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564 White Pond Drive
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April 17, 2019

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

Run-on/Run-off Control System Plan
New CCR Landfill (Cell 1)
EPA Final CCR Rule
TVA Paradise Fossil Plant
Drakesboro, Kentucky

1.0 PURPOSE

This letter documents AECOM's certification of the Run-on/Run-off Control System Plan for the TVA Paradise Fossil Plant's New CCR Landfill (Cell 1).

2.0 RUN-ON/RUN-OFF CONTROL SYSTEM PLAN

The Run-on/Run-off Control System Plan documents how the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of40 CFR 257.81(c).

3.0 SUMMARY OF FINDINGS

The attached Run-on/Run-off Control System Plan demonstrates compliance with the requirements set forth in 40 CFR § 257. 81(c).

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Nicholas Golden PE, being a Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below;
3. that the Run-on/Run-off Control System Plan for the TVA Paradise Fossil Plant's New CCR Landfill (Cell 1) meet(s) the requirements described in 40 CFR 257.81(c)

SIGNATURE _____ DATE 4/17/19

ADDRESS: AECOM
564 White Pond Drive
Akron, OH 44320

TELEPHONE: (502)-217-1525

ATTACHMENTS: §257. 81(c) Run-on/Run-off Control System Plan for Coal Combustion Residuals (CCR) New CCR Landfill

Tennessee Valley Authority – Paradise CCR Landfill
Muhlenberg County, Kentucky

§257.81(c) Run-on/Run-off Control System Plan for Coal Combustion Residuals (CCR)
New CCR Landfill
TVA Paradise Fossil Plant

Prepared for

Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402-2801

April 17, 2019

Prepared by
AECOM

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FIGURES

APPENDICES

1.0 INTRODUCTION

This Run-on/Run-off Control System Plan was prepared for a new proposed CCR landfill (Cell 1) owned by Tennessee Valley Authority (TVA) in Muhlenberg County, Kentucky.

The disposal facility will accept the coal combustion residuals (CCR) generated by the dry scrubber as well as other CCR produced at Paradise Fossil Plant including ash, flue gas desulfurization byproducts (FGD), and other byproducts from power generation operations.

The plan was prepared in accordance with 40 CFR Part 257 and specifically addresses the requirements under Subpart D, §257.81(c) of the U.S. Environmental Protection Agency (EPA) CCR Final Rule. Accordingly, run-on and run-off control system requirements for the disposal facility meet or exceed those of the Final CCR Rule.

1.1 SITE LOCATION AND DESCRIPTION

The Paradise Fossil Plant Landfill is a new CCR landfill owned by TVA. TVA uses the landfill for disposal of CCR generated by the TVA Paradise Fossil Plant. The Paradise Fossil Plant is located in western Kentucky, situated along the west bank of the Green River in Muhlenberg County, Kentucky. The landfill is located south of the cooling towers, east of the Riverside Road, and north of Jacobs Creek. The site location is shown in **Figure 1**. **Figure 2** depicts the plant and also landfill (Cell 1).

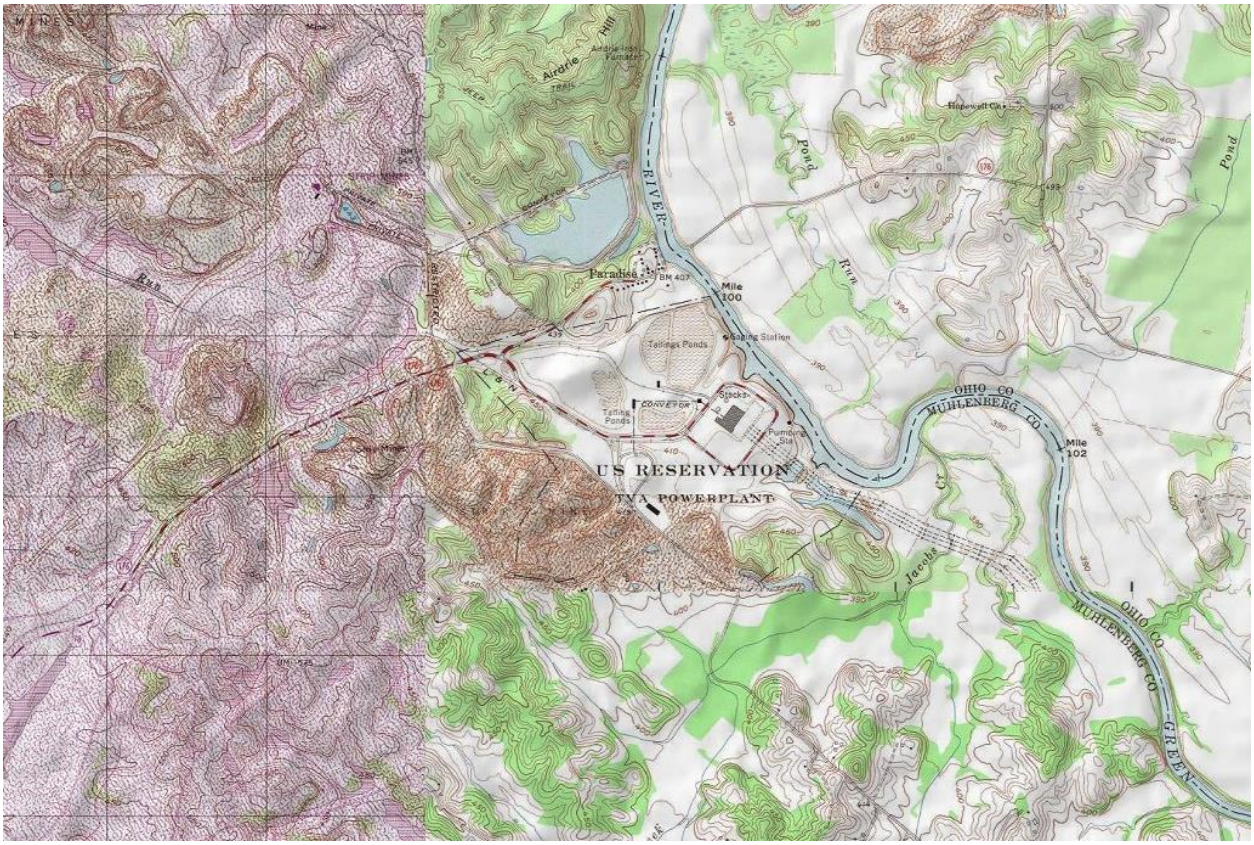


Figure 1 – Paradise Fossil Plant Site Location Map

1.2 DESCRIPTION OF CCR LANDFILL OPERATIONS

CCR will be hauled by truck to the new landfill for disposal. This new landfill is being developed to accommodate projected CCR production of the Paradise Fossil Plant. The location of the new landfill will be located southeast of the power plant.

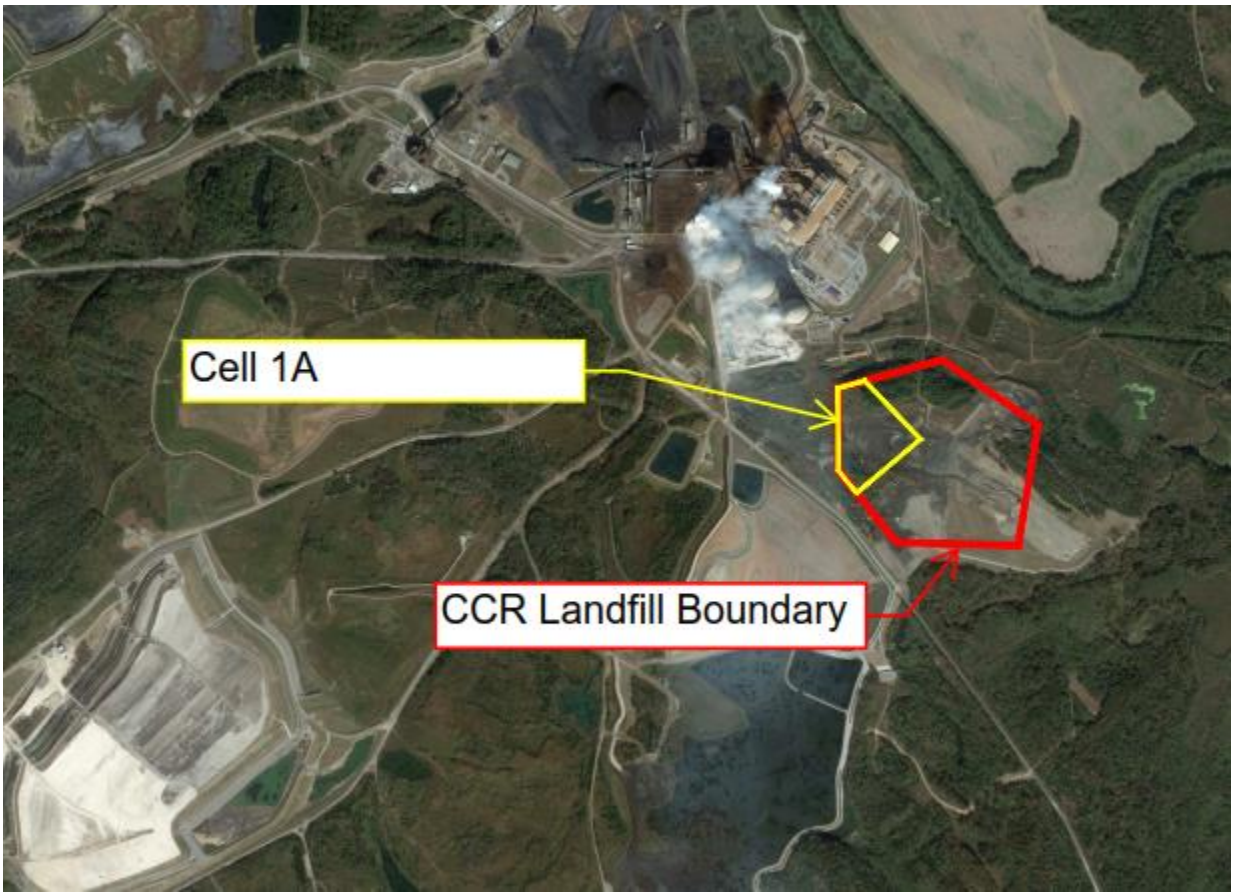


Figure 2 – Paradise Fossil Plant Site Plan
Imagery: Esri

1.3 CCR FINAL RULE REQUIREMENTS

(40 CFR) *257.81(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 § 257.3–3.

The Paradise Fossil Plant Landfill is a new CCR landfill that was designed to incorporate run-on and run-off controls systems, which prevent flow from and onto the active portion of the CCR unit during a 24-hour, 25-year storm.

1.4 PLAN CONTENT

(40 CFR) *257.81(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 § 257.105(g)(3).

This plan describes how the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of the Final CCR Rule. A certification statement from a qualified professional engineer verifying that this initial Plan meets the requirements of this section § 257.81 is provided. In accordance with § 257.81(c)(1), this Plan will be amended whenever there is a change in conditions that substantially affect the written plan in effect.

2.0 OVERVIEW OF RUN-ON/RUN-OFF CONTROL SYSTEMS

2.0 RUN-ON CONTROLS

Temporary storm water diversion structures, including ditches, rain flap berms, sumps, and pumps will be used as needed to minimize storm water run-on into an active cell. Non-contact storm water will be diverted to one sedimentation basin. The outer slopes of the cell will be covered with soil to reduce leachate generation and the potential for fugitive dust emissions.

2.0.1 BERMS

Run-on from adjacent land onto the active portion of the facility will be prevented using diversion berms designed to accommodate a 25-year/24-hour storm. The intent of the diversion berms is to route run-on from undisturbed areas such that run-on is not combined with sediment-laden run-off from the landfill site. Supporting design calculations for the berms are presented in **Appendix A**.

2.1 PERMANENT RUN-OFF MANAGEMENT FEATURES

The location of permanent run-off management features are shown on **Figure 3**. The outer slopes of the disposal facility have been designed with intermediate benches to intercept storm water that sheet flows down the slopes of the new landfill, routing the flow to the perimeter ditch via letdowns. This will aid to minimize erosion on those slopes. These benches will be constructed progressively as the elevation of the disposal facility is raised. All permanent run-off measures, including perimeter channels and culverts, are designed to collect and control the peak flow resulting from a 25-year/24-hour storm under final design conditions. Supporting design calculations for the surface water control structures are provided in **Appendix A**.

2.2 COLLECTION AND HOLDING FACILITIES

Holding facilities associated with storm water management consist of a sedimentation basin, the West Pond, as depicted on **Figure 4**. The sedimentation basin has been designed in accordance with the Total Suspended Solids (TSS) limits included in KPDES permit No. KY0004201. The primary spillway of the sediment basin has been designed to manage runoff resulting from the 25-year/24-hour storm, as required by § 257.81(a)(2) of the Final CCR Rule. The sedimentation basin's primary and emergency spillways are designed to manage runoff resulting from the 100-year/24-hour storm event with no flow overtopping the structure. This is typical for landfills in Kentucky.

The results of the sedimentation basin design are summarized in Table 1 below. The pond detains the water volume generated by the 24-hour/25-year storm, and the discharge structures are sized appropriately such that the peak water surface elevation in the basin during the 24-hour, 100-year storm remains safely below the peak storage elevation of the basin with greater than one foot of freeboard. The principal spillway structure in the sediment basin consists of one riser inlet discharging via 1 X 36" HDPE pipe. The sediment basin discharges into the Green River via drainage channels leading to a permitted Kentucky Pollutant Discharge Elimination System (KPDES) outfall.

Table 1 – Stormwater Pond Hydraulic Summary

	West Pond (Riser/Culvert)	Leachate Lagoon (Riser/Culvert)
Total Contributing Drainage Area (acres)	**31.89**	**1.55**
Principal Spillway Riser Inlet Invert Elevation (feet)	**435.00**	**436.00**
Principal Spillway Pipe Inlet Invert Elevation (feet)	**431.00**	**434.00**
Principal Spillway Pipe Outlet Invert Elevation (feet)	**430.12**	**430.12**
Emergency Spillway Inlet Invert Elevation (feet)	**436.50**	**437.99**
24-hour, 25-year storm – 5.44 inches		
Surface water volume generated (acre-feet)	**11.107**	**6.775**
Peak water elevation in pond (feet)	**435.41**	**436.20**
Peak discharge – Principal Spillway (cfs)	**11.43**	**8.70**
Peak discharge – Emergency Spillway (cfs)	**0**	**0**

The sediment basin will be cleaned periodically to maintain the minimum required sediment storage volume. A forebay has been incorporated into the design to allow more frequent cleaning of a smaller area.

2.3 STORM WATER AND LEACHATE MANAGEMENT

The leachate management design is illustrated on **Figure 5**. Leachate will be collected in lateral pipes on the floor of the liner and routed to a sump, which will ultimately be pumped to the

Leachate Collection Basin through a slope riser and force main. Stormwater will be collected and routed to the sedimentation basin, as previously described. Surface water drainage features and either intermediate cover or the final cover system will be installed progressively as filling proceeds, such that intermediate cover soil with an assumed permeability of $4.2x10^{-5}$ cm/sec will be placed on all exterior slopes prior to allowing run-off to enter the storm water management system. Water that comes in contact with CCR will be treated as leachate and collected in the leachate collection system.

2.4 EROSION CONTROL

Temporary erosion and sediment control measures are presented in **Figure 6**. The final storm water management plan is provided in **Figure 7**. Storm water run-off will be controlled and managed through a series of temporary and permanent surface water and erosion control measures including silt fences, seeding and mulching, and drainage channels.

3.0 FREQUENCY FOR REVISING THE PLAN

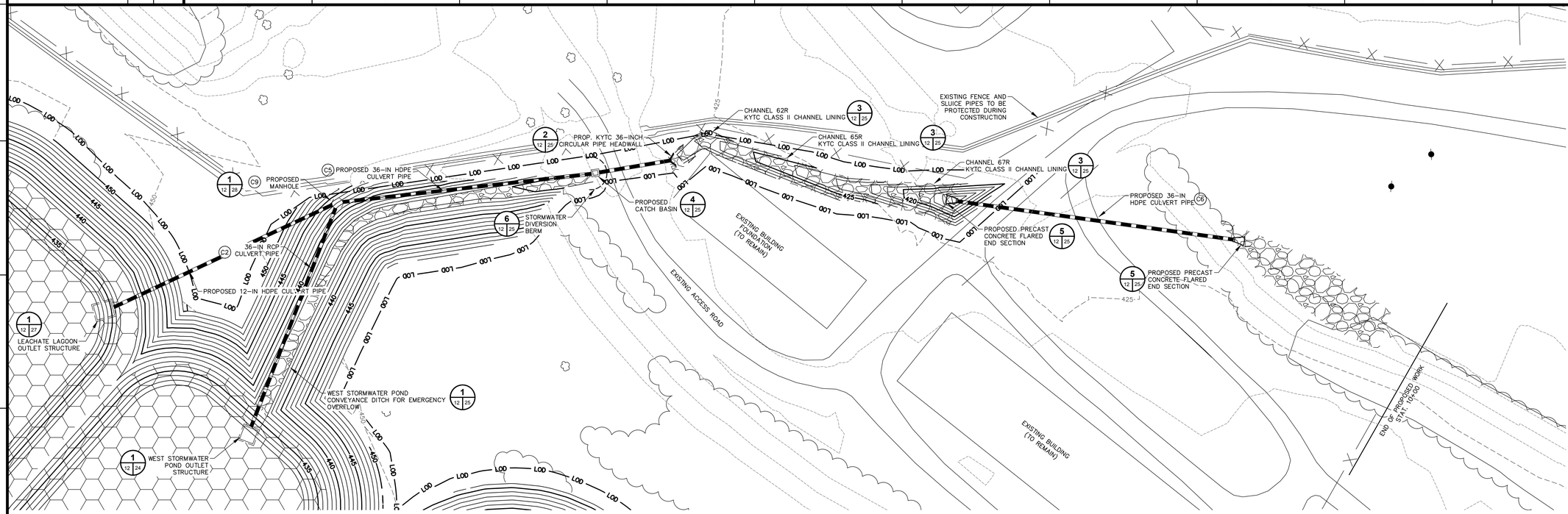
(40 CFR) *257.81(c)(4). The owner or operator of the CCR unit must prepare periodic run-on and runoff control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent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

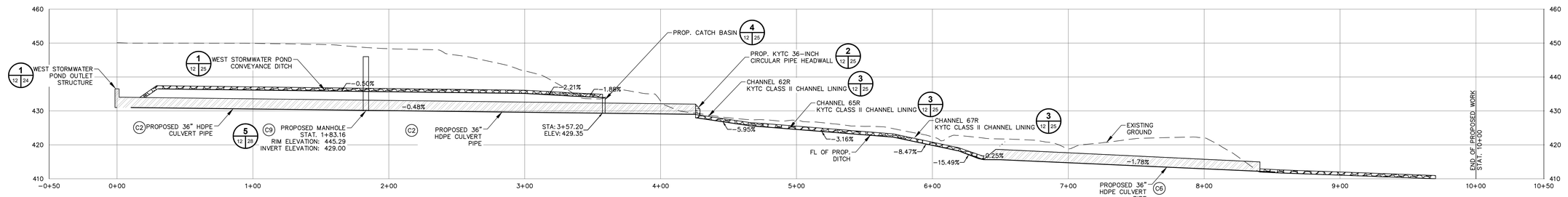
TVA will prepare an updated run-on and runoff control system plan five years after the effective date of this one, or when Cell 2A is constructed, whichever comes sooner. This plan will be placed in the facility's operating record. TVA will obtain a certification from a qualified professional engineer stating that the updated run-on and run-off control system plans meet the requirements of § 257.81.

4.0 CONCLUSION

This Run-on/Run-off Control System Plan was prepared for the new proposed CCR landfill (Cell 1). The plan was prepared in accordance with 40 CFR Part 257 and specifically addresses the requirements under Subpart D, §257.81(c). Accordingly, run-on and run-off control system requirements for the disposal facility meet or exceed those of the Final CCR Rule.

