch\1 Assorted Tasks\GRDA Runoff Report\GRDA_W1 Run-on.

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
W1		Outlet	0.74	82	0.1

Total area: .74 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

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GRDA
RUN-ON W1
Mayes County, Oklahoma

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data

Rainfall Distribution Type: Type II

Dimensionless Unit Hydrograph: <standard>

B&V

GRDA
RUN-ON W1
Mayes County, Oklahoma

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 25-Yr (cfs)
<hr/>	
SUBAREAS	
W1	5.27
<hr/>	
REACHES	
OUTLET	5.27

B&V

GRDA
RUN-ON W1
Mayes County, Oklahoma

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period
	25-Yr (cfs) (hr)
SUBAREAS	
W1	5.27
	11.93

REACHES

OUTLET	5.27
--------	------

B&V

GRDA
RUN-ON W1
Mayes County, Oklahoma

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
W1	.74	0.100	82	Outlet	
Total Area: .74 (ac)					

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GRDA
RUN-ON W1
Mayes County, Oklahoma

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Mannings's Slope (ft/ft)	n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
W1	SHEET CHANNEL	30 365	0.0102 0.0102	0.150 0.015	4.00	8.26	6.337 0.016
					Time of Concentration		0.1
							=====

B&V

GRDA
RUN-ON W1
Mayes County, Oklahoma

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
W1	Open space; grass cover 50% to 75% (fair)	C	.37	79
	Open space; grass cover 50% to 75% (fair)	D	.37	84
Total Area / Weighted Curve Number			.74	82
			====	==

WinTR-55 Current Data Description

--- Identification Data ---

User: B&V Date: 5/5/2023
Project: GRDA Units: English
SubTitle: RUN-OFF W2 Areal Units: Acres
State: Oklahoma
County: Mayes
Filename: C:\Users\lel92886\OneDrive - Black & Veatch\1 Assorted Tasks\GRDA Runoff Report\GRDA_W2 Run-off

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
W2		Outlet	8.27	82	.502

Total area: 8.27 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

B&V

GRDA
RUN-OFF W2
Mayes County, Oklahoma

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.96	4.83	5.61	6.76	7.71	8.72	3.47

Storm Data Source: User-provided custom storm data

Rainfall Distribution Type: Type II

Dimensionless Unit Hydrograph: <standard>

B&V

GRDA
RUN-OFF W2
Mayes County, Oklahoma

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 25-Yr (cfs)
SUBAREAS W2	33.92
REACHES	
OUTLET	33.92

B&V

GRDA
RUN-OFF W2
Mayes County, Oklahoma

Hydrograph Peak/Peak Time Table

Sub-Area Peak Flow and Peak Time (hr) by Rainfall Return Period
or Reach 25-Yr
Identifier (cfs)
(hr)

SUBAREAS

W2 33.92
 12.16

REACHES

OUTLET 33.92

B&V

GRDA
RUN-OFF W2
Mayes County, Oklahoma

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
W2	8.27	0.502	82	Outlet	
Total Area: 8.27 (ac)					

B&V

GRDA
RUN-OFF W2
Mayes County, Oklahoma

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Mannings's Slope (ft/ft)	n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
<hr/>							
W2							
SHEET	100	0.0031	0.150				0.309
CHANNEL	1542	0.0078	0.030	21.00	24.32	3.966	0.108
CHANNEL	1273	0.0078	0.030	10.00	10.79	4.160	0.085
Time of Concentration							.502
<hr/>							

B&V

GRDA
RUN-OFF W2
Mayes County, Oklahoma

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use	Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
W2	Open space; grass cover 50% to 75% (fair)	C	4.134	79
	Open space; grass cover 50% to 75% (fair)	D	4.136	84
Total Area / Weighted Curve Number			8.27	82
			=====	====