FIGURES





LEGEND

- EXISTING GROUND
- PROPOSED FLOW LINE OF CONVEYANCE DITCH
- KYTC CLASS CHANNEL LINING
- CULVERT PIPE

0 20 40
HORIZONTAL SCALE IN FEET

0 8 16
VERTICAL SCALE IN FEET

ISSUED FOR BID
NOT FOR CONSTRUCTION

AECOM

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ISSUED FOR BID											
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SCALE: AS SHOWN EXCEPT AS NOTED

WEST STORMWATER POND CONVEYANCE DITCH
PLAN AND PROFILE

COAL COMBUSTION RESIDUALS (CCR) LANDFILL

CELL 1A CONSTRUCTION

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
CLF	CLF	MBC	NSG	RSH	MST	JCK

PARADISE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD	2017	DATE 10/25/17	64	C	FIGURE 3	R 0

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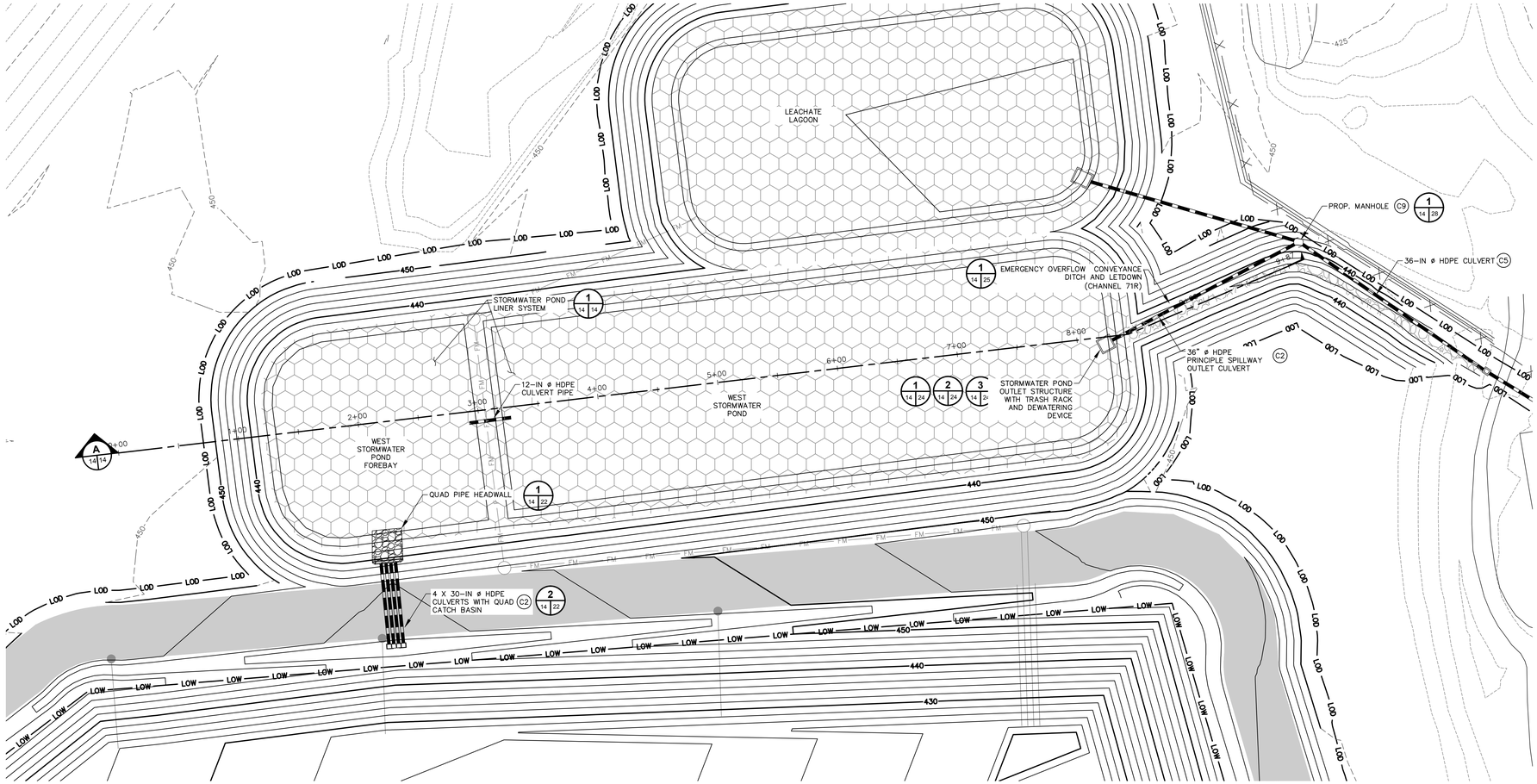
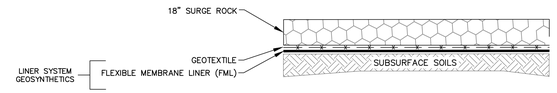


LEGEND

- EXISTING MAJOR CONTOURS (25')
- EXISTING MINOR CONTOURS (5')
- PROPOSED MAJOR CONTOURS (10')
- PROPOSED MINOR CONTOURS (2')
- PROPOSED PERIMETER AND ACCESS ROADS
- LOD — LIMIT OF DISTURBANCE
- LOW — CELL 1A LIMIT OF WASTE (12.5 ACRES)
- TREELINE
- TRANSMISSION TOWER
- OE — OVERHEAD ELECTRIC LINE
- EXISTING ROAD
- EXISTING EDGE OF WATER
- L — LEACHATE COLLECTION PIPE
- FM — LEACHATE FORCE MAIN PIPE
- LEACHATE CLEANOUT
- KYTC CLASS CHANNEL LINING
- SURGE ROCK

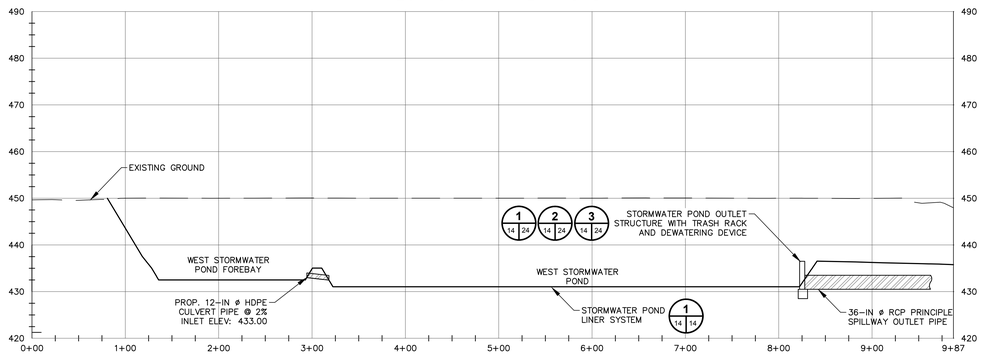
NOTE:
1. REFER TO DRAWINGS 10W723-22, 10W723-24, AND 10W723-25 FOR CULVERT AND STORMWATER POND SCHEDULES.
2. REFER TO DRAWING 10W723-12 FOR WEST STORMWATER POND CONVEYANCE DITCH



STORMWATER POND LINER SYSTEM
NOT TO SCALE

NOTES:
1. LINER SYSTEM FML TO BE TEXTURED 60-MIL LINEAR LOW DENSITY POLYETHYLENE (LLDPE).
2. THE SUBSURFACE SOILS TO BE MECHANICALLY SCREENED, HAND PICKED, OR MECHANICALLY PICKED TO REMOVE ROCKS GREATER THAN 1/2 INCH PRIOR TO GEOSYNTHETIC PLACEMENT.

WEST STORMWATER POND



LEGEND

- EXISTING GROUND
- PROPOSED GROUND
- CULVERT PIPE

0 60 120
HORIZONTAL SCALE IN FEET
0 12 24
VERTICAL SCALE IN FEET

ISSUED FOR BID
NOT FOR CONSTRUCTION

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DISCIPLINE INTERFACE

SCALE: AS SHOWN EXCEPT AS NOTED

WEST STORMWATER POND PLAN AND PROFLE

COAL COMBUSTION RESIDUALS (CCR) LANDFILL

CELL 1A CONSTRUCTION

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
CLF	CLF	MBC	NSG	RSH	MST	JCK

PARADISE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AECOM

AUTOCAD 2017	DATE 10/25/17	64	C	FIGURE 4	R 0

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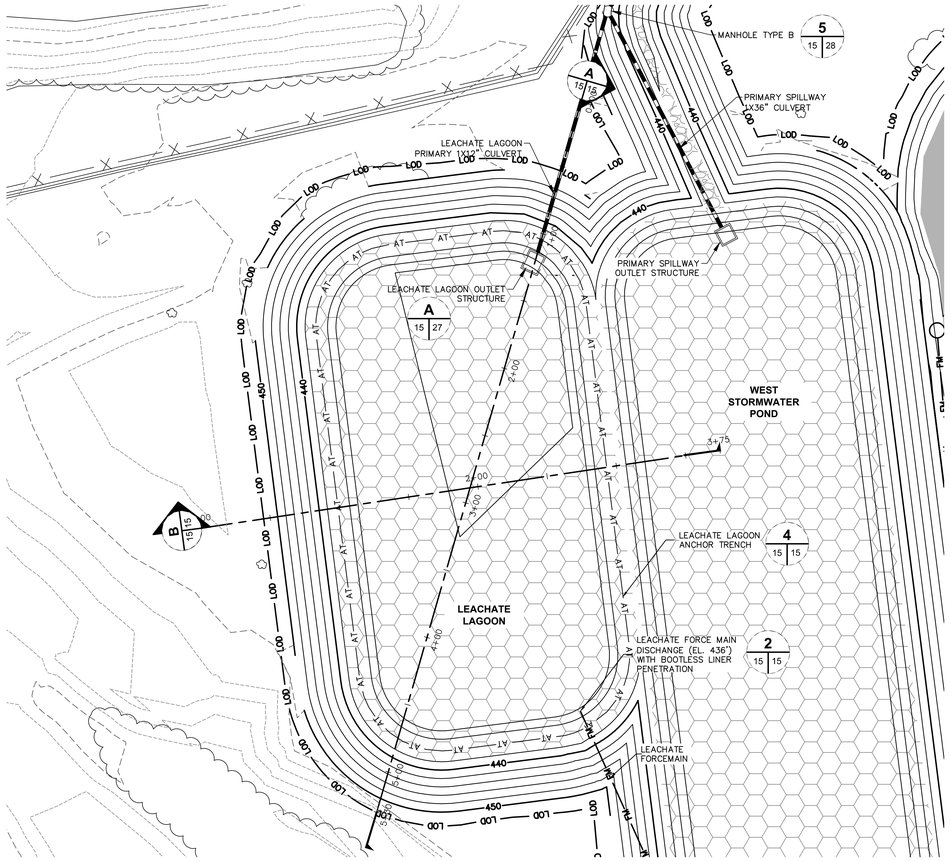
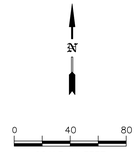
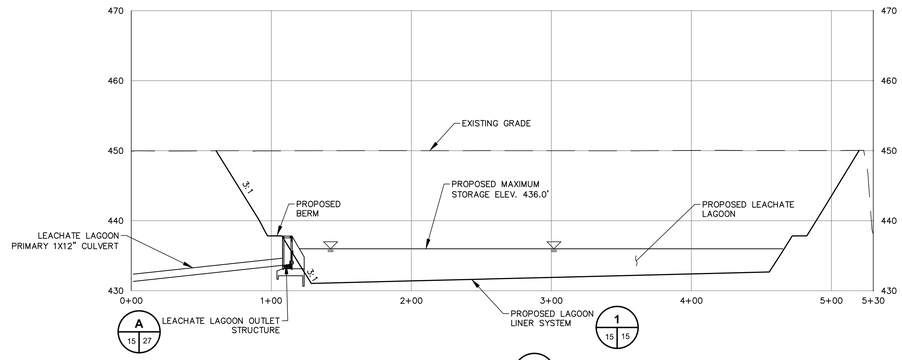


LEACHATE LAGOON PLAN

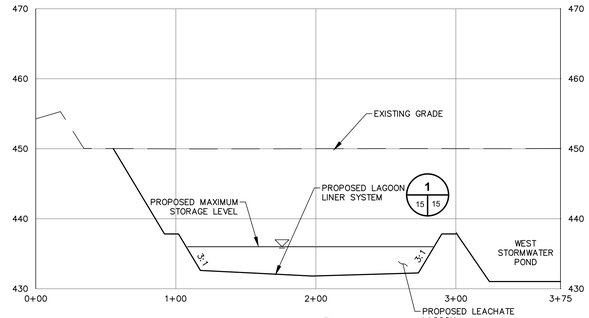




SECTION A 15 15

0 40 80

HORIZONTAL SCALE IN FEET



SECTION B 15 15

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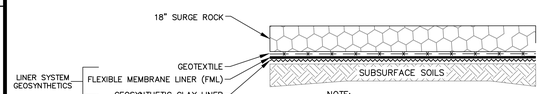
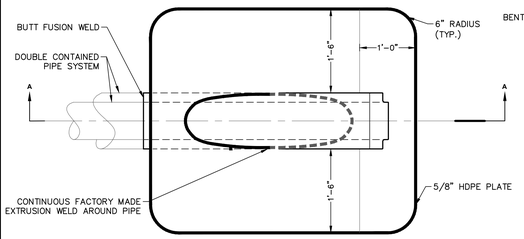
HORIZONTAL SCALE IN FEET

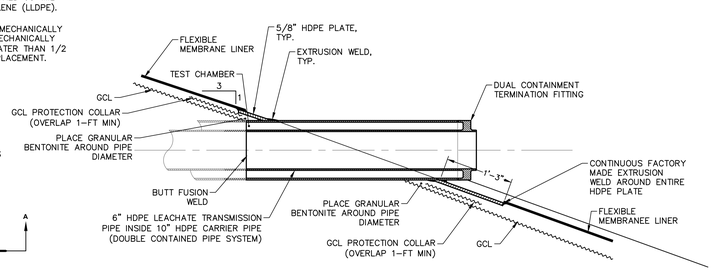


NOTE:
1. LINER SYSTEM FML TO BE TEXTURED 60-MIL LINEAR LOW DENSITY POLYETHYLENE (LLDPE).
2. THE SUBSURFACE SOILS TO BE MECHANICALLY SCREENED, HAND PICKED, OR MECHANICALLY PICKED TO REMOVE ROCKS GREATER THAN 1/2 INCH PRIOR TO GEOSYNTHETIC PLACEMENT.

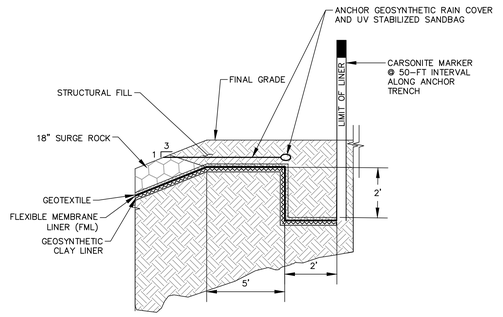
1 / 15 15 LAGOON SPECIFIED LINER SYSTEM
NOT TO SCALE



2 / 15 15 BOOTLESS LINER PENETRATION - DOUBLE CONTAINED LEACHATE TRANSMISSION PIPE PLAN VIEW
NOT TO SCALE



3 / 15 15 BOOTLESS LINER PENETRATION - DOUBLE CONTAINED LEACHATE TRANSMISSION PIPE - SECTION VIEW A-A'
NOT TO SCALE



4 / 15 15 LEACHATE LAGOON ANCHOR TRENCH
NOT TO SCALE

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DISCIPLINE INTERFACE

SCALE: AS SHOWN EXCEPT AS NOTED

LEACHATE LAGOON PLAN AND CROSS-SECTIONS

COAL COMBUSTION RESIDUALS (CCR) LANDFILL

CELL 1A CONSTRUCTION

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
FS	DAS	MBC	NSG	RSH	MST	JCK

PARADISE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

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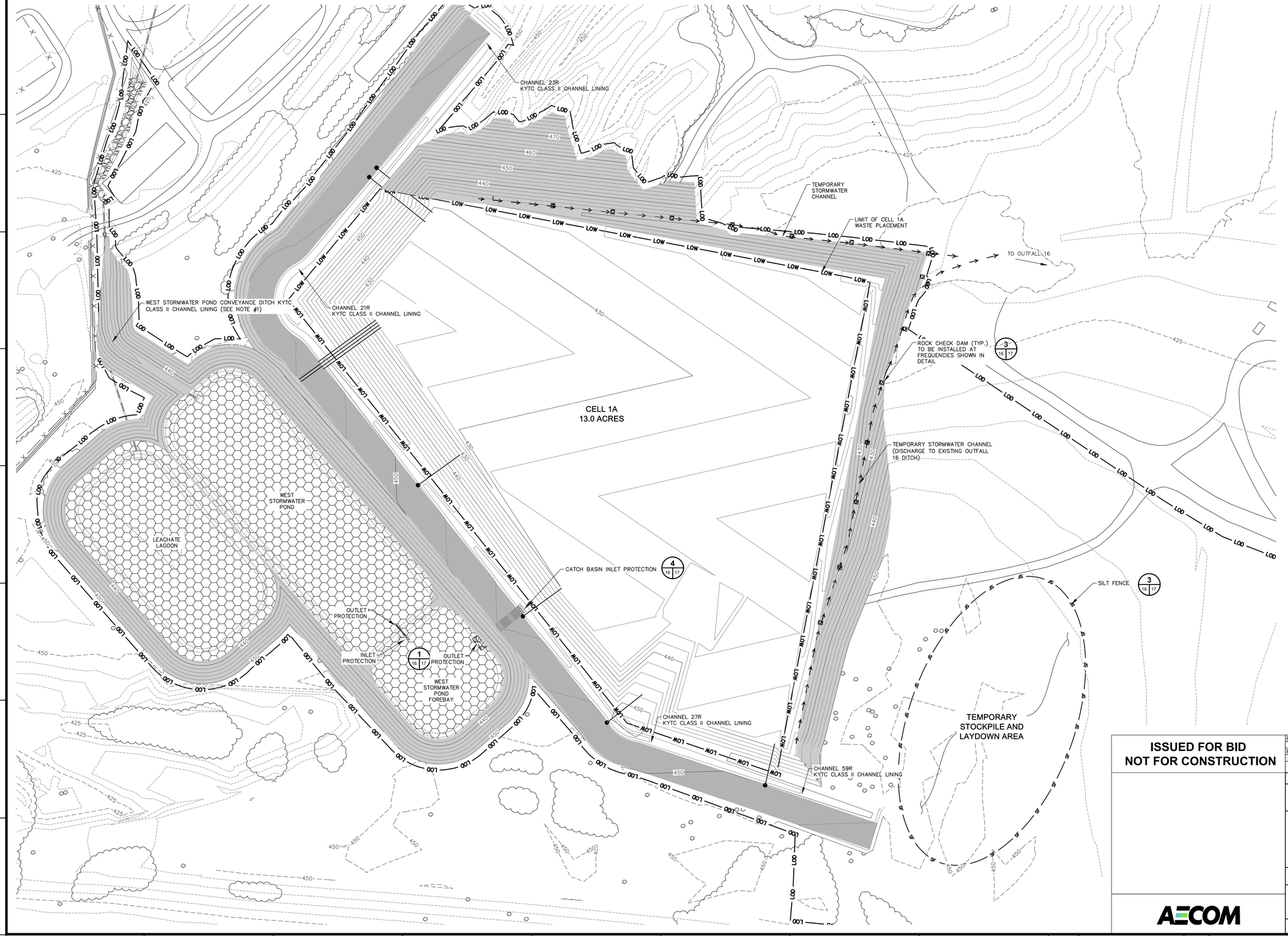


N

0 60 120

SCALE IN FEET

LEGEND

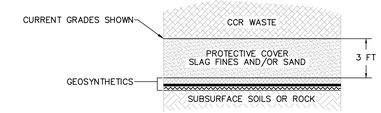
- EXISTING MAJOR CONTOURS (25')
- EXISTING MINOR CONTOURS (5')
- PROPOSED MAJOR CONTOURS (10')
- PROPOSED MINOR CONTOURS (2')
- LOD — LIMIT OF DISTURBANCE
- LOW — CELL 1A LIMIT OF WASTE (12.8 ACRES)
- TREELINE
- TRANSMISSION TOWER
- OE — OVERHEAD ELECTRIC LINE
- EXISTING ROAD
- EXISTING EDGE OF WATER
- FM — LEACHATE FORCE MAIN PIPE
- STORMWATER FLOW DIRECTION
- KYTC CLASS CHANNEL LINING
- SURGE ROCK
- EROSION CONTROL MATTING (ECM)
- CHECK DAM
- SF — SILT FENCE

NOTES:
1. SEE DRAWING 10W723-12 FOR ADDITIONAL EROSION AND SEDIMENT CONTROLS FOR THE WEST STORMWATER POND CONVEYANCE DITCH

CONSTRUCTION SEQUENCE:

THE TOTAL SITE DISTURBANCE IS APPROXIMATELY 49.4 ACRES. THE FOLLOWING SEQUENCE OF CONSTRUCTION IS PROPOSED TO REDUCE THE TOTAL DISTURBED AREAS AT ANY GIVEN TIME:

1. ESTABLISH SITE SUPPORT FACILITIES (DRAWING 10W723-03).
2. COMPLETE PARTIAL CLEARING, SUBGRADE IMPROVEMENTS NECESSARY TO CONSTRUCTION WEST STORMWATER POND (DRAWING 10W273-14) AND LEACHATE LAGOON (10W723-15).
3. COMPLETE MINE MITIGATION WITHIN CELL 1A AREA.
4. FOLLOWING MINE MITIGATION, COMPLETE EARTHWORK TO THE EXCAVATION OF BOTTOM OF LINEAR GRADES (DRAWING 10W723-04), INCLUDING THE PERIMETER ROAD AND ACCESS ROAD.
5. STOCKPILES AND OTHER DISTURBED AREAS TO BE STABILIZED AS SOON AS PRACTICAL BY USE OF TEMPORARY SEEDING AND AS DEEMED NECESSARY
6. INSTALL STORMWATER STRUCTURES AND EROSION AND SEDIMENT CONTROLS AS EARTHWORK PROGRESSES. PROVIDE TEMPORARY DEWATERING OF THE CELL AREA TO THE WEST STORMWATER POND AS NECESSARY.
7. CONSTRUCT LANDFILL COMPONENTS, INCLUDING COMPOSITE LINER SYSTEM, LEACHATE COLLECTION SYSTEM AND PROTECTIVE COVER.
8. COMPLETE FORCEMAIN CONSTRUCTION.
9. ESTABLISH PERMANENT VEGETATION ON ALL DISTURBED AREAS.



COMPOSITE LINER SYSTEM

ISSUED FOR BID
NOT FOR CONSTRUCTION

AECOM

R #										
R 0	10/25/17	CLF	CLF	MBC	NSG	RSH	MST	JCK	202229	
ISSUED FOR BID										
REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST

DISCIPLINE INTERFACE: REV 0, 1, 2, 3, 4

SCALE: AS SHOWN EXCEPT AS NOTED

EROSION AND SEDIMENT CONTROL PLAN

COAL COMBUSTION RESIDUALS (CCR) LANDFILL

CELL 1A CONSTRUCTION

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
CLF	CLF	MBC	NSG	RSH	MST	JCK

PARADISE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 2017	DATE 10/25/17	64	C	FIGURE 6	R 0

AECOM	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

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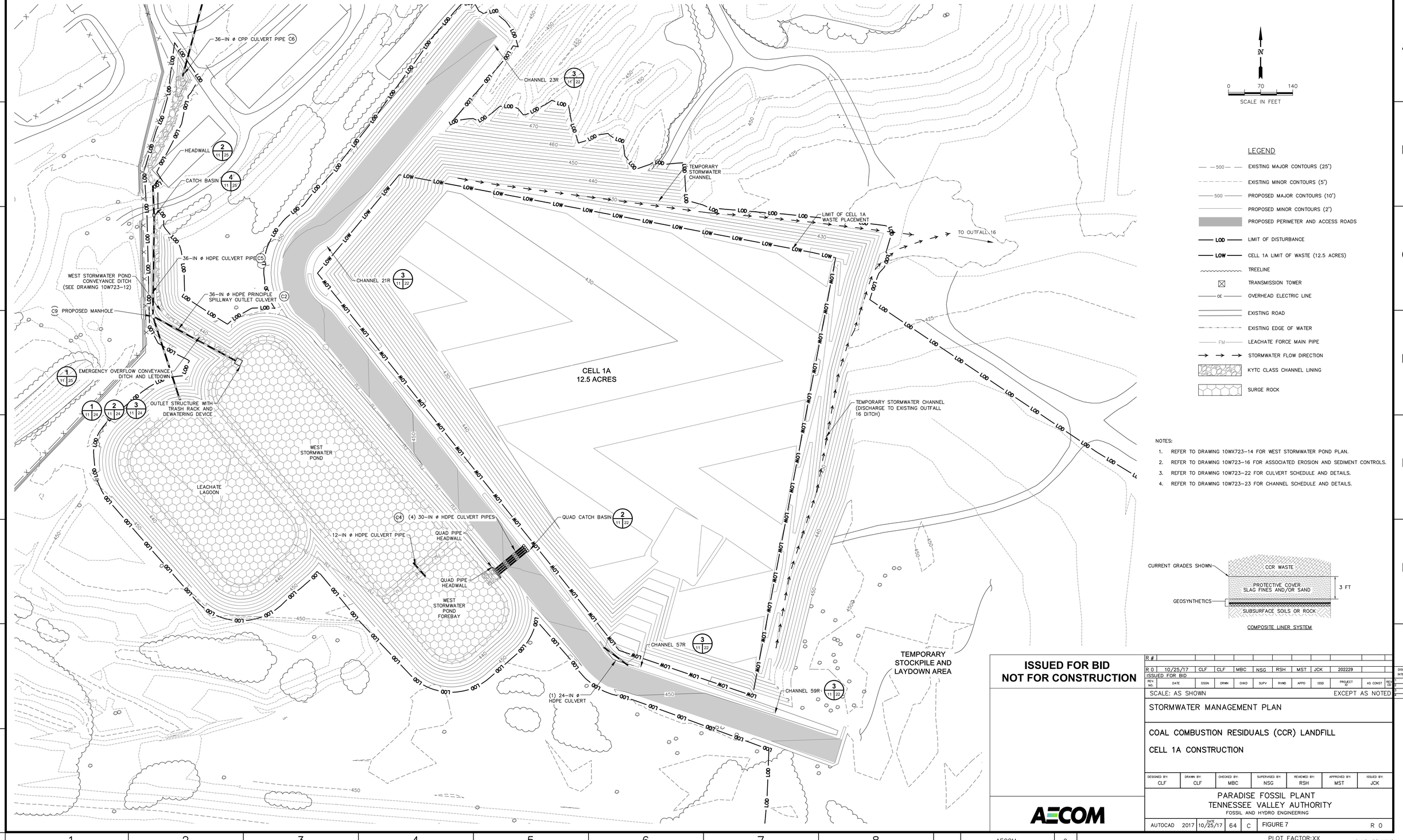

NOTES:

1. REFER TO DRAWING 10WX723-14 FOR WEST STORMWATER POND PLAN.
2. REFER TO DRAWING 10W723-16 FOR ASSOCIATED EROSION AND SEDIMENT CONTROLS.
3. REFER TO DRAWING 10W723-22 FOR CULVERT SCHEDULE AND DETAILS.
4. REFER TO DRAWING 10W723-23 FOR CHANNEL SCHEDULE AND DETAILS.

COMPOSITE LINER SYSTEM

ISSUED FOR BID
NOT FOR CONSTRUCTION

R #											
R 0	10/25/17	CLF	CLF	MBC	NSG	RSH	MST	JCK	202229		
ISSUED FOR BID											
REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	

DISCIPLINE INTERFACE: REV. CLD

SCALE: AS SHOWN EXCEPT AS NOTED

STORMWATER MANAGEMENT PLAN

COAL COMBUSTION RESIDUALS (CCR) LANDFILL

CELL 1A CONSTRUCTION

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
CLF	CLF	MBC	NSG	RSH	MST	JCK

PARADISE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 2017 | DATE 10/25/17 | 64 | C | FIGURE 7 | R 0

AECOM

AECOM	0
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

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APPENIDIX A

APPENDIX A:
STORM WATER CALCULATIONS

Culvert Design

Storm Water Calculations

AECOM

Job	TVA PAF: CCR Proposed Landfill (Cell 1)	Project No.	60549496	Sheet	1 of 3
Description	Culvert Design	Computed by	FS	Date	01/26/2018
		Checked by	YC	Date	02/15/2018

I. PURPOSE

The purpose of this analysis is to design the proposed culverts and associated catch basins as applicable at Tennessee Valley Authority's (TVA) Paradise Fossil Plant (PAF) consistent with CCR Rule.

II. SITE AND PROJECT DESCRIPTION

The culverts design was performed for the new proposed landfill facility (Cell 1) at TVA PAF in Muhlenberg County, Kentucky. The proposed site is designed as a new landfill through the EPA Final Coal Combustion Residuals (CCR) rule: Federal Register/ Vol. 80/ No. 74 / Part II. The following sections summarize the design criteria, procedure, assumptions, and results of the culverts design.

III. REGULATORY REQUIREMENTS / DESIGN CRITERIA

The below parts of the Final CCR rules specify requirements for the design of the culverts:

Rule §257.81(a)(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

Rule §257.81(a)(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.

The results of the analysis presented herein show that the culverts and associated catch basins are designed to collect and control at least the peak flow resulting from a 25-year/24-hour storm so that stormwater is diverted appropriately.

IV. PROCEDURE

Design of the landfill site stormwater features was an iterative process beginning with basic assumptions and a proposed grading plan for the site. The hydraulic features of the culverts and associated catch basins (as applicable) were initially assumed and then confirmed through multiple iterations.

The AutoCAD Civil 3D software package was used to generate the proposed site grading plan and subsequently to determine drainage areas, volumes, and other site geometry. HydroCAD (version 10.00) modeling software was used to conduct the hydrologic and hydraulic calculations for this analysis with inputs based on the site geometry, rainfall data, and other design assumptions.

The model was used to generate peak flow rates and peak water surface elevations at the inlets of the culverts/catch basins for the design storm conditions and based on upstream watershed features of the site and the culvert/catch basin design parameters. The number, size, and elevation of culverts and need for associated catch basins were designed/determined such that the regulatory requirements would be met while minimizing cost through reduced number and size of structures to the extent possible. The proposed structures will pass flows equal to and lesser than those generated by the 24-hour, 25-year storm.

To provide energy dissipation and greatly reduce potential for erosion downstream of the culvert outlets, outlet protection was designed consistent with guidance provided in the Tennessee Erosion and Sediment Control Handbook. Riprap apron lengths and stone sizes were selected for each outlet to meet or exceed the recommended amounts based upon a minimum 24-hour, 25-year storm peak flow rate and the pipe diameter.

V. NOTES/ASSUMPTIONS

The following is a list of key notes and assumptions made in completing this analysis.

- Surcharge/ponding above catch basin grate inlets was undesirable, however where unavoidable, a design parameter minimum six (6) inches of freeboard was used for impounded water upstream of grate inlets.
- Within the HydroCAD program, the runoff was calculated using the SCS TR-20 method.
- Runoff curve numbers (CN) used in the analysis were as follows:
    - 74 for landfill vegetated cover and offsite areas, and
    - 89 for access roads.
    - 98 for stormwater pond water surface.
- The time of concentration was calculated using the Curve Number Method in HydroCAD which takes inputs for each drainage area of the longest hydraulic flow path and average land slope.
- Pipe flow in HydroCAD was calculated by the program using Manning's equation for low flow conditions and the orifice equation for high flow (submerged) conditions.
- Flow into the catch basins in HydroCAD was calculated by the program using weir flow for low flow conditions and the orifice equation for high flow (submerged) conditions.
- The grates for the discharge catch basins were assumed to have at minimum 60% open area.
- Appropriate width, grade, thickness, and separators (geotextile or gravel) are included in the final design and construction of the riprap outlet protection.

VI. SUMMARY OF RESULTS

A summary of all culverts/catch basins for the facility is presented in Table 1. The results of the culverts and associated catch basin design show that the objectives have been met (see also Attachments B1-3 for associated HydroCAD output reports). The structures properly control and convey the water volume generated by the 24-hour, 25-year storm such that the peak water surface elevation immediately upstream remains safely below the impounding sideslopes with greater than six (6) inches of freeboard.

VII. CONCLUSIONS

The proposed grading of the landfill (Cell 1) in combination with the design of the culvert/catch basin structures as discussed above is sufficient to safely control and convey the 24-hour, 25-year storm as stipulated by the CCR Rule. Appropriate outlet protection riprap has been selected for each culvert based on regulatory guidance. Refer to accompanying calculations used to design upstream conveyance features (storm water terraces and perimeter channels) entering the culverts and the sediment basins.

VIII. ATTACHMENTS

Tables:

Table 1: Culverts

Attachments:

Attachment B1-1: NOAA Precipitation Frequency Data
Attachment B1-2: HydroCAD Diagram
Attachment B1-3: HydroCAD Report for Culverts Design

IX. REFERENCES

1- *EPA Final Coal Combustion Residuals (CCR) Rules: Federal Register/ Vol. 80/ No. 74 /Part II. Hazardous and Solid Waste Management System; Disposal of Coal, April 17, 2015*

TABLE 1

Culverts

Table 1 - Culverts

		Hydraulic Summary*		Riser/Catch Basin Summary		Pipe Summary						Outlet Protection Summary	
Structure ID	Structure Type	25-YR/24-Hr. Inflow (cfs)	Headwater Elevation (ft)	Inlet Dimensions	Inlet Elevation	Number/Diameter	Type	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Length (ft)	Slope (%)	Apron Length, L_A (ft)	Riprap Class / Min Size (in)
C2* (West Pond Principal Spillway)	Riser with Culvert	150.13	435.41	36.0" x 36.0"	435.00	1 - 36"	HDPE	431.00	430.12	183.20	0.48%	24.00	Class III, 16 inch
C4 (Culverts to West Pond)	Catch Basin with Culverts	67.40	442.82	40.0" x 161.0"	442.10	4 - 30"	HDPE	439.10	438.00	85.00	1.29%	16.00	Class III, 16 inch
C5 (Culverts to Green River)	Catch Basin with Culvert	16.34	431.19	36.0" x 36.0" (H)	429.35	1 - 36"	HDPE	429.35	429.00	72.90	0.48%	16.00	Class III, 16 inch
C6 (Culverts to Green River)	Culvert	28.11	417.81	36.0" x 36.0" (V)	415.61	1 - 36"	HDPE	415.61	412.00	202.20	1.79%	10.00	Class III, 16 inch
C7 (Culverts to Green River)	Culvert	104.80	408.95	36.0" x 36.0" (V)	397.97	1 - 36"	HDPE	397.97	391.97	134.90	4.45%	10.00	Class III, 16 inch
C9 (Manhole)	Manhole	13.09	431.89	-	-	1 - 36"	HDPE	430.18	429.35	174.00	0.48%	-	-
Leachate Lagoon	Riser with Culvert	17.84	436.2	54.0" x 120.0" (H)	436.00	1 - 24"	HDPE	434.00	430.12	177.00	2.19%	-	-

*The emergency spillways are designed to convey flows greater than a 25-yr/24-hr storm event.

ATTACHMENT A1-1

NOAA Precipitation Frequency Data

NOAA Atlas 14, Volume 2, Version 3 PARADISE STEAM PLANT
Station ID: 15-6155
Location name: Beaver Dam, Kentucky, US*
Latitude: 37.2592°, Longitude: -86.9778°
Elevation:
Elevation (station metadata): 402 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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	0.358 (0.328-0.392)	0.420 (0.385-0.459)	0.484 (0.443-0.528)	0.535 (0.488-0.583)	0.598 (0.543-0.653)	0.646 (0.584-0.705)	0.693 (0.623-0.756)	0.737 (0.659-0.807)	0.793 (0.702-0.870)	0.836 (0.734-0.921)
10-min	0.572 (0.524-0.626)	0.672 (0.616-0.735)	0.775 (0.709-0.846)	0.855 (0.781-0.933)	0.954 (0.866-1.04)	1.03 (0.930-1.12)	1.10 (0.990-1.20)	1.17 (1.04-1.28)	1.25 (1.11-1.38)	1.32 (1.16-1.45)
15-min	0.715 (0.655-0.782)	0.844 (0.774-0.924)	0.981 (0.897-1.07)	1.08 (0.988-1.18)	1.21 (1.10-1.32)	1.30 (1.18-1.42)	1.39 (1.25-1.52)	1.47 (1.32-1.61)	1.58 (1.40-1.73)	1.65 (1.45-1.82)
30-min	0.981 (0.898-1.07)	1.17 (1.07-1.28)	1.39 (1.27-1.52)	1.57 (1.43-1.71)	1.79 (1.63-1.95)	1.96 (1.77-2.14)	2.13 (1.92-2.33)	2.29 (2.05-2.51)	2.51 (2.22-2.76)	2.67 (2.35-2.95)
60-min	1.22 (1.12-1.34)	1.46 (1.34-1.60)	1.79 (1.63-1.95)	2.04 (1.86-2.23)	2.38 (2.17-2.60)	2.66 (2.40-2.90)	2.94 (2.64-3.20)	3.22 (2.88-3.53)	3.60 (3.19-3.96)	3.90 (3.43-4.30)
2-hr	1.47 (1.35-1.60)	1.76 (1.62-1.92)	2.16 (1.99-2.35)	2.47 (2.27-2.69)	2.90 (2.65-3.15)	3.24 (2.95-3.52)	3.59 (3.24-3.90)	3.95 (3.54-4.30)	4.44 (3.93-4.85)	4.82 (4.23-5.29)
3-hr	1.60 (1.48-1.74)	1.92 (1.77-2.09)	2.35 (2.17-2.56)	2.70 (2.49-2.93)	3.18 (2.92-3.45)	3.57 (3.26-3.88)	3.97 (3.60-4.32)	4.39 (3.94-4.78)	4.97 (4.41-5.43)	5.42 (4.76-5.96)
6-hr	1.97 (1.82-2.15)	2.36 (2.17-2.58)	2.90 (2.67-3.17)	3.35 (3.07-3.65)	3.98 (3.62-4.33)	4.50 (4.07-4.90)	5.05 (4.53-5.51)	5.64 (5.01-6.16)	6.47 (5.66-7.09)	7.14 (6.17-7.86)
12-hr	2.38 (2.17-2.64)	2.85 (2.60-3.17)	3.51 (3.19-3.90)	4.06 (3.67-4.50)	4.83 (4.34-5.35)	5.47 (4.88-6.05)	6.15 (5.44-6.82)	6.87 (6.02-7.63)	7.90 (6.81-8.78)	8.74 (7.43-9.75)
24-hr	2.89 (2.64-3.20)	3.48 (3.17-3.84)	4.33 (3.94-4.79)	5.04 (4.57-5.56)	6.04 (5.44-6.67)	6.88 (6.16-7.59)	7.77 (6.91-8.58)	8.73 (7.69-9.65)	10.1 (8.78-11.2)	11.2 (9.64-12.5)
2-day	3.48 (3.17-3.81)	4.17 (3.81-4.58)	5.20 (4.73-5.71)	6.04 (5.48-6.64)	7.27 (6.55-7.98)	8.29 (7.42-9.11)	9.39 (8.34-10.3)	10.6 (9.30-11.7)	12.3 (10.7-13.7)	13.7 (11.8-15.3)
3-day	3.69 (3.38-4.04)	4.43 (4.05-4.84)	5.51 (5.04-6.03)	6.42 (5.84-7.02)	7.72 (6.99-8.44)	8.82 (7.92-9.65)	10.0 (8.91-11.0)	11.3 (9.95-12.4)	13.1 (11.4-14.5)	14.7 (12.6-16.3)
4-day	3.91 (3.59-4.26)	4.69 (4.30-5.11)	5.83 (5.35-6.36)	6.79 (6.20-7.40)	8.18 (7.42-8.91)	9.35 (8.42-10.2)	10.6 (9.48-11.6)	12.0 (10.6-13.1)	14.0 (12.2-15.4)	15.6 (13.4-17.4)
7-day	4.58 (4.20-5.04)	5.50 (5.03-6.04)	6.88 (6.30-7.57)	8.10 (7.38-8.89)	9.92 (8.97-10.9)	11.5 (10.3-12.6)	13.3 (11.8-14.6)	15.2 (13.4-16.8)	18.2 (15.7-20.3)	20.8 (17.6-23.3)
10-day	5.16 (4.72-5.67)	6.18 (5.65-6.79)	7.68 (7.03-8.45)	8.98 (8.19-9.86)	10.9 (9.87-12.0)	12.6 (11.3-13.8)	14.4 (12.8-15.8)	16.4 (14.5-18.1)	19.4 (16.8-21.5)	21.9 (18.7-24.5)
20-day	7.07 (6.58-7.61)	8.40 (7.82-9.04)	10.1 (9.40-10.9)	11.5 (10.7-12.4)	13.4 (12.4-14.5)	15.0 (13.8-16.1)	16.6 (15.2-17.9)	18.2 (16.6-19.7)	20.5 (18.5-22.3)	22.8 (20.3-25.0)
30-day	8.70 (8.16-9.30)	10.3 (9.65-11.0)	12.2 (11.4-13.1)	13.7 (12.8-14.7)	15.8 (14.7-16.9)	17.4 (16.2-18.6)	19.1 (17.6-20.4)	20.7 (19.0-22.3)	23.0 (20.9-24.8)	24.7 (22.3-26.9)
45-day	10.9 (10.3-11.5)	12.8 (12.1-13.6)	14.9 (14.1-15.8)	16.5 (15.6-17.5)	18.6 (17.5-19.8)	20.2 (19.0-21.5)	21.8 (20.3-23.1)	23.3 (21.6-24.8)	25.2 (23.3-26.9)	26.6 (24.5-28.5)
60-day	13.1 (12.4-13.8)	15.4 (14.6-16.2)	17.7 (16.8-18.7)	19.4 (18.4-20.5)	21.6 (20.4-22.8)	23.1 (21.8-24.4)	24.6 (23.1-26.0)	26.0 (24.4-27.6)	27.8 (25.9-29.5)	29.0 (26.9-30.9)

[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.