GRDA Channel Analysis
A1 Letdown, 25-Year Storm

Catchment Table - Time: 12.15 hours

Label	Outflow Element	Area (User Defined) (acres)	SCS CN	Time of Concentration (hours)	Flow (Maximum) (cfs)
A1	A1 UPSTREAM	26.180	84.000	0.469	109.70

Cross Section Table - Time: 12.15 hours

Label	Bottom Width (ft)	Height (ft)	Slope (Left Side) (H:V)	Slope (Right Side) (H:V)	Manning's n	Hydraulic Grade (ft)	Flow-Area (ft ²)	Flow-Width (ft)	Froude Number	Is Ever Overflowing?	Time to Maximum Hydraulic Grade (hours)	Depth (Node) (ft)	Hydraulic Grade (Maximum) (ft)	Section Type	Velocity (ft/s)
A1 UPSTREAM	20.0	2.24	0.330	0.330	0.030	706.41	8.3	20.3	3.612	False	12.150	0.41	706.41	Trapezoidal Cross Section	13.11

Channel Table - Time: 12.15 hours

Label	Length (User Defined) (ft)	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Volume (Total Outflow) (gal)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Depth (Middle) (ft)	Depth/Rise (%)	Flow-Area (Middle) (ft ²)	Flow-Width (Middle) (ft)	Froude Number	Hydraulic Grade (Maximum) (ft)
A1 LETDOWN	321.0	A1 UPSTREAM	706.00	A1 OUTFALL	625.00	0.252	1,302,485.5	108.73	13.11	0.41	18.4	8.3	20.3	3.612	706.41

Outfall Table - Time: 12.15 hours

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Flow (Total Out) (cfs)	Hydraulic Grade (Maximum) (ft)	Time to Maximum Hydraulic Grade (hours)	Volume (Total Outflow) (gal)
A1 OUTFALL	627.24	625.00	Free Outfall	108.73	665.91	12.150	1,302,485.5

Design Check: Depth is less than 2' of freeboard.

GRDA Channel Analysis
A2 Letdown, 25-Year Storm

Catchment Table - Time: 12.15 hours

Label	Outflow Element	Area (User Defined) (acres)	SCS CN	Time of Concentration (hours)	Flow (Maximum) (cfs)
A2	A2 UPSTREAM	22.230	84.000	0.384	103.56

Cross Section Table - Time: 12.15 hours

Label	Bottom Width (ft)	Height (ft)	Slope (Left Side) (H:V)	Slope (Right Side) (H:V)	Manning's n	Hydraulic Grade (ft)	Flow-Area (ft ²)	Flow-Width (ft)	Froude Number	Is Ever Overflowing?	Time to Maximum Hydraulic Grade (hours)	Depth (Node) (ft)	Hydraulic Grade (Maximum) (ft)	Section Type	Velocity (ft/s)
A2 UPSTREAM	20.0	2.21	0.330	0.330	0.030	706.38	7.7	20.3	3.590	False	12.100	0.38	706.40	Trapezoidal Cross Section	12.54

Channel Table - Time: 12.15 hours

Label	Length (User Defined) (ft)	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Volume (Total Outflow) (gal)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Depth (Middle) (ft)	Depth/Rise (%)	Flow-Area (Middle) (ft ²)	Flow-Width (Middle) (ft)	Froude Number	Hydraulic Grade (Maximum) (ft)
A2 LETDOWN	324.8	A2 UPSTREAM	706.00	A2 OUTFALL	625.00	0.249	1,265,852.8	102.25	12.70	0.38	17.3	7.7	20.3	3.590	706.40

Outfall Table - Time: 12.15 hours

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Flow (Total Out) (cfs)	Hydraulic Grade (Maximum) (ft)	Time to Maximum Hydraulic Grade (hours)	Volume (Total Outflow) (gal)
A2 OUTFALL	627.21	625.00	Free Outfall	96.27	665.90	12.100	1,265,852.8

Design Check: Depth is less than 2' of freeboard.