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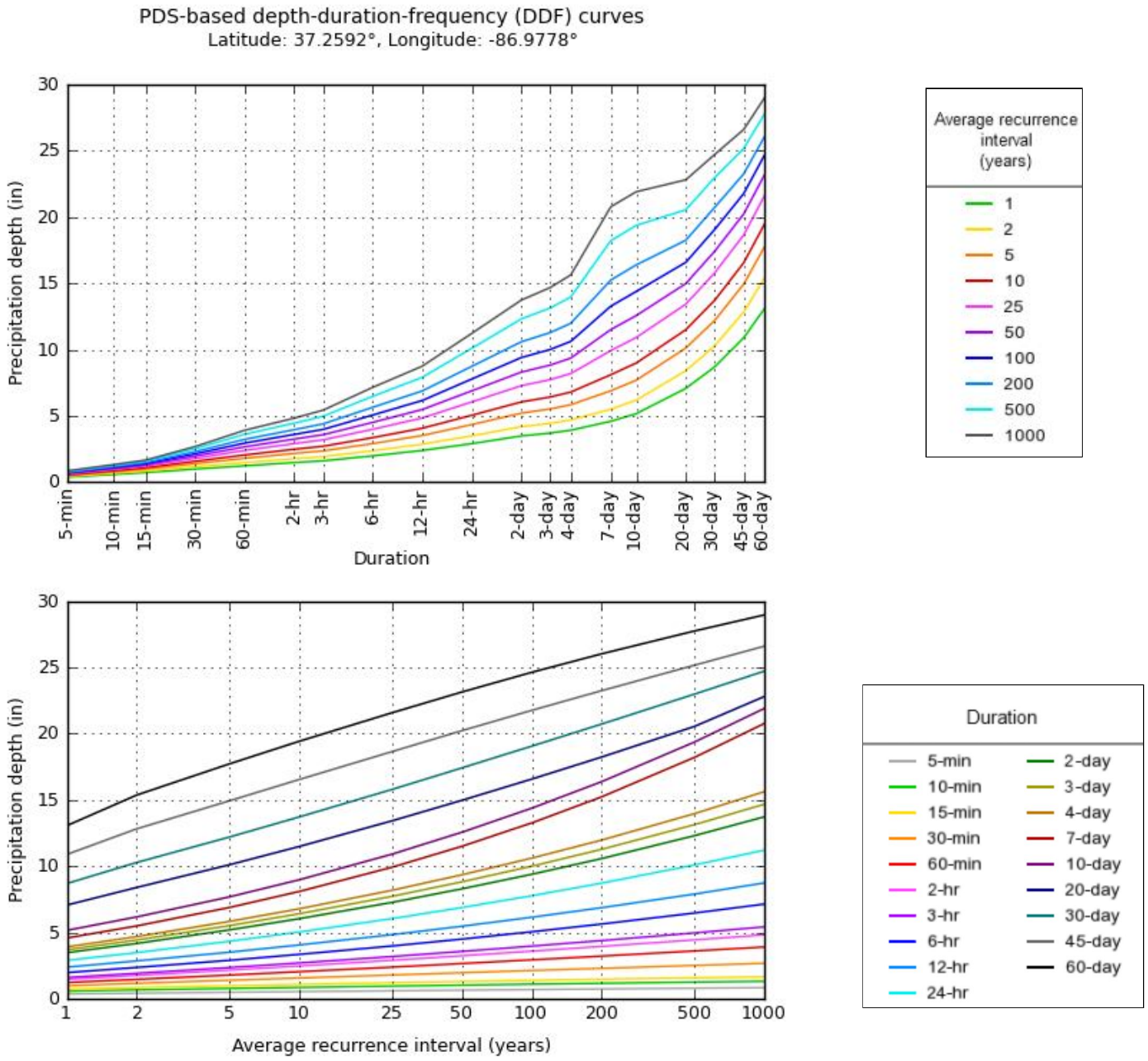
PF graphical



NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Mon Mar 21 14:00:30 2016

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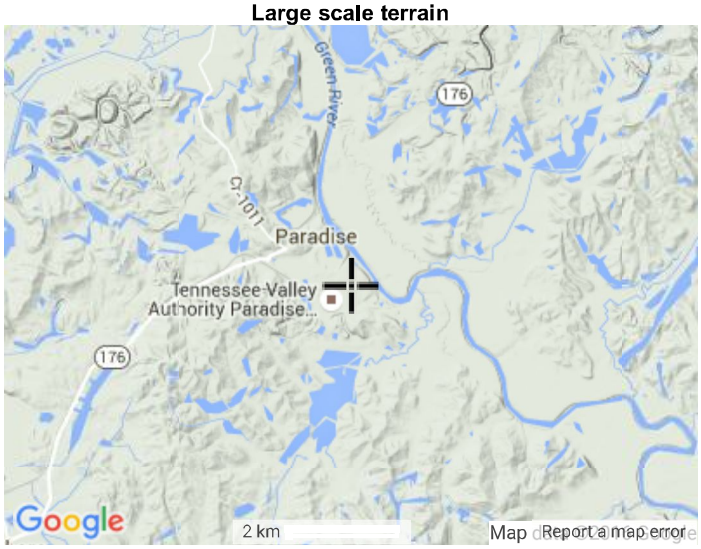
Maps & aerials

Small scale terrain

Large scale terrain



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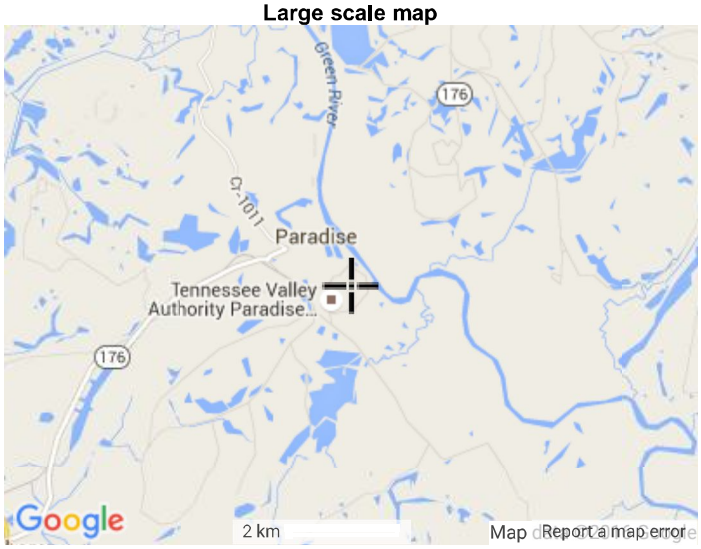
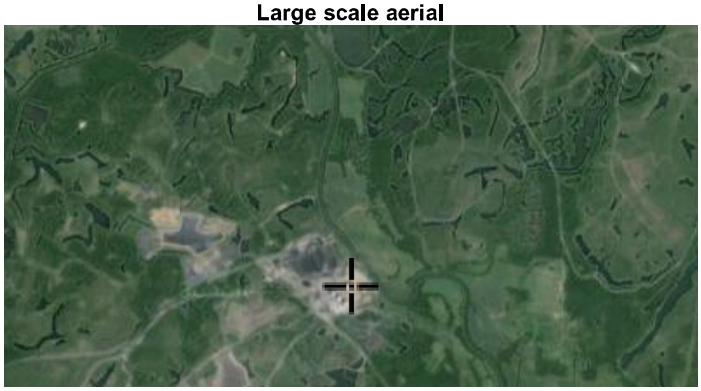
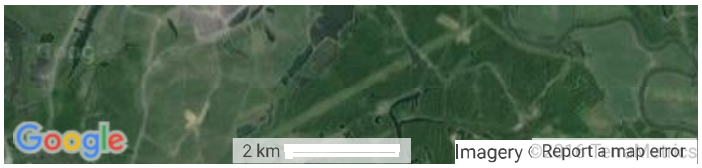


Large scale aerial





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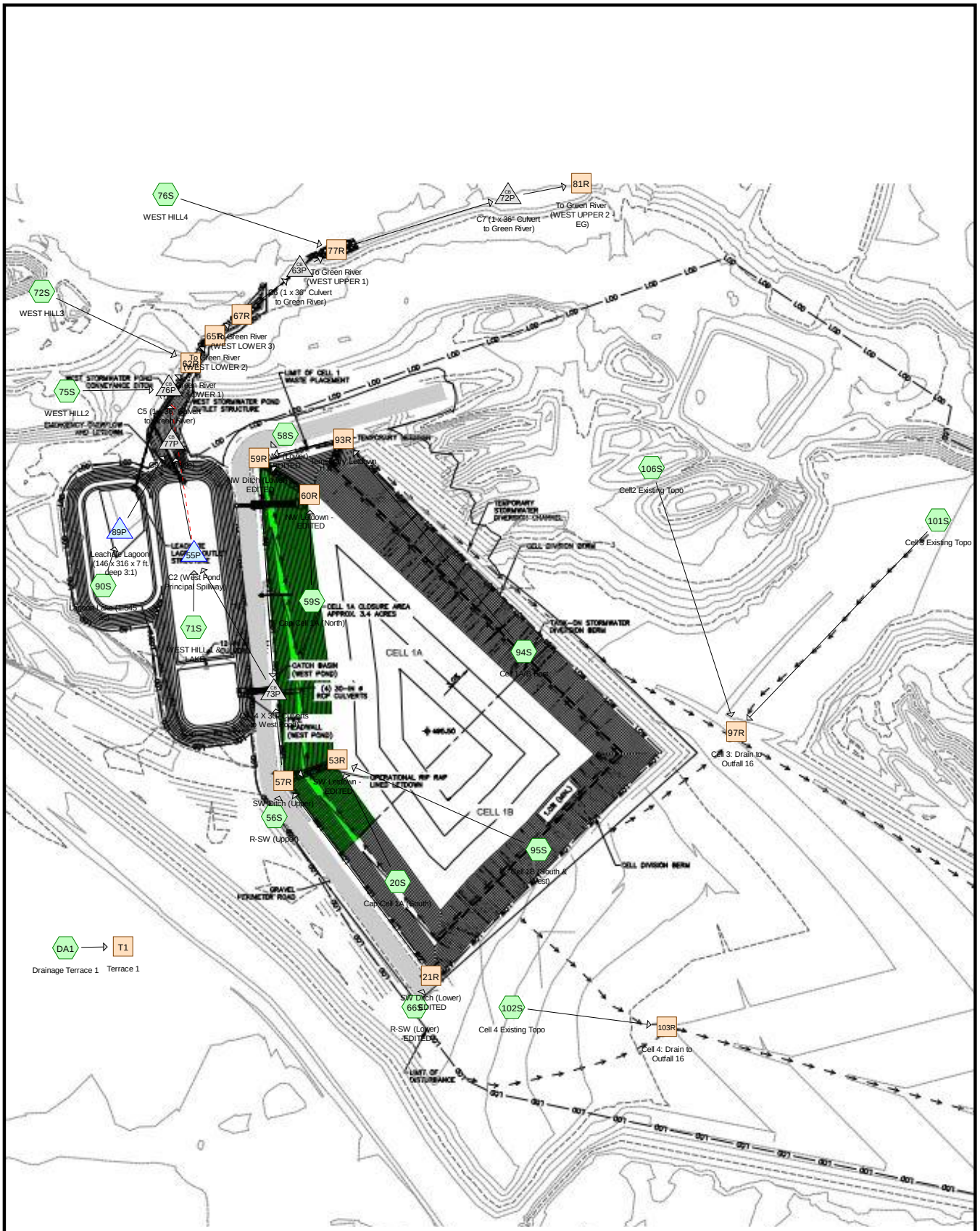
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

ATTACHMENT A1-2

HydroCAD Diagram



Routing Diagram for PAF_RRCP_FS_02-22-18_Rev 1
Prepared by AECOM, Printed 2/23/2018

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
108.250	74	>75% Grass cover, Good, HSG C (20S, 59S, 71S, 72S, 75S, 76S, 94S, 95S, 101S, 102S, 106S, DA1)
1.698	89	Gravel roads, HSG C (56S, 58S, 66S)
4.193	98	Water Surface, HSG A (71S, 90S)
114.141	**75**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
4.193	HSG A	71S, 90S
0.000	HSG B	
109.948	HSG C	20S, 56S, 58S, 59S, 66S, 71S, 72S, 75S, 76S, 94S, 95S, 101S, 102S, 106S, DA1
0.000	HSG D	
0.000	Other	
114.141		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	108.250	0.000	0.000	108.250	>75% Grass cover, Good	20S, 59S, 71S, 72S, 75S, 76S, 94S, 95S, 101S, 102S, 106S, DA1
0.000	0.000	1.698	0.000	0.000	1.698	Gravel roads	56S, 58S, 66S
4.193	0.000	0.000	0.000	0.000	4.193	Water Surface	71S, 90S
4.193	**0.000**	**109.948**	**0.000**	**0.000**	**114.141**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	55P	431.00	430.12	183.2	0.0048	0.013	36.0	0.0	0.0
2	63P	415.61	412.00	202.2	0.0179	0.012	36.0	0.0	0.0
3	72P	397.97	391.97	134.9	0.0445	0.012	36.0	0.0	0.0
4	73P	439.10	438.00	85.0	0.0129	0.012	30.0	0.0	0.0
5	76P	429.35	429.00	72.9	0.0048	0.012	36.0	0.0	0.0
6	77P	430.18	429.35	174.0	0.0048	0.012	36.0	0.0	0.0
7	89P	434.00	430.12	177.0	0.0219	0.013	24.0	0.0	0.0

Notes Listing (all nodes)

Line#	Node Number	Notes
1	89P	0.55 cfs baseflow from leachate forcemain pipe
2		0.06 cfs baseflow from trcukwash

ATTACHMENT A1-3

HydroCAD Report for Culverts Design

Summary for Pond 55P: C2 (West Pond Principal Spillway)

Inflow Area = 31.886 ac, 8.30% Impervious, Inflow Depth = 4.05" for 25 Year event
Inflow = 150.13 cfs @ 11.97 hrs, Volume= 10.752 af
Outflow = 11.43 cfs @ 13.22 hrs, Volume= 7.737 af, Atten= 92%, Lag= 75.2 min
Primary = 11.43 cfs @ 13.22 hrs, Volume= 7.737 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 433.00' Surf.Area= 2.379 ac Storage= 4.956 af
Peak Elev= 435.41' @ 13.22 hrs Surf.Area= 2.686 ac Storage= 11.107 af (6.151 af above start)
Flood Elev= 438.00' Surf.Area= 3.013 ac Storage= 18.398 af (13.441 af above start)

Plug-Flow detention time= 1,328.9 min calculated for 2.781 af (26% of inflow)
Center-of-Mass det. time= 492.8 min (1,315.2 - 822.4)

Volume	Invert	Avail.Storage	Storage Description
#1	430.50'	18.398 af	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
430.50	1.586	0.000	0.000
433.00	2.379	4.956	4.956
435.00	2.654	5.033	9.989
436.50	2.772	4.070	14.059
438.00	3.013	4.339	18.398

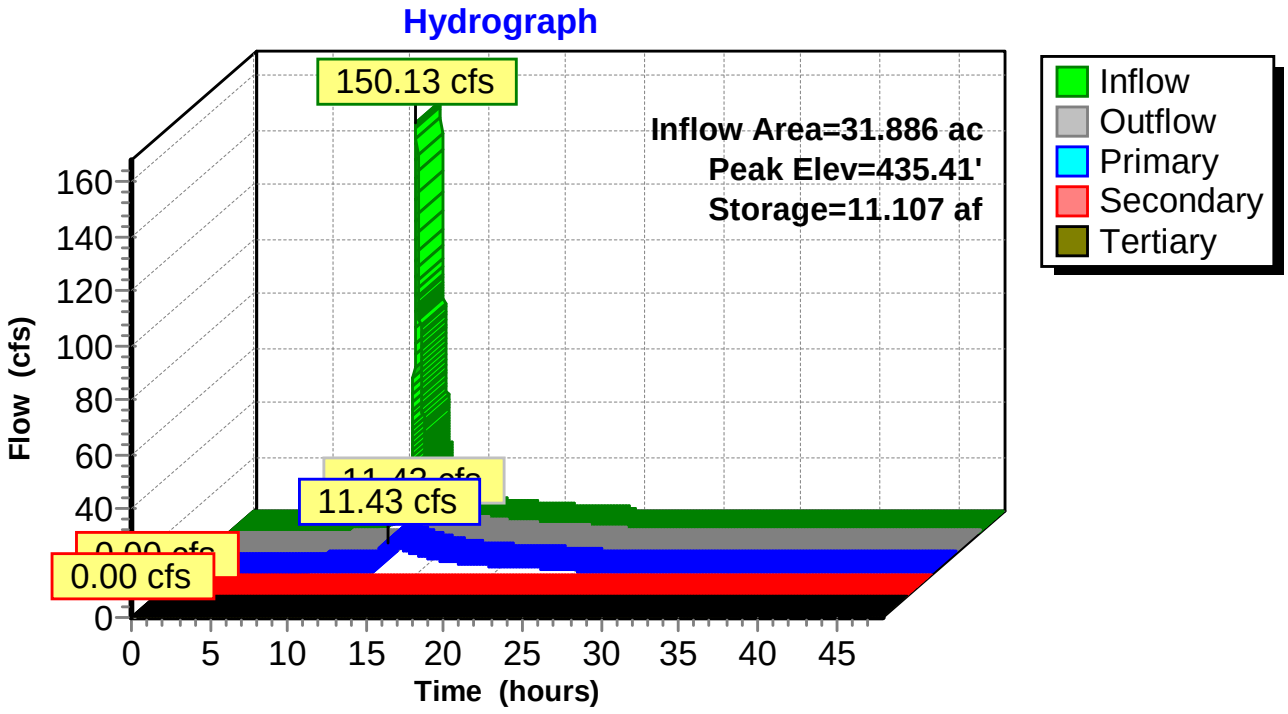
Device	Routing	Invert	Outlet Devices
#1	Primary	431.00'	**36.0" Round Culvert** L= 183.2' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 431.00' / 430.12' S= 0.0048 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf
#2	Device 1	433.00'	**1.130 cfs Constant Flow/Skimmer**
#3	Device 1	435.00'	**2.0" x 4.0" Horiz. Grate X 4.00 columns** X 15 rows C= 0.600 in 36.0" x 36.0" Grate (37% open area) Limited to weir flow at low heads
#4	Secondary	436.50'	**Emergency Spillway, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.75 1.50 Width (feet) 10.00 13.00 16.00
#5	Tertiary	437.99'	**100.0' long x 15.0' breadth Broad-Crested Rectangular Weir_Top of Dike** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=11.43 cfs @ 13.22 hrs HW=435.41' TW=431.88' (Dynamic Tailwater)
└─**1=Culvert** (Passes 11.43 cfs of 51.05 cfs potential flow)
  └─**2=Constant Flow/Skimmer** (Constant Controls 1.13 cfs)
  └─**3=Grate** (Orifice Controls 10.30 cfs @ 3.09 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=433.00' TW=429.36' (Dynamic Tailwater)
└─**4=Emergency Spillway** (Controls 0.00 cfs)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=433.00' (Free Discharge)
└─**5=Broad-Crested Rectangular Weir_Top of Dike** (Controls 0.00 cfs)

Pond 55P: C2 (West Pond Principal Spillway)



Hydrograph for Pond 55P: C2 (West Pond Principal Spillway)

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)	Tertiary (cfs)
0.00	0.00	4.956	433.00	0.00	0.00	**0.00**	**0.00**
1.00	0.00	4.956	433.00	0.00	0.00	0.00	0.00
2.00	0.00	4.956	433.00	0.00	0.00	0.00	0.00
3.00	0.00	4.956	433.00	0.00	0.00	0.00	0.00
4.00	0.01	4.956	433.00	0.01	0.01	0.00	0.00
5.00	0.03	4.956	433.00	0.03	0.03	0.00	0.00
6.00	0.06	4.956	433.00	0.06	0.06	0.00	0.00
7.00	0.22	4.956	433.00	0.22	0.22	0.00	0.00
8.00	0.47	4.956	433.00	0.47	0.47	0.00	0.00
9.00	1.20	4.957	433.00	1.13	1.13	0.00	0.00
10.00	2.23	4.999	433.02	1.13	1.13	0.00	0.00
11.00	**5.40**	5.197	433.10	1.13	1.13	0.00	0.00
12.00	**139.07**	7.897	434.17	1.13	1.13	0.00	0.00
13.00	13.63	**11.089**	**435.41**	**11.25**	**11.25**	0.00	0.00
14.00	7.59	**11.000**	**435.37**	**10.06**	**10.06**	0.00	0.00
15.00	5.81	10.813	435.30	7.70	7.70	0.00	0.00
16.00	4.57	10.675	435.25	6.12	6.12	0.00	0.00
17.00	3.93	10.566	435.21	4.98	4.98	0.00	0.00
18.00	3.48	10.492	435.19	4.26	4.26	0.00	0.00
19.00	3.02	10.432	435.16	3.72	3.72	0.00	0.00
20.00	2.57	10.376	435.14	3.24	3.24	0.00	0.00
21.00	2.38	10.327	435.12	2.86	2.86	0.00	0.00
22.00	2.29	10.295	435.11	2.62	2.62	0.00	0.00
23.00	2.20	10.272	435.10	2.45	2.45	0.00	0.00
24.00	2.11	10.253	435.10	2.32	2.32	0.00	0.00
25.00	0.08	10.138	435.05	1.64	1.64	0.00	0.00
26.00	0.01	10.027	435.01	1.19	1.19	0.00	0.00
27.00	0.00	9.933	434.98	1.13	1.13	0.00	0.00
28.00	0.00	9.840	434.94	1.13	1.13	0.00	0.00
29.00	0.00	9.746	434.90	1.13	1.13	0.00	0.00
30.00	0.00	9.653	434.87	1.13	1.13	0.00	0.00
31.00	0.00	9.560	434.83	1.13	1.13	0.00	0.00
32.00	0.00	9.466	434.79	1.13	1.13	0.00	0.00
33.00	0.00	9.373	434.76	1.13	1.13	0.00	0.00
34.00	0.00	9.279	434.72	1.13	1.13	0.00	0.00
35.00	0.00	9.186	434.68	1.13	1.13	0.00	0.00
36.00	0.00	9.093	434.64	1.13	1.13	0.00	0.00
37.00	0.00	8.999	434.61	1.13	1.13	0.00	0.00
38.00	0.00	8.906	434.57	1.13	1.13	0.00	0.00
39.00	0.00	8.812	434.53	1.13	1.13	0.00	0.00
40.00	0.00	8.719	434.50	1.13	1.13	0.00	0.00
41.00	0.00	8.626	434.46	1.13	1.13	0.00	0.00
42.00	0.00	8.532	434.42	1.13	1.13	0.00	0.00
43.00	0.00	8.439	434.38	1.13	1.13	0.00	0.00
44.00	0.00	8.345	434.35	1.13	1.13	0.00	0.00
45.00	0.00	8.252	434.31	1.13	1.13	0.00	0.00
46.00	0.00	8.159	434.27	1.13	1.13	0.00	0.00
47.00	0.00	8.065	434.24	1.13	1.13	0.00	0.00
48.00	0.00	7.972	434.20	1.13	1.13	0.00	0.00

Summary for Pond 63P: C6 (1 x 36" Culvert to Green River)

Inflow Area = 36.511 ac, 11.48% Impervious, Inflow Depth > 3.91" for 25 Year event
Inflow = 28.11 cfs @ 12.00 hrs, Volume= 11.900 af
Outflow = 28.11 cfs @ 12.00 hrs, Volume= 11.900 af, Atten= 0%, Lag= 0.0 min
Primary = 28.11 cfs @ 12.00 hrs, Volume= 11.900 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

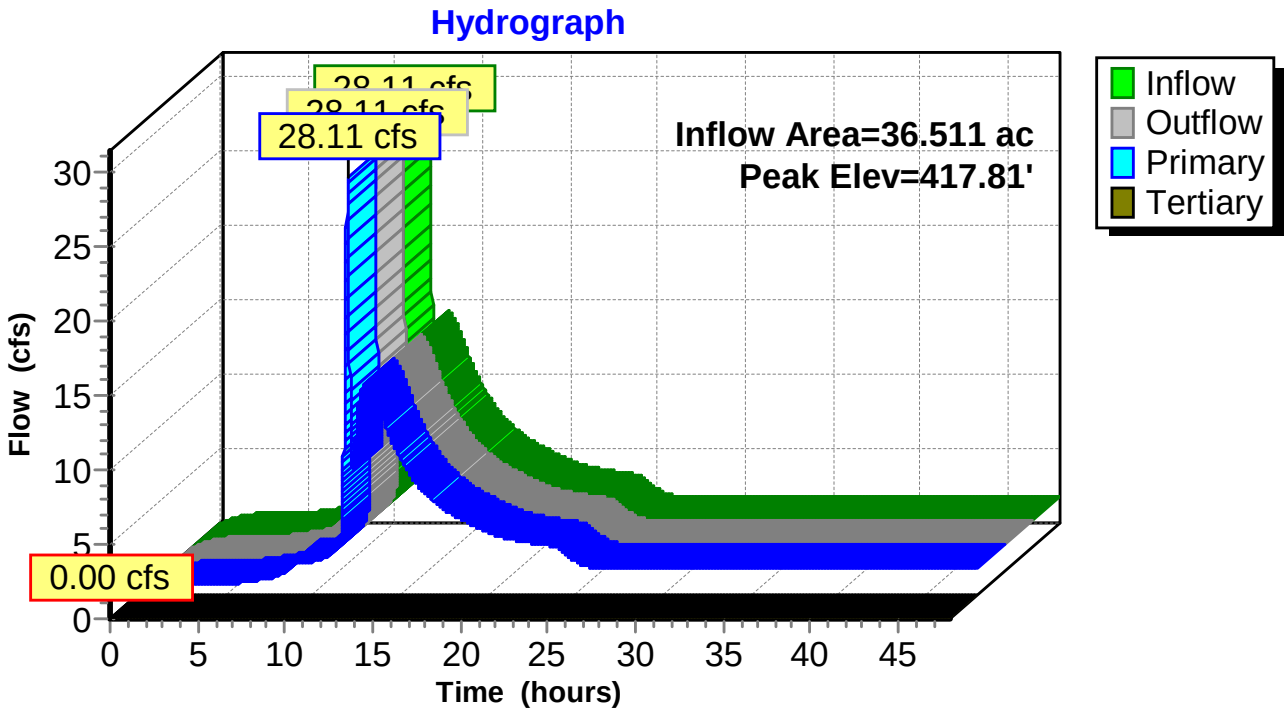
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 417.81' @ 12.00 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	415.61'	**36.0" Round Culvert** L= 202.2' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 415.61' / 412.00' S= 0.0179 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 7.07 sf
#2	Tertiary	422.00'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 5.00 Width (feet) 50.00 50.00

Primary OutFlow Max=28.08 cfs @ 12.00 hrs HW=417.81' TW=413.26' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 28.08 cfs @ 5.05 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=415.61' (Free Discharge)
└─**2=Custom Weir/Orifice** (Controls 0.00 cfs)

Pond 63P: C6 (1 x 36" Culvert to Green River)



Hydrograph for Pond 63P: C6 (1 x 36" Culvert to Green River)

Time (hours)	Inflow (cfs)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Tertiary (cfs)
0.00	0.00	415.61	0.00	0.00	**0.00**
1.00	0.40	415.84	0.40	0.40	0.00
2.00	0.61	415.89	0.61	0.61	0.00
3.00	0.68	415.91	0.68	0.68	0.00
4.00	0.72	415.92	0.72	0.72	0.00
5.00	0.77	415.93	0.77	0.77	0.00
6.00	0.82	415.94	0.82	0.82	0.00
7.00	1.01	415.98	1.01	1.01	0.00
8.00	1.29	416.02	1.29	1.29	0.00
9.00	2.09	416.14	2.09	2.09	0.00
10.00	2.25	416.16	2.25	2.25	0.00
11.00	2.76	416.22	2.76	2.76	0.00
12.00	**28.10**	**417.81**	**28.10**	**28.10**	0.00
13.00	14.22	417.08	14.22	14.22	0.00
14.00	11.92	416.94	11.92	11.92	0.00
15.00	9.23	416.77	9.23	9.23	0.00
16.00	7.44	416.64	7.44	7.44	0.00
17.00	6.20	416.55	6.20	6.20	0.00
18.00	5.41	416.48	5.41	5.41	0.00
19.00	4.79	416.43	4.79	4.79	0.00
20.00	4.24	416.38	4.24	4.24	0.00
21.00	3.83	416.34	3.83	3.83	0.00
22.00	3.57	416.31	3.57	3.57	0.00
23.00	3.39	416.29	3.39	3.39	0.00
24.00	3.25	416.28	3.25	3.25	0.00
25.00	2.28	416.16	2.28	2.28	0.00
26.00	1.81	416.10	1.81	1.81	0.00
27.00	1.74	416.09	1.74	1.74	0.00
28.00	1.74	416.09	1.74	1.74	0.00
29.00	1.74	416.09	1.74	1.74	0.00
30.00	1.74	416.09	1.74	1.74	0.00
31.00	1.74	416.09	1.74	1.74	0.00
32.00	1.74	416.09	1.74	1.74	0.00
33.00	1.74	416.09	1.74	1.74	0.00
34.00	1.74	416.09	1.74	1.74	0.00
35.00	1.74	416.09	1.74	1.74	0.00
36.00	1.74	416.09	1.74	1.74	0.00
37.00	1.74	416.09	1.74	1.74	0.00
38.00	1.74	416.09	1.74	1.74	0.00
39.00	1.74	416.09	1.74	1.74	0.00
40.00	1.74	416.09	1.74	1.74	0.00
41.00	1.74	416.09	1.74	1.74	0.00
42.00	1.74	416.09	1.74	1.74	0.00
43.00	1.74	416.09	1.74	1.74	0.00
44.00	1.74	416.09	1.74	1.74	0.00
45.00	1.74	416.09	1.74	1.74	0.00
46.00	1.74	416.09	1.74	1.74	0.00
47.00	1.74	416.09	1.74	1.74	0.00
48.00	1.74	416.09	1.74	1.74	0.00

Summary for Pond 72P: C7 (1 x 36" Culvert to Green River)

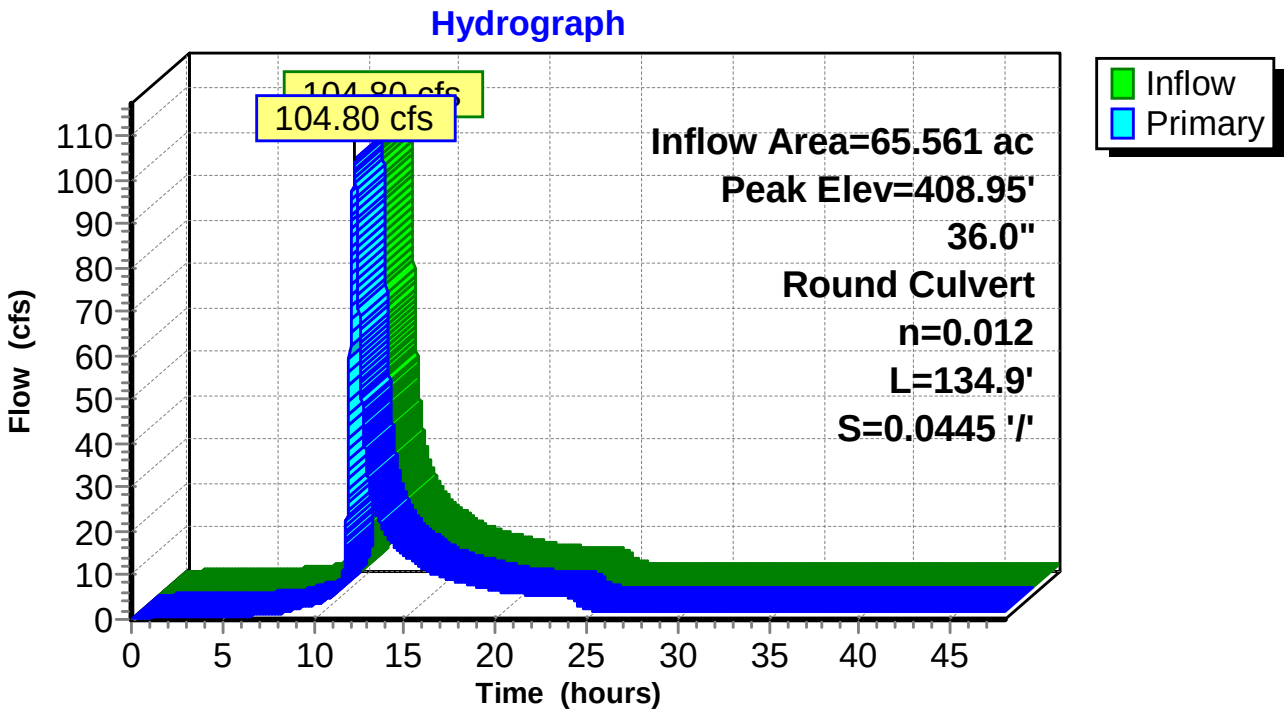
Inflow Area = 65.561 ac, 6.40% Impervious, Inflow Depth > 3.84" for 25 Year event
Inflow = 104.80 cfs @ 12.25 hrs, Volume= 20.972 af
Outflow = 104.80 cfs @ 12.25 hrs, Volume= 20.972 af, Atten= 0%, Lag= 0.0 min
Primary = 104.80 cfs @ 12.25 hrs, Volume= 20.972 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 408.95' @ 12.25 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	397.97'	**36.0" Round Culvert** L= 134.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 397.97' / 391.97' S= 0.0445 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 7.07 sf

Primary OutFlow Max=104.80 cfs @ 12.25 hrs HW=408.95' TW=393.79' (Dynamic Tailwater)
1=Culvert (Inlet Controls 104.80 cfs @ 14.83 fps)

Pond 72P: C7 (1 x 36" Culvert to Green River)



Hydrograph for Pond 72P: C7 (1 x 36" Culvert to Green River)

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	397.97	0.00
0.50	0.06	398.06	0.06
1.00	0.31	398.17	0.31
1.50	0.50	398.22	0.50
2.00	0.59	398.25	0.59
2.50	0.64	398.26	0.64
3.00	0.68	398.27	0.68
3.50	0.70	398.27	0.70
4.00	0.72	398.28	0.72
4.50	0.74	398.28	0.74
5.00	0.76	398.29	0.76
5.50	0.79	398.29	0.79
6.00	0.82	398.30	0.82
6.50	0.88	398.31	0.88
7.00	0.99	398.33	0.99
7.50	1.09	398.35	1.09
8.00	1.31	398.39	1.31
8.50	1.77	398.46	1.77
9.00	2.52	398.55	2.52
9.50	2.99	398.61	2.99
10.00	3.44	398.66	3.44
10.50	4.27	398.74	4.27
11.00	5.74	398.87	5.74
11.50	8.79	399.10	8.79
12.00	**62.45**	**402.84**	**62.45**
12.50	**70.57**	**403.77**	**70.57**
13.00	32.39	400.39	32.39
13.50	23.81	399.95	23.81
14.00	19.65	399.74	19.65
14.50	16.63	399.58	16.63
15.00	14.74	399.47	14.74
15.50	13.22	399.38	13.22
16.00	11.83	399.30	11.83
16.50	10.62	399.22	10.62
17.00	9.82	399.17	9.82
17.50	9.18	399.13	9.18
18.00	8.62	399.09	8.62
18.50	8.10	399.05	8.10
19.00	7.60	399.01	7.60
19.50	7.12	398.98	7.12
20.00	6.65	398.94	6.65
20.50	6.23	398.91	6.23
21.00	5.98	398.89	5.98
21.50	5.79	398.87	5.79
22.00	5.64	398.86	5.64
22.50	5.50	398.85	5.50
23.00	5.38	398.84	5.38
23.50	5.26	398.83	5.26
24.00	5.15	398.82	5.15
24.50	3.63	398.68	3.63
25.00	2.42	398.54	2.42
25.50	2.04	398.49	2.04
26.00	1.84	398.47	1.84
26.50	1.75	398.45	1.75
27.00	1.74	398.45	1.74
27.50	1.74	398.45	1.74
28.00	1.74	398.45	1.74
28.50	1.74	398.45	1.74
29.00	1.74	398.45	1.74
29.50	1.74	398.45	1.74
30.00	1.74	398.45	1.74
30.50	1.74	398.45	1.74
31.00	1.74	398.45	1.74
31.50	1.74	398.45	1.74
32.00	1.74	398.45	1.74
32.50	1.74	398.45	1.74
33.00	1.74	398.45	1.74
33.50	1.74	398.45	1.74
34.00	1.74	398.45	1.74
34.50	1.74	398.45	1.74
35.00	1.74	398.45	1.74
35.50	1.74	398.45	1.74
36.00	1.74	398.45	1.74
36.50	1.74	398.45	1.74
37.00	1.74	398.45	1.74
37.50	1.74	398.45	1.74
38.00	1.74	398.45	1.74
38.50	1.74	398.45	1.74
39.00	1.74	398.45	1.74
39.50	1.74	398.45	1.74
40.00	1.74	398.45	1.74
40.50	1.74	398.45	1.74
41.00	1.74	398.45	1.74
41.50	1.74	398.45	1.74
42.00	1.74	398.45	1.74
42.50	1.74	398.45	1.74
43.00	1.74	398.45	1.74
43.50	1.74	398.45	1.74
44.00	1.74	398.45	1.74
44.50	1.74	398.45	1.74
45.00	1.74	398.45	1.74
45.50	1.74	398.45	1.74
46.00	1.74	398.45	1.74
46.50	1.74	398.45	1.74
47.00	1.74	398.45	1.74
47.50	1.74	398.45	1.74
48.00	1.74	398.45	1.74

Summary for Pond 73P: C4 (4 X 30" Culverts to West Pond)

Inflow Area = 19.568 ac, 0.00% Impervious, Inflow Depth = 3.90" for 25 Year event
Inflow = 67.40 cfs @ 12.14 hrs, Volume= 6.355 af
Outflow = 67.40 cfs @ 12.14 hrs, Volume= 6.355 af, Atten= 0%, Lag= 0.0 min
Primary = 67.40 cfs @ 12.14 hrs, Volume= 6.355 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

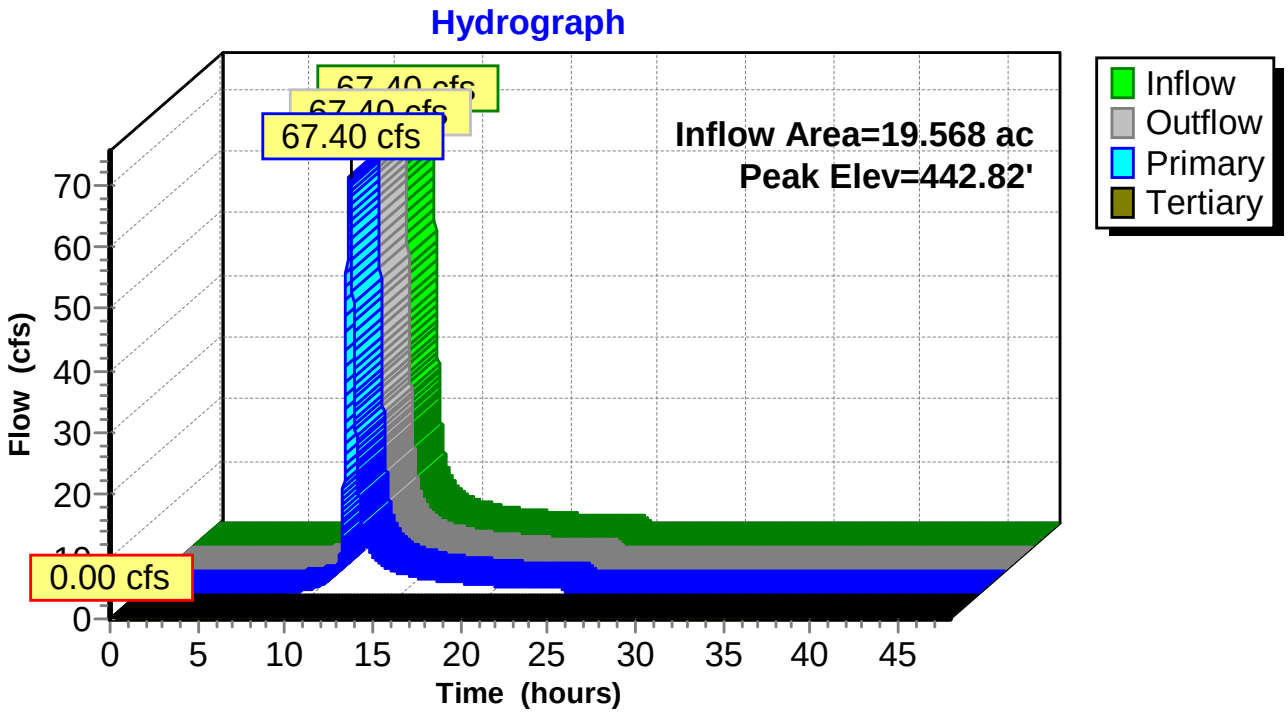
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 442.82' @ 12.14 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	439.10'	**30.0" Round Culvert X 4.00** L= 85.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 439.10' / 438.00' S= 0.0129 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 4.91 sf
#2	Device 1	442.10'	**2.0" x 12.0" Horiz. Orifice/Grate X 144.00** C= 0.600 in 40.0" x 161.0" Grate (54% open area) Limited to weir flow at low heads
#3	Tertiary	445.56'	**Custom Weir/Orifice_Top of Ditch, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 5.00 Width (feet) 50.00 50.00

Primary OutFlow Max=67.39 cfs @ 12.14 hrs HW=442.82' TW=434.63' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 67.39 cfs of 148.68 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 67.39 cfs @ 2.78 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=439.33' (Free Discharge)
↑—**3=Custom Weir/Orifice_Top of Ditch** (Controls 0.00 cfs)

Pond 73P: C4 (4 X 30" Culverts to West Pond)



Hydrograph for Pond 73P: C4 (4 X 30" Culverts to West Pond)

Time (hours)	Inflow (cfs)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Tertiary (cfs)
0.00	0.00	439.33	0.00	0.00	**0.00**
1.00	0.00	442.10	0.00	0.00	0.00
2.00	0.00	442.10	0.00	0.00	0.00
3.00	0.00	442.10	0.00	0.00	0.00
4.00	0.01	442.10	0.01	0.01	0.00
5.00	0.03	442.10	0.03	0.03	0.00
6.00	0.06	442.11	0.06	0.06	0.00
7.00	0.09	442.11	0.09	0.09	0.00
8.00	0.16	442.11	0.16	0.16	0.00
9.00	0.52	442.13	0.52	0.52	0.00
10.00	1.08	442.15	1.08	1.08	0.00
11.00	2.70	442.18	2.70	2.70	0.00
12.00	**59.86**	**442.77**	**59.86**	**59.86**	0.00
13.00	**8.98**	**442.29**	**8.98**	**8.98**	0.00
14.00	4.79	442.22	4.79	4.79	0.00
15.00	3.58	442.20	3.58	3.58	0.00
16.00	2.83	442.19	2.83	2.83	0.00
17.00	2.40	442.18	2.40	2.40	0.00
18.00	2.13	442.17	2.13	2.13	0.00
19.00	1.85	442.17	1.85	1.85	0.00
20.00	1.58	442.16	1.58	1.58	0.00
21.00	1.44	442.16	1.44	1.44	0.00
22.00	1.39	442.15	1.39	1.39	0.00
23.00	1.34	442.15	1.34	1.34	0.00
24.00	1.28	442.15	1.28	1.28	0.00
25.00	0.08	442.11	0.08	0.08	0.00
26.00	0.01	442.10	0.01	0.01	0.00
27.00	0.00	442.10	0.00	0.00	0.00
28.00	0.00	442.10	0.00	0.00	0.00
29.00	0.00	442.10	0.00	0.00	0.00
30.00	0.00	442.10	0.00	0.00	0.00
31.00	0.00	439.10	0.00	0.00	0.00
32.00	0.00	439.10	0.00	0.00	0.00
33.00	0.00	439.10	0.00	0.00	0.00
34.00	0.00	439.10	0.00	0.00	0.00
35.00	0.00	439.10	0.00	0.00	0.00
36.00	0.00	439.10	0.00	0.00	0.00
37.00	0.00	439.10	0.00	0.00	0.00
38.00	0.00	439.10	0.00	0.00	0.00
39.00	0.00	439.10	0.00	0.00	0.00
40.00	0.00	439.10	0.00	0.00	0.00
41.00	0.00	439.10	0.00	0.00	0.00
42.00	0.00	439.10	0.00	0.00	0.00
43.00	0.00	439.10	0.00	0.00	0.00
44.00	0.00	439.10	0.00	0.00	0.00
45.00	0.00	439.10	0.00	0.00	0.00
46.00	0.00	439.10	0.00	0.00	0.00
47.00	0.00	439.10	0.00	0.00	0.00
48.00	0.00	439.10	0.00	0.00	0.00

Summary for Pond 76P: C5 (1 x 36" Culvert to Green River)

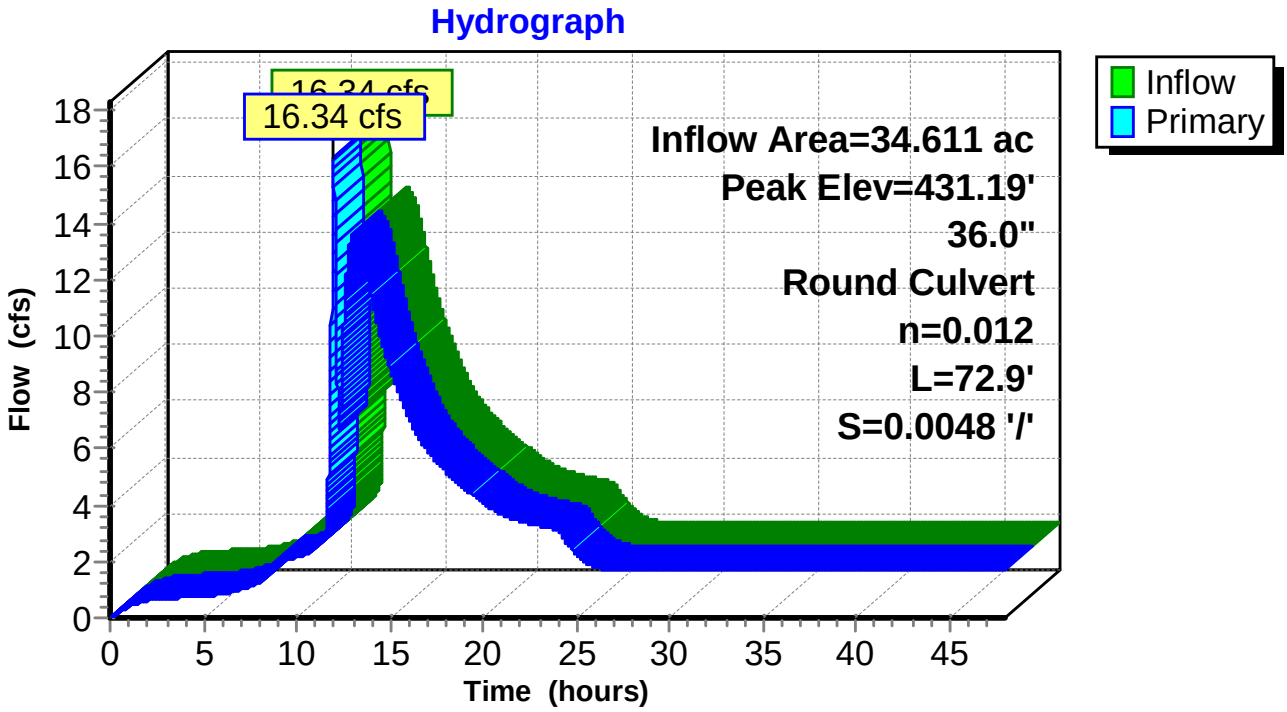
Inflow Area = 34.611 ac, 12.11% Impervious, Inflow Depth > 3.92" for 25 Year event
Inflow = 16.34 cfs @ 11.99 hrs, Volume= 11.310 af
Outflow = 16.34 cfs @ 11.99 hrs, Volume= 11.310 af, Atten= 0%, Lag= 0.0 min
Primary = 16.34 cfs @ 11.99 hrs, Volume= 11.310 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.19' @ 11.99 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	429.35'	**36.0" Round Culvert** L= 72.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 429.35' / 429.00' S= 0.0048 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 7.07 sf

Primary OutFlow Max=16.33 cfs @ 11.99 hrs HW=431.19' TW=428.69' (Dynamic Tailwater)
1=Culvert (Barrel Controls 16.33 cfs @ 5.13 fps)

Pond 76P: C5 (1 x 36" Culvert to Green River)



Hydrograph for Pond 76P: C5 (1 x 36" Culvert to Green River)

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	429.36	0.00
0.50	0.20	429.54	0.20
1.00	0.41	429.61	0.41
1.50	0.54	429.65	0.54
2.00	0.61	429.67	0.61
2.50	0.66	429.68	0.66
3.00	0.68	429.69	0.68
3.50	0.70	429.69	0.70
4.00	0.72	429.70	0.72
4.50	0.75	429.70	0.75
5.00	0.77	429.71	0.77
5.50	0.80	429.72	0.80
6.00	0.82	429.72	0.82
6.50	0.91	429.74	0.91
7.00	1.01	429.76	1.01
7.50	1.12	429.78	1.12
8.00	1.29	429.82	1.29
8.50	1.61	429.87	1.61
9.00	2.04	429.94	2.04
9.50	2.09	429.95	2.09
10.00	2.15	429.96	2.15
10.50	2.27	429.97	2.27
11.00	2.49	430.00	2.49
11.50	**2.96**	**430.07**	**2.96**
12.00	**16.32**	**431.19**	**16.32**
12.50	9.86	430.73	9.86
13.00	13.53	431.00	13.53
13.50	12.94	430.96	12.94
14.00	11.48	430.85	11.48
14.50	10.02	430.74	10.02
15.00	8.88	430.65	8.88
15.50	7.96	430.57	7.96
16.00	7.16	430.50	7.16
16.50	6.48	430.44	6.48
17.00	5.96	430.39	5.96
17.50	5.55	430.35	5.55
18.00	5.20	430.32	5.20
18.50	4.89	430.29	4.89
19.00	4.61	430.26	4.61
19.50	4.34	430.23	4.34
20.00	4.09	430.20	4.09
20.50	3.86	430.17	3.86
21.00	3.69	430.15	3.69
21.50	3.55	430.14	3.55
22.00	3.44	430.12	3.44
22.50	3.34	430.11	3.34
23.00	3.26	430.10	3.26
23.50	3.19	430.09	3.19
24.00	3.13	430.09	3.13
24.50	2.67	430.03	2.67
25.00	2.27	429.97	2.27
25.50	1.98	429.93	1.98
26.00	1.81	429.90	1.81
26.50	1.74	429.89	1.74
27.00	1.74	429.89	1.74
27.50	1.74	429.89	1.74
28.00	1.74	429.89	1.74
28.50	1.74	429.89	1.74
29.00	1.74	429.89	1.74
29.50	1.74	429.89	1.74
30.00	1.74	429.89	1.74
30.50	1.74	429.89	1.74
31.00	1.74	429.89	1.74
31.50	1.74	429.89	1.74
32.00	1.74	429.89	1.74
32.50	1.74	429.89	1.74
33.00	1.74	429.89	1.74
33.50	1.74	429.89	1.74
34.00	1.74	429.89	1.74
34.50	1.74	429.89	1.74
35.00	1.74	429.89	1.74
35.50	1.74	429.89	1.74
36.00	1.74	429.89	1.74
36.50	1.74	429.89	1.74
37.00	1.74	429.89	1.74
37.50	1.74	429.89	1.74
38.00	1.74	429.89	1.74
38.50	1.74	429.89	1.74
39.00	1.74	429.89	1.74
39.50	1.74	429.89	1.74
40.00	1.74	429.89	1.74
40.50	1.74	429.89	1.74
41.00	1.74	429.89	1.74
41.50	1.74	429.89	1.74
42.00	1.74	429.89	1.74
42.50	1.74	429.89	1.74
43.00	1.74	429.89	1.74
43.50	1.74	429.89	1.74
44.00	1.74	429.89	1.74
44.50	1.74	429.89	1.74
45.00	1.74	429.89	1.74
45.50	1.74	429.89	1.74
46.00	1.74	429.89	1.74
46.50	1.74	429.89	1.74
47.00	1.74	429.89	1.74
47.50	1.74	429.89	1.74
48.00	1.74	429.89	1.74

Summary for Pond 77P: C9 (Manhole)

Inflow Area = 33.431 ac, 12.54% Impervious, Inflow Depth > 3.93" for 25 Year event
Inflow = 13.15 cfs @ 13.06 hrs, Volume= 10.940 af
Outflow = 13.15 cfs @ 13.06 hrs, Volume= 10.940 af, Atten= 0%, Lag= 0.0 min
Primary = 13.15 cfs @ 13.06 hrs, Volume= 10.940 af
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

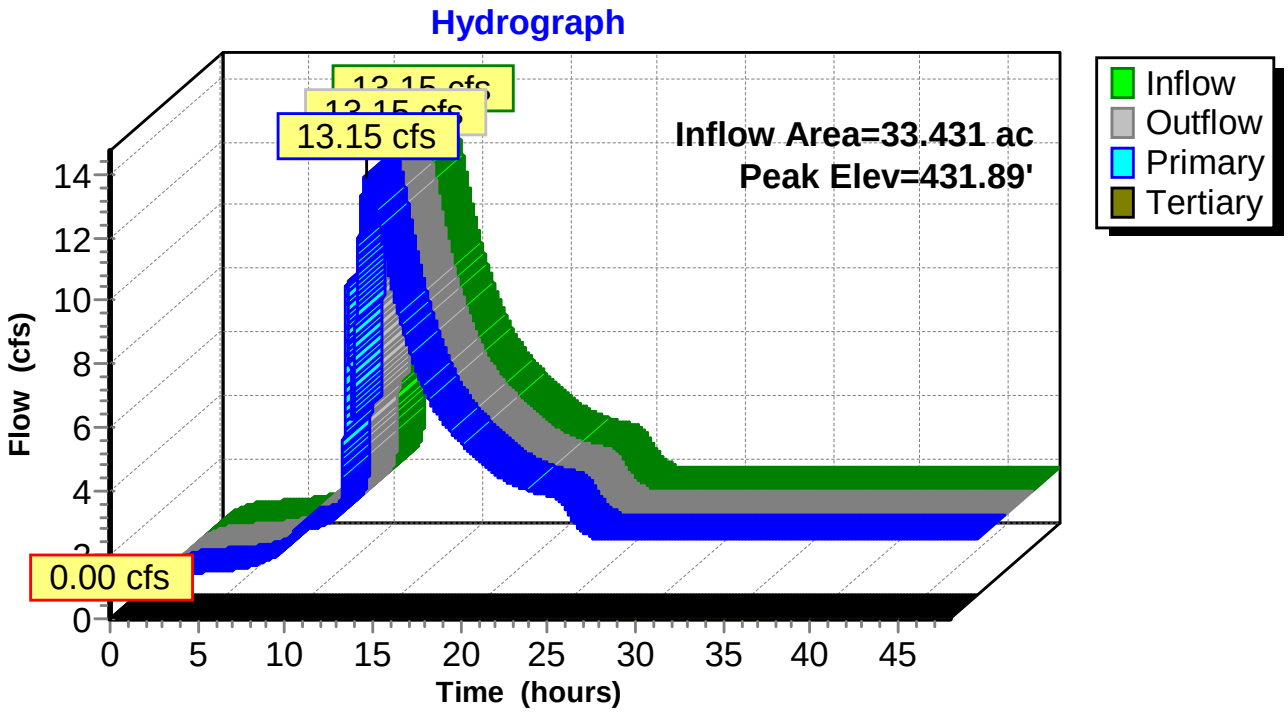
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 431.89' @ 13.06 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	430.18'	**36.0" Round Culvert** L= 174.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 430.18' / 429.35' S= 0.0048 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 7.07 sf
#2	Tertiary	445.29'	**Custom Weir/Orifice_Top of Ditch, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 5.00 Width (feet) 50.00 50.00

Primary OutFlow Max=13.15 cfs @ 13.06 hrs HW=431.89' TW=431.00' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 13.15 cfs @ 4.56 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=430.19' (Free Discharge)
└**2=Custom Weir/Orifice_Top of Ditch** (Controls 0.00 cfs)

Pond 77P: C9 (Manhole)



Hydrograph for Pond 77P: C9 (Manhole)

Time (hours)	Inflow (cfs)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Tertiary (cfs)
0.00	0.00	430.19	0.00	0.00	**0.00**
1.00	0.41	430.44	0.41	0.41	0.00
2.00	0.61	430.50	0.61	0.61	0.00
3.00	0.68	430.52	0.68	0.68	0.00
4.00	0.72	430.53	0.72	0.72	0.00
5.00	0.77	430.54	0.77	0.77	0.00
6.00	0.82	430.55	0.82	0.82	0.00
7.00	1.01	430.60	1.01	1.01	0.00
8.00	1.28	430.65	1.28	1.28	0.00
9.00	2.01	430.77	2.01	2.01	0.00
10.00	2.09	430.78	2.09	2.09	0.00
11.00	2.31	430.82	2.31	2.31	0.00
12.00	9.52	431.77	9.52	9.52	0.00
13.00	**13.10**	**431.89**	**13.10**	**13.10**	0.00
14.00	**11.22**	**431.73**	**11.22**	**11.22**	0.00
15.00	8.67	431.51	8.67	8.67	0.00
16.00	7.00	431.35	7.00	7.00	0.00
17.00	5.82	431.24	5.82	5.82	0.00
18.00	5.08	431.16	5.08	5.08	0.00
19.00	4.50	431.09	4.50	4.50	0.00
20.00	4.00	431.04	4.00	4.00	0.00
21.00	3.60	430.99	3.60	3.60	0.00
22.00	3.35	430.96	3.35	3.35	0.00
23.00	3.18	430.94	3.18	3.18	0.00
24.00	3.05	430.92	3.05	3.05	0.00
25.00	2.27	430.81	2.27	2.27	0.00
26.00	1.81	430.74	1.81	1.81	0.00
27.00	1.74	430.73	1.74	1.74	0.00
28.00	1.74	430.73	1.74	1.74	0.00
29.00	1.74	430.73	1.74	1.74	0.00
30.00	1.74	430.73	1.74	1.74	0.00
31.00	1.74	430.73	1.74	1.74	0.00
32.00	1.74	430.73	1.74	1.74	0.00
33.00	1.74	430.73	1.74	1.74	0.00
34.00	1.74	430.73	1.74	1.74	0.00
35.00	1.74	430.73	1.74	1.74	0.00
36.00	1.74	430.73	1.74	1.74	0.00
37.00	1.74	430.73	1.74	1.74	0.00
38.00	1.74	430.73	1.74	1.74	0.00
39.00	1.74	430.73	1.74	1.74	0.00
40.00	1.74	430.73	1.74	1.74	0.00
41.00	1.74	430.73	1.74	1.74	0.00
42.00	1.74	430.73	1.74	1.74	0.00
43.00	1.74	430.73	1.74	1.74	0.00
44.00	1.74	430.73	1.74	1.74	0.00
45.00	1.74	430.73	1.74	1.74	0.00
46.00	1.74	430.73	1.74	1.74	0.00
47.00	1.74	430.73	1.74	1.74	0.00
48.00	1.74	430.73	1.74	1.74	0.00

Summary for Pond 89P: Leachate Lagoon (146 x 316 x 7 ft. deep 3:1)

Inflow Area = 1.545 ac,100.00% Impervious, Inflow Depth > 25.23" for 25 Year event
Inflow = 17.84 cfs @ 11.90 hrs, Volume= 3.248 af, Incl. 0.61 cfs Base Flow
Outflow = 8.70 cfs @ 11.97 hrs, Volume= 3.203 af, Atten= 51%, Lag= 3.9 min
Primary = 8.70 cfs @ 11.97 hrs, Volume= 3.203 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 436.00' Surf.Area= 1.406 ac Storage= 6.510 af
Peak Elev= 436.20' @ 11.97 hrs Surf.Area= 1.420 ac Storage= 6.775 af (0.265 af above start)
Flood Elev= 438.00' Surf.Area= 1.545 ac Storage= 9.114 af (2.604 af above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 24.4 min (1,284.5 - 1,260.1)

Volume	Invert	Avail.Storage	Storage Description
#1	431.00'	9.114 af	**Custom Stage Data (Prismatic)** Listed below

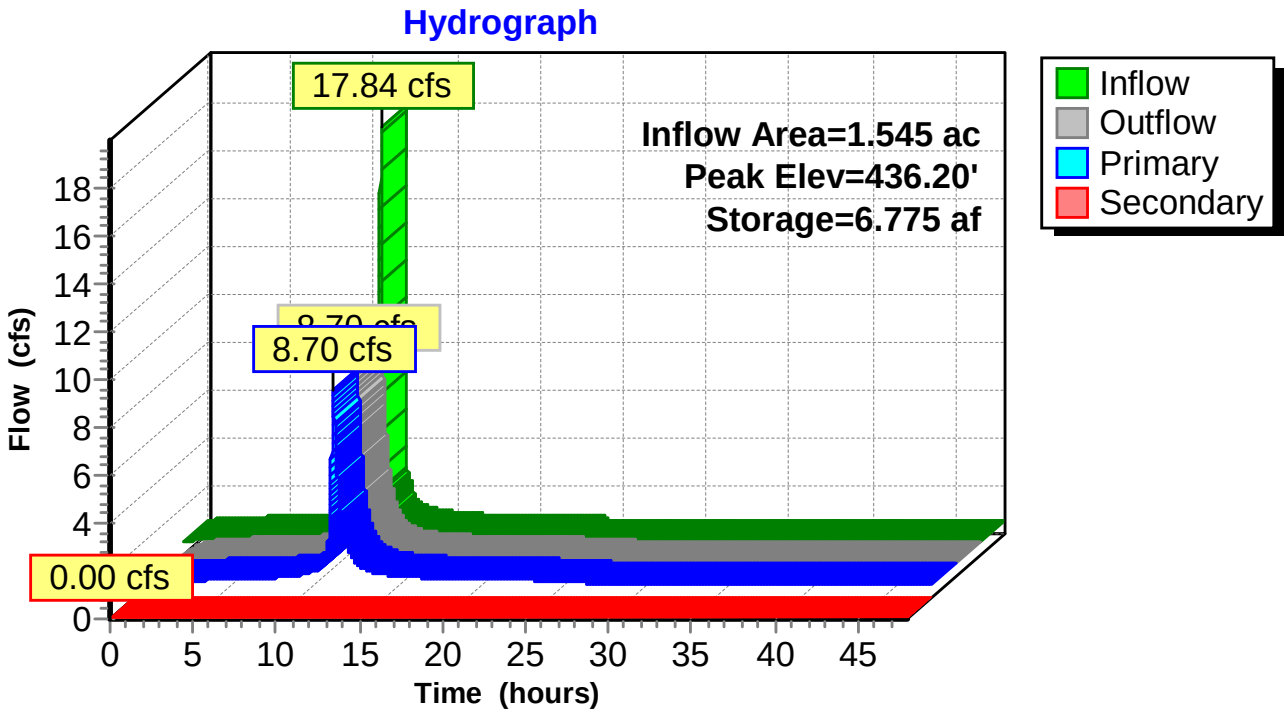
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
431.00	1.059	0.000	0.000
438.00	1.545	9.114	9.114

Device	Routing	Invert	Outlet Devices
#1	Primary	434.00'	**24.0" Round Culvert** L= 177.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 434.00' / 430.12' S= 0.0219 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Device 1	436.00'	**54.0" x 120.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Secondary	437.99'	**100.0' long x 15.0' breadth Broad-Crested Rectangular Weir_Top of Dike** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=8.70 cfs @ 11.97 hrs HW=436.20' TW=431.78' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 8.70 cfs of 16.59 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 8.70 cfs @ 1.47 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=436.00' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir_Top of Dike** (Controls 0.00 cfs)

Pond 89P: Leachate Lagoon (146 x 316 x 7 ft. deep 3:1)



Hydrograph for Pond 89P: Leachate Lagoon (146 x 316 x 7 ft. deep 3:1)

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.61	6.510	436.00	0.00	0.00	**0.00**
1.00	0.64	6.544	436.03	0.41	0.41	0.00
2.00	0.68	6.555	436.03	0.61	0.61	0.00
3.00	0.71	6.559	436.04	0.68	0.68	0.00
4.00	0.73	6.560	436.04	0.72	0.72	0.00
5.00	0.76	6.561	436.04	0.74	0.74	0.00
6.00	0.78	6.562	436.04	0.77	0.77	0.00
7.00	0.80	6.564	436.04	0.79	0.79	0.00
8.00	0.83	6.565	436.04	0.82	0.82	0.00
9.00	0.93	6.568	436.04	0.88	0.88	0.00
10.00	1.02	6.571	436.05	0.96	0.96	0.00
11.00	**1.35**	**6.580**	**436.05**	**1.18**	**1.18**	0.00
12.00	**3.66**	**6.768**	**436.20**	**8.39**	**8.39**	0.00
13.00	1.25	6.604	436.07	1.84	1.84	0.00
14.00	1.00	6.579	436.05	1.15	1.15	0.00
15.00	0.92	6.572	436.05	0.97	0.97	0.00
16.00	0.85	6.568	436.04	0.89	0.89	0.00
17.00	0.82	6.566	436.04	0.84	0.84	0.00
18.00	0.80	6.564	436.04	0.81	0.81	0.00
19.00	0.77	6.563	436.04	0.79	0.79	0.00
20.00	0.75	6.562	436.04	0.76	0.76	0.00
21.00	0.74	6.561	436.04	0.74	0.74	0.00
22.00	0.73	6.561	436.04	0.74	0.74	0.00
23.00	0.73	6.561	436.04	0.73	0.73	0.00
24.00	0.72	6.561	436.04	0.73	0.73	0.00
25.00	0.61	6.556	436.04	0.63	0.63	0.00
26.00	0.61	6.555	436.03	0.61	0.61	0.00
27.00	0.61	6.555	436.03	0.61	0.61	0.00
28.00	0.61	6.555	436.03	0.61	0.61	0.00
29.00	0.61	6.555	436.03	0.61	0.61	0.00
30.00	0.61	6.555	436.03	0.61	0.61	0.00
31.00	0.61	6.555	436.03	0.61	0.61	0.00
32.00	0.61	6.555	436.03	0.61	0.61	0.00
33.00	0.61	6.555	436.03	0.61	0.61	0.00
34.00	0.61	6.555	436.03	0.61	0.61	0.00
35.00	0.61	6.555	436.03	0.61	0.61	0.00
36.00	0.61	6.555	436.03	0.61	0.61	0.00
37.00	0.61	6.555	436.03	0.61	0.61	0.00
38.00	0.61	6.555	436.03	0.61	0.61	0.00
39.00	0.61	6.555	436.03	0.61	0.61	0.00
40.00	0.61	6.555	436.03	0.61	0.61	0.00
41.00	0.61	6.555	436.03	0.61	0.61	0.00
42.00	0.61	6.555	436.03	0.61	0.61	0.00
43.00	0.61	6.555	436.03	0.61	0.61	0.00
44.00	0.61	6.555	436.03	0.61	0.61	0.00
45.00	0.61	6.555	436.03	0.61	0.61	0.00
46.00	0.61	6.555	436.03	0.61	0.61	0.00
47.00	0.61	6.555	436.03	0.61	0.61	0.00
48.00	0.61	6.555	436.03	0.61	0.61	0.00

Channel Design

Storm Water Calculations

AECOM

Job	TVA PAF: CCR Proposed Landfill (Cell 1)	Project No.	60549496	Sheet	1 of 3
Description	Perimeter Channel Design	Computed by	FS	Date	01/26/2018
		Checked by	YC	Date	02/15/2018

I. PURPOSE

The purpose of this analysis is to design the proposed perimeter and diversion channels as applicable at Tennessee Valley Authority's (TVA) Paradise Fossil Plant (PAF) consistent with CCR Rule

II. SITE AND PROJECT DESCRIPTION

The channel design was performed for the new proposed landfill facility (Cell 1) at TVA PAF in Muhlenberg County, Kentucky. The proposed site is designed as a new landfill through the EPA Final Coal Combustion Residuals (CCR) rule: Federal Register/ Vol. 80/ No. 74 / Part II. The following sections summarize the design criteria, procedure, assumptions, and results of the channel design.

III. REGULATORY REQUIREMENTS / DESIGN CRITERIA

The below parts of the Final CCR rules specify requirements for the design of the channels:

Rule §257.81(a)(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

Rule §257.81(a)(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

The results of the analysis presented herein show that the channels are designed to collect and control at least the peak flow resulting from a 25-year/24-hour storm so that storm water is diverted appropriately. The perimeter channels will convey landfill run-off flow towards the stormwater pond and the diversion channels will divert run-on flow from primarily undisturbed areas away from the site such that run-on is not combined with sediment laden run-off from the landfill site.

Proper channel lining will be selected based on anticipated velocities such that erosion within the channels will be significantly reduced.

AECOM

Job	TVA PAF: CCR Proposed Landfill (Cell 1)	Project No.	60549496	Sheet	2 of 3
Description	Perimeter Channel Design	Computed by	FS	Date	01/26/2018
		Checked by	YC	Date	02/15/2018

IV. PROCEDURE

Design of the landfill site stormwater features was an iterative process beginning with basic assumptions and a proposed grading plan for the site. The hydraulic features of the channels were initially assumed and then confirmed through multiple iterations.

The AutoCAD Civil 3D software package was used to generate the proposed site grading plan and subsequently to determine drainage areas, volumes, and other site geometry. HydroCAD (version 10) modeling software was used to conduct the hydrologic and hydraulic calculations for this analysis with inputs based on the site geometry, rainfall data, and other design assumptions.

The model was used to generate peak flow rates, velocities, and water surface elevations at the outlets of the channels for the design storm conditions and based on upstream watershed features of the site and the channel design parameters. The proposed channels will pass flows equal to and lesser than those generated by the 24-hour, 25-year storm.

The shear stress was calculated for each channel reach to confirm the type of ditch lining selected. Actual shear stress was calculated by the following equation:

$\tau_{ac} = 62.4 * D * S$

where,

D = water surface depth, ft

S = channel slope, ft/ft

τ_{ac} = Actual shear stress, lbs/ft^2

V. NOTES/ASSUMPTIONS

The following is a list of key notes and assumptions made in completing this analysis.

- A design parameter minimum six (6) inches of freeboard was used during the 25-year storm.
- Within the HydroCAD program, the runoff was calculated using the SCS TR-20 method.
- Runoff curve numbers (CN) used in the analysis were as follows:
    - 74 for landfill vegetated cover and offsite areas, and

- 89 for access roads.

· The time of concentration was calculated using the Curve Number Method in HydroCAD which takes inputs for each drainage area of the longest hydraulic flow path and average land slope.

VI. SUMMARY OF RESULTS

The results of the channel design are summarized in Table 1 (see also Attachment B2 for the HydroCAD output report). The channels properly control and convey the water volume generated by the 24-hour, 25-year storm such that the peak water surface elevation stays safely below the impounding sideslopes with greater than six (6) inches of freeboard. The channels shown in Table 1 are perimeter channels collecting landfill (Cell 1) run-off which is conveyed to the sediment basin and Green River. A channel lining of RIPRAP (Class III) was chosen for all perimeter and conveyance channels as the peak velocity ranged from 2.48 to 6.82 fps and the actual shear stress ranged from 0.24 to 3.33 lbs/ft^2. It was deemed more appropriate and economical to stay consistent with a single, more erosion resistant material.

VII. CONCLUSIONS

The proposed grading of the landfill site (Cell 1) in combination with the design of the channels as presented above is sufficient to safely control and convey the 24-hour, 25-year storm as stipulated by the CCR Rule. Refer to accompanying calculations used to design upstream (storm water terraces and letdowns) and downstream (culverts and sediment basins) conveyance features.

VIII. ATTACHMENTS

Tables:
Table 1: Ditches

Attachments:
Attachment B2: HydroCAD Report for Ditches Design

IX. REFERENCES

1- *EPA Final Coal Combustion Residuals (CCR) Rules: Federal Register/ Vol. 80/ No. 74 /Part II. Hazardous and Solid Waste Management System; Disposal of Coal, April 17, 2015*

TABLE 1

Ditches

Table 1 - Ditches

	Channel Properties										Hydraulic Summary				
Channel ID	**Mannings Coefficient**	**Depth (ft)**	**Bottom Width (ft)**	**Left Side Slope (H:V)**	**Right Side Slope (H:V)**	**Invert Elevation (ft)**	**Outlet Elevation (ft)**	**Length (ft)**	**Average Slope (%)**	**Average Slope (ft/ft)**	**25-YR/24-Hr. Inflow (cfs)**	**Max. Velocity (fps)**	**Average Water Surface Depth (ft)**	**Actual Shear Stress (lbs/ft^2)**	**Proposed Channel Lining, Minimum Size (in)**
21R: SW Ditch (Lower)- EDITED	0.03	3	6	2	2	450.59	445.10	733.00	0.75%	0.0075	11.04	2.48	0.52	0.24	Class III, 16 inch
57R: SW Ditch (Upper)	0.03	3	6	2	2	445.10	442.10	206.00	1.46%	0.0146	35.44	4.81	0.93	0.85	Class III, 16 inch
59R: NW Ditch (Lower)- EDITED	0.03	3	6	2	2	454.00	442.10	905.00	1.31%	0.0131	44.25	4.93	1.07	0.87	Class III, 16 inch
62R: To Green River (WEST LOWER 1 - RIPRAP)	0.045	3	6	2	2	428.00	425.61	40.20	5.95%	0.0595	28.15	5.49	0.69	2.56	Class III, 16 inch
65R: To Green River (WEST LOWER 2)	0.045	3	6	2	2	425.61	422.28	105.30	3.16%	0.0316	28.15	4.43	0.83	1.64	Class III, 16 inch
67R: To Green River (WEST LOWER 3)	0.045	3	6	2	2	422.28	415.61	78.80	8.46%	0.0846	28.12	6.18	0.63	3.33	Class III, 16 inch
77R: To Green River (WEST UPPER 1 - EG)	0.03	3	6	2	2	412.00	397.97	889.80	1.58%	0.0158	105.44	6.82	1.65	1.63	Class III, 16 inch
81R: To Green River (WEST UPPER 2 - EG)	0.03	3	6	2	2	391.97	390.00	181.10	1.09%	0.0109	104.80	5.97	1.82	1.24	Class III, 16 inch
97R: Cell 3: Drain to Outfall 16	0.03	3	3	2	2	415.00	400.00	1557.00	0.96%	0.0096	125.65	6.11	2.50	1.50	Class III, 16 inch
103R: Cell 4: Drain to Outfall 16	0.03	3	1	2	2	420.00	395.00	1584.00	1.58%	0.0158	4.85	3.15	0.81	0.80	Class III, 16 inch

ATTACHMENT A2

HydroCAD Report for Ditches Design

Summary for Reach 21R: SW Ditch (Lower) EDITED

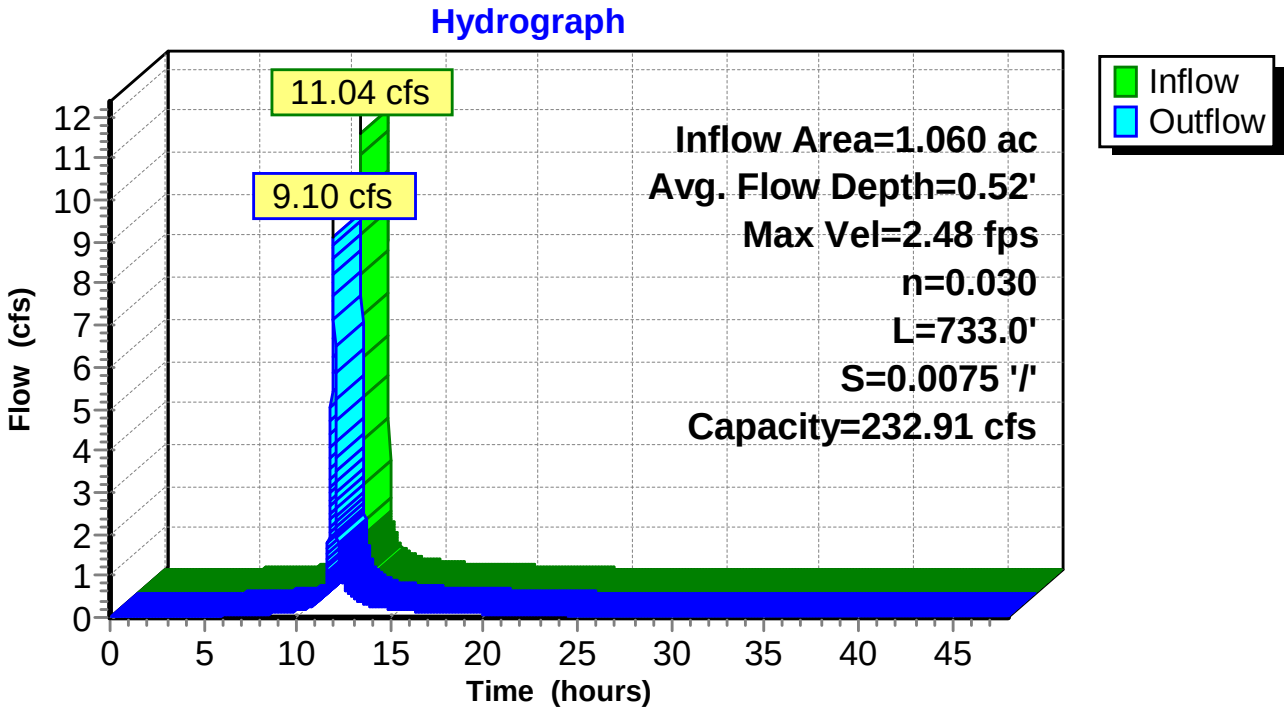
Inflow Area = 1.060 ac, 0.00% Impervious, Inflow Depth = 5.39" for 25 Year event
Inflow = 11.04 cfs @ 11.91 hrs, Volume= 0.476 af
Outflow = 9.10 cfs @ 11.94 hrs, Volume= 0.476 af, Atten= 18%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.48 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 22.2 min

Peak Storage= 2,689 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.52'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 232.91 cfs

6.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 733.0' Slope= 0.0075 '/'
Inlet Invert= 450.59', Outlet Invert= 445.10'

Reach 21R: SW Ditch (Lower) EDITED



Hydrograph for Reach 21R: SW Ditch (Lower) EDITED

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	450.59	0.00
1.00	0.00	0	450.59	0.00
2.00	0.00	0	450.59	0.00
3.00	0.00	0	450.59	0.00
4.00	0.01	10	450.59	0.01
5.00	0.03	33	450.60	0.02
6.00	0.04	62	450.60	0.03
7.00	0.06	95	450.61	0.05
8.00	0.08	129	450.62	0.07
9.00	0.14	174	450.63	0.12
10.00	0.19	216	450.64	0.17
11.00	**0.39**	**336**	**450.66**	**0.35**
12.00	**2.61**	**2,156**	**451.02**	**6.52**
13.00	0.42	410	450.68	0.47
14.00	0.26	294	450.66	0.28
15.00	0.21	253	450.65	0.22
16.00	0.16	213	450.64	0.17
17.00	0.14	193	450.63	0.15
18.00	0.12	178	450.63	0.13
19.00	0.11	164	450.63	0.11
20.00	0.09	150	450.62	0.09
21.00	0.09	144	450.62	0.09
22.00	0.08	141	450.62	0.08
23.00	0.08	138	450.62	0.08
24.00	0.08	135	450.62	0.08
25.00	0.00	18	450.59	0.01
26.00	0.00	2	450.59	0.00
27.00	0.00	0	450.59	0.00
28.00	0.00	0	450.59	0.00
29.00	0.00	0	450.59	0.00
30.00	0.00	0	450.59	0.00
31.00	0.00	0	450.59	0.00
32.00	0.00	0	450.59	0.00
33.00	0.00	0	450.59	0.00
34.00	0.00	0	450.59	0.00
35.00	0.00	0	450.59	0.00
36.00	0.00	0	450.59	0.00
37.00	0.00	0	450.59	0.00
38.00	0.00	0	450.59	0.00
39.00	0.00	0	450.59	0.00
40.00	0.00	0	450.59	0.00
41.00	0.00	0	450.59	0.00
42.00	0.00	0	450.59	0.00
43.00	0.00	0	450.59	0.00
44.00	0.00	0	450.59	0.00
45.00	0.00	0	450.59	0.00
46.00	0.00	0	450.59	0.00
47.00	0.00	0	450.59	0.00
48.00	0.00	0	450.59	0.00

Summary for Reach 57R: SW Ditch (Upper)

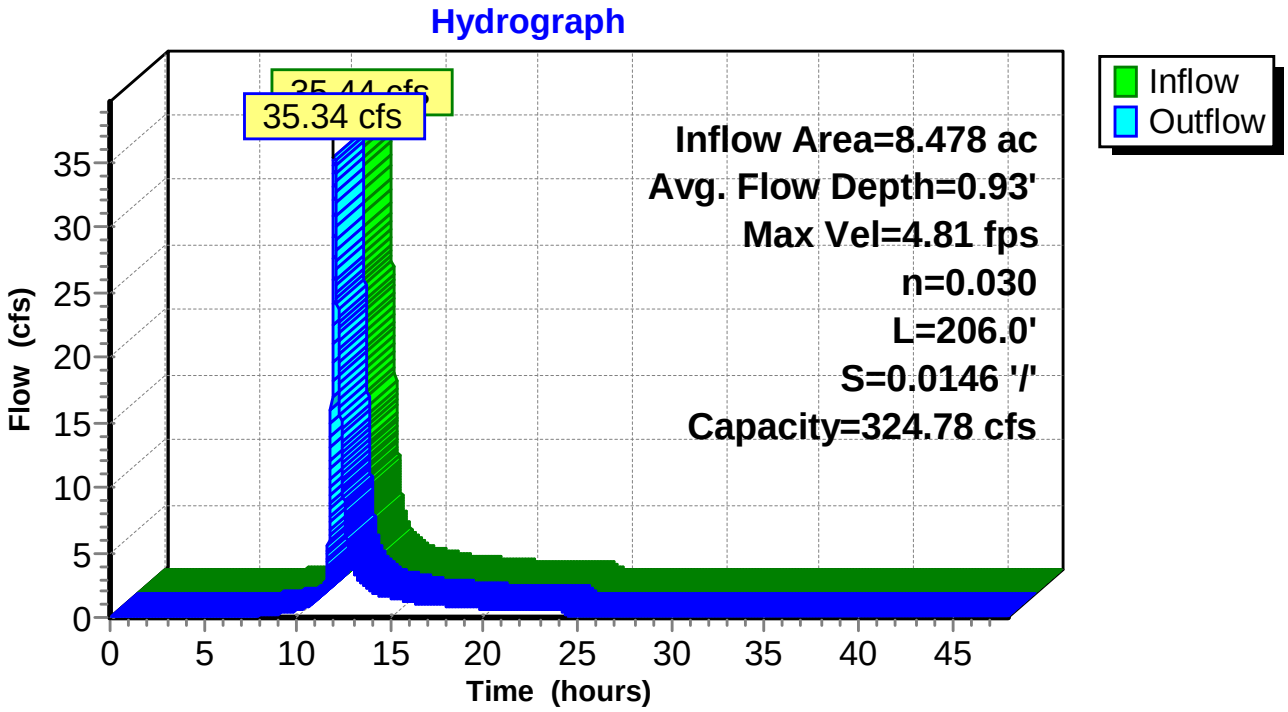
Inflow Area = 8.478 ac, 0.00% Impervious, Inflow Depth = 4.02" for 25 Year event
Inflow = 35.44 cfs @ 11.98 hrs, Volume= 2.838 af
Outflow = 35.34 cfs @ 11.99 hrs, Volume= 2.838 af, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.81 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.19 fps, Avg. Travel Time= 2.9 min

Peak Storage= 1,513 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.93'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 324.78 cfs

6.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 206.0' Slope= 0.0146 '/'
Inlet Invert= 445.10', Outlet Invert= 442.10'

Reach 57R: SW Ditch (Upper)



Hydrograph for Reach 57R: SW Ditch (Upper)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	445.10	0.00
1.00	0.00	0	445.10	0.00
2.00	0.00	0	445.10	0.00
3.00	0.00	0	445.10	0.00
4.00	0.01	2	445.10	0.01
5.00	0.03	9	445.11	0.02
6.00	0.05	16	445.11	0.04
7.00	0.07	25	445.12	0.07
8.00	0.13	41	445.13	0.12
9.00	0.32	72	445.16	0.31
10.00	0.58	105	445.18	0.57
11.00	**1.41**	**181**	**445.24**	**1.38**
12.00	**34.95**	**1,509**	**446.03**	**35.20**
13.00	3.60	336	445.35	3.66
14.00	2.01	232	445.28	2.03
15.00	1.54	195	445.25	1.55
16.00	1.21	168	445.23	1.22
17.00	1.04	153	445.22	1.04
18.00	0.92	141	445.21	0.92
19.00	0.80	129	445.20	0.80
20.00	0.68	117	445.19	0.68
21.00	0.63	112	445.19	0.63
22.00	0.61	109	445.19	0.61
23.00	0.58	106	445.18	0.58
24.00	0.56	103	445.18	0.56
25.00	0.01	6	445.11	0.02
26.00	0.00	1	445.10	0.00
27.00	0.00	0	445.10	0.00
28.00	0.00	0	445.10	0.00
29.00	0.00	0	445.10	0.00
30.00	0.00	0	445.10	0.00
31.00	0.00	0	445.10	0.00
32.00	0.00	0	445.10	0.00
33.00	0.00	0	445.10	0.00
34.00	0.00	0	445.10	0.00
35.00	0.00	0	445.10	0.00
36.00	0.00	0	445.10	0.00
37.00	0.00	0	445.10	0.00
38.00	0.00	0	445.10	0.00
39.00	0.00	0	445.10	0.00
40.00	0.00	0	445.10	0.00
41.00	0.00	0	445.10	0.00
42.00	0.00	0	445.10	0.00
43.00	0.00	0	445.10	0.00
44.00	0.00	0	445.10	0.00
45.00	0.00	0	445.10	0.00
46.00	0.00	0	445.10	0.00
47.00	0.00	0	445.10	0.00
48.00	0.00	0	445.10	0.00

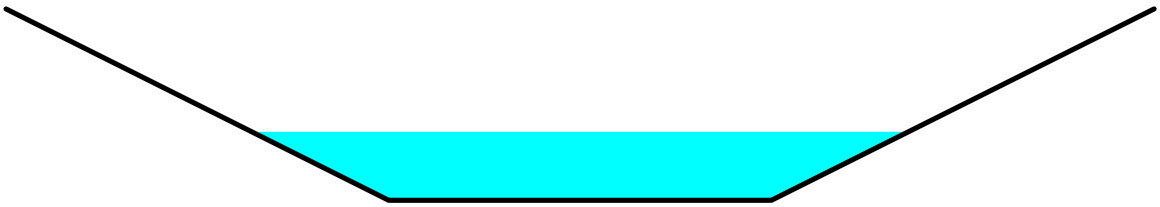
Summary for Reach 59R: NW Ditch (Lower)- EDITED

Inflow Area = 11.090 ac, 0.00% Impervious, Inflow Depth = 3.81" for 25 Year event
Inflow = 44.25 cfs @ 12.13 hrs, Volume= 3.517 af
Outflow = 43.00 cfs @ 12.17 hrs, Volume= 3.517 af, Atten= 3%, Lag= 2.1 min

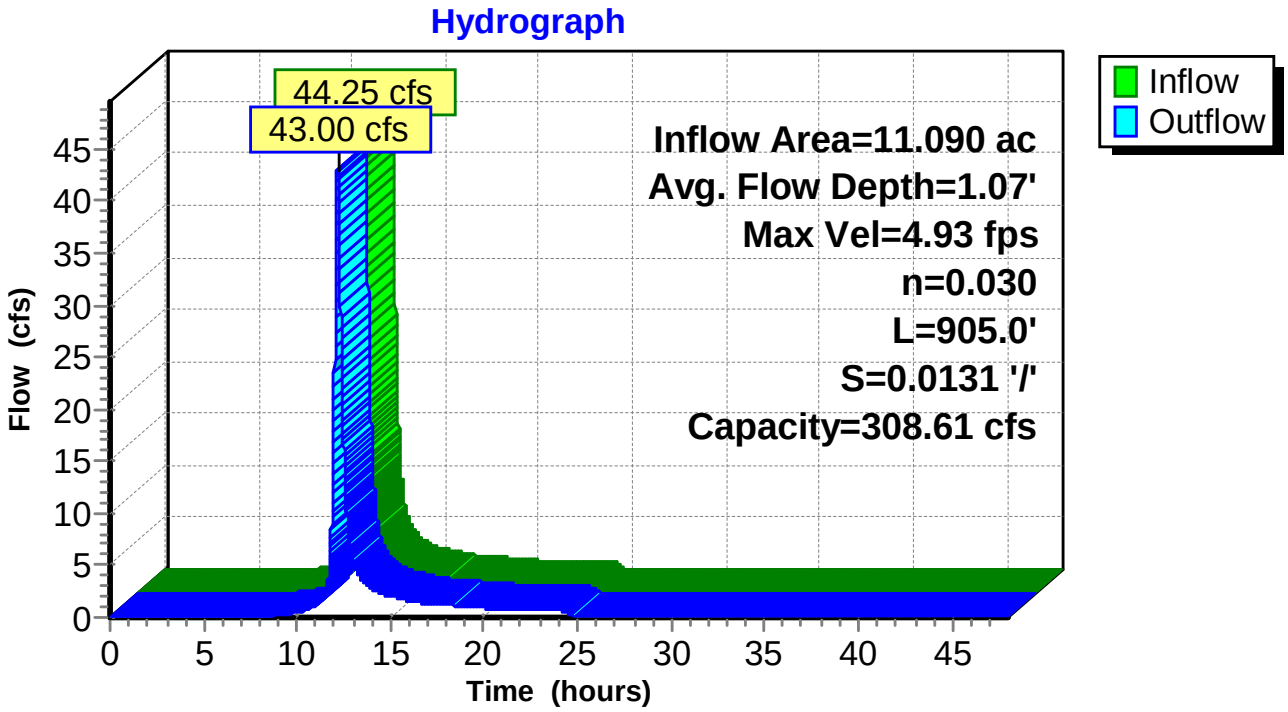
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.93 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 1.21 fps, Avg. Travel Time= 12.5 min

Peak Storage= 7,894 cf @ 12.17 hrs
Average Depth at Peak Storage= 1.07'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 308.61 cfs

6.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 905.0' Slope= 0.0131 '/'
Inlet Invert= 454.00', Outlet Invert= 442.10'



Reach 59R: NW Ditch (Lower)- EDITED



Hydrograph for Reach 59R: NW Ditch (Lower)- EDITED

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	454.00	0.00
1.00	0.00	0	454.00	0.00
2.00	0.00	0	454.00	0.00
3.00	0.00	0	454.00	0.00
4.00	0.00	3	454.00	0.00
5.00	0.01	10	454.00	0.01
6.00	0.01	19	454.00	0.01
7.00	0.02	29	454.01	0.02
8.00	0.07	62	454.01	0.04
9.00	0.27	253	454.05	0.21
10.00	0.57	443	454.08	0.51
11.00	1.47	802	454.14	1.32
12.00	**29.96**	**5,376**	**454.78**	**24.66**
13.00	**4.90**	**1,941**	**454.32**	**5.32**
14.00	2.66	1,276	454.22	2.76
15.00	2.00	1,052	454.18	2.03
16.00	1.58	910	454.16	1.62
17.00	1.34	815	454.14	1.36
18.00	1.19	757	454.13	1.21
19.00	1.04	697	454.12	1.05
20.00	0.88	631	454.11	0.90
21.00	0.81	592	454.11	0.81
22.00	0.78	578	454.10	0.78
23.00	0.75	565	454.10	0.75
24.00	0.72	551	454.10	0.72
25.00	0.00	109	454.02	0.07
26.00	0.00	13	454.00	0.01
27.00	0.00	1	454.00	0.00
28.00	0.00	0	454.00	0.00
29.00	0.00	0	454.00	0.00
30.00	0.00	0	454.00	0.00
31.00	0.00	0	454.00	0.00
32.00	0.00	0	454.00	0.00
33.00	0.00	0	454.00	0.00
34.00	0.00	0	454.00	0.00
35.00	0.00	0	454.00	0.00
36.00	0.00	0	454.00	0.00
37.00	0.00	0	454.00	0.00
38.00	0.00	0	454.00	0.00
39.00	0.00	0	454.00	0.00
40.00	0.00	0	454.00	0.00
41.00	0.00	0	454.00	0.00
42.00	0.00	0	454.00	0.00
43.00	0.00	0	454.00	0.00
44.00	0.00	0	454.00	0.00
45.00	0.00	0	454.00	0.00
46.00	0.00	0	454.00	0.00
47.00	0.00	0	454.00	0.00
48.00	0.00	0	454.00	0.00

Summary for Reach 62R: To Green River (WEST LOWER 1)

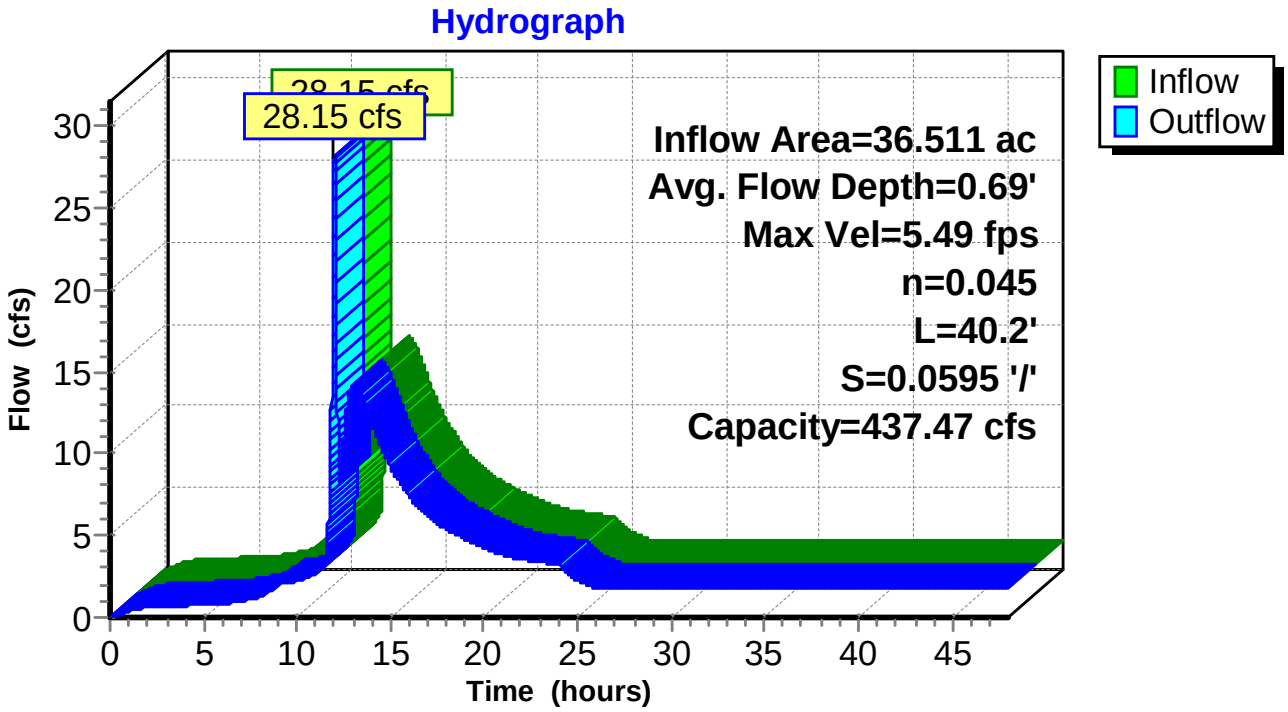
Inflow Area = 36.511 ac, 11.48% Impervious, Inflow Depth > 3.91" for 25 Year event
Inflow = 28.15 cfs @ 11.99 hrs, Volume= 11.904 af
Outflow = 28.15 cfs @ 12.00 hrs, Volume= 11.904 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.49 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.30 fps, Avg. Travel Time= 0.3 min

Peak Storage= 206 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 437.47 cfs

6.00' x 3.00' deep channel, n= 0.045
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 40.2' Slope= 0.0595 '/'
Inlet Invert= 428.00', Outlet Invert= 425.61'

Reach 62R: To Green River (WEST LOWER 1)



Hydrograph for Reach 62R: To Green River (WEST LOWER 1)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	428.00	0.00
1.00	0.41	14	428.06	0.41
2.00	0.61	18	428.07	0.61
3.00	0.68	19	428.08	0.68
4.00	0.72	20	428.08	0.72
5.00	0.77	20	428.08	0.77
6.00	0.82	21	428.09	0.82
7.00	1.01	24	428.10	1.01
8.00	1.30	28	428.11	1.30
9.00	2.09	38	428.15	2.09
10.00	2.26	40	428.16	2.26
11.00	**2.78**	46	428.18	2.77
12.00	**28.10**	**206**	**428.69**	**28.12**
13.00	14.22	131	428.47	14.22
14.00	11.89	116	428.42	11.89
15.00	9.20	98	428.36	9.21
16.00	7.42	85	428.32	7.42
17.00	6.18	76	428.29	6.19
18.00	5.40	70	428.26	5.40
19.00	4.78	64	428.25	4.78
20.00	4.23	60	428.23	4.24
21.00	3.82	56	428.22	3.82
22.00	3.57	53	428.21	3.57
23.00	3.39	52	428.20	3.39
24.00	3.25	50	428.20	3.25
25.00	2.27	40	428.16	2.27
26.00	1.81	35	428.14	1.81
27.00	1.74	34	428.13	1.74
28.00	1.74	34	428.13	1.74
29.00	1.74	34	428.13	1.74
30.00	1.74	34	428.13	1.74
31.00	1.74	34	428.13	1.74
32.00	1.74	34	428.13	1.74
33.00	1.74	34	428.13	1.74
34.00	1.74	34	428.13	1.74
35.00	1.74	34	428.13	1.74
36.00	1.74	34	428.13	1.74
37.00	1.74	34	428.13	1.74
38.00	1.74	34	428.13	1.74
39.00	1.74	34	428.13	1.74
40.00	1.74	34	428.13	1.74
41.00	1.74	34	428.13	1.74
42.00	1.74	34	428.13	1.74
43.00	1.74	34	428.13	1.74
44.00	1.74	34	428.13	1.74
45.00	1.74	34	428.13	1.74
46.00	1.74	34	428.13	1.74
47.00	1.74	34	428.13	1.74
48.00	1.74	34	428.13	1.74

Summary for Reach 65R: To Green River (WEST LOWER 2)

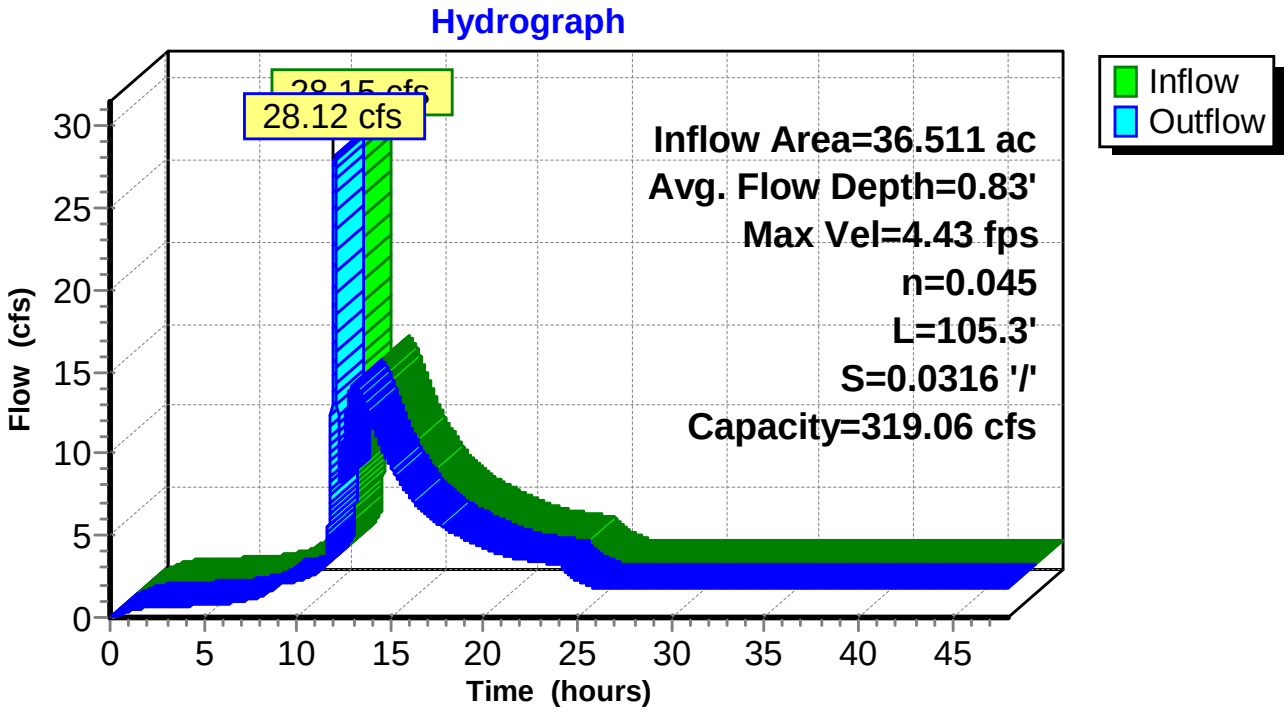
Inflow Area = 36.511 ac, 11.48% Impervious, Inflow Depth > 3.91" for 25 Year event
Inflow = 28.15 cfs @ 12.00 hrs, Volume= 11.904 af
Outflow = 28.12 cfs @ 12.00 hrs, Volume= 11.901 af, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.43 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.88 fps, Avg. Travel Time= 0.9 min

Peak Storage= 669 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.83'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 319.06 cfs

6.00' x 3.00' deep channel, n= 0.045
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 105.3' Slope= 0.0316 '/'
Inlet Invert= 425.61', Outlet Invert= 422.28'

Reach 65R: To Green River (WEST LOWER 2)



Hydrograph for Reach 65R: To Green River (WEST LOWER 2)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	425.61	0.00
1.00	0.41	43	425.68	0.40
2.00	0.61	57	425.70	0.61
3.00	0.68	61	425.70	0.68
4.00	0.72	63	425.71	0.72
5.00	0.77	65	425.71	0.77
6.00	0.82	68	425.71	0.82
7.00	1.01	77	425.73	1.01
8.00	1.30	90	425.75	1.29
9.00	2.09	122	425.79	2.09
10.00	2.26	128	425.80	2.26
11.00	2.77	146	425.82	2.77
12.00	**28.12**	**669**	**426.44**	**28.12**
13.00	14.22	422	426.17	14.22
14.00	11.89	375	426.12	11.91
15.00	9.21	316	426.05	9.22
16.00	7.42	275	426.00	7.43
17.00	6.19	244	425.96	6.19
18.00	5.40	223	425.93	5.40
19.00	4.78	207	425.91	4.79
20.00	4.24	191	425.89	4.24
21.00	3.82	179	425.87	3.83
22.00	3.57	171	425.86	3.57
23.00	3.39	166	425.85	3.39
24.00	3.25	161	425.85	3.25
25.00	2.27	129	425.80	2.28
26.00	1.81	111	425.78	1.81
27.00	1.74	109	425.77	1.74
28.00	1.74	109	425.77	1.74
29.00	1.74	109	425.77	1.74
30.00	1.74	109	425.77	1.74
31.00	1.74	109	425.77	1.74
32.00	1.74	109	425.77	1.74
33.00	1.74	109	425.77	1.74
34.00	1.74	109	425.77	1.74
35.00	1.74	109	425.77	1.74
36.00	1.74	109	425.77	1.74
37.00	1.74	109	425.77	1.74
38.00	1.74	109	425.77	1.74
39.00	1.74	109	425.77	1.74
40.00	1.74	109	425.77	1.74
41.00	1.74	109	425.77	1.74
42.00	1.74	109	425.77	1.74
43.00	1.74	109	425.77	1.74
44.00	1.74	109	425.77	1.74
45.00	1.74	109	425.77	1.74
46.00	1.74	109	425.77	1.74
47.00	1.74	109	425.77	1.74
48.00	1.74	109	425.77	1.74

Summary for Reach 67R: To Green River (WEST LOWER 3)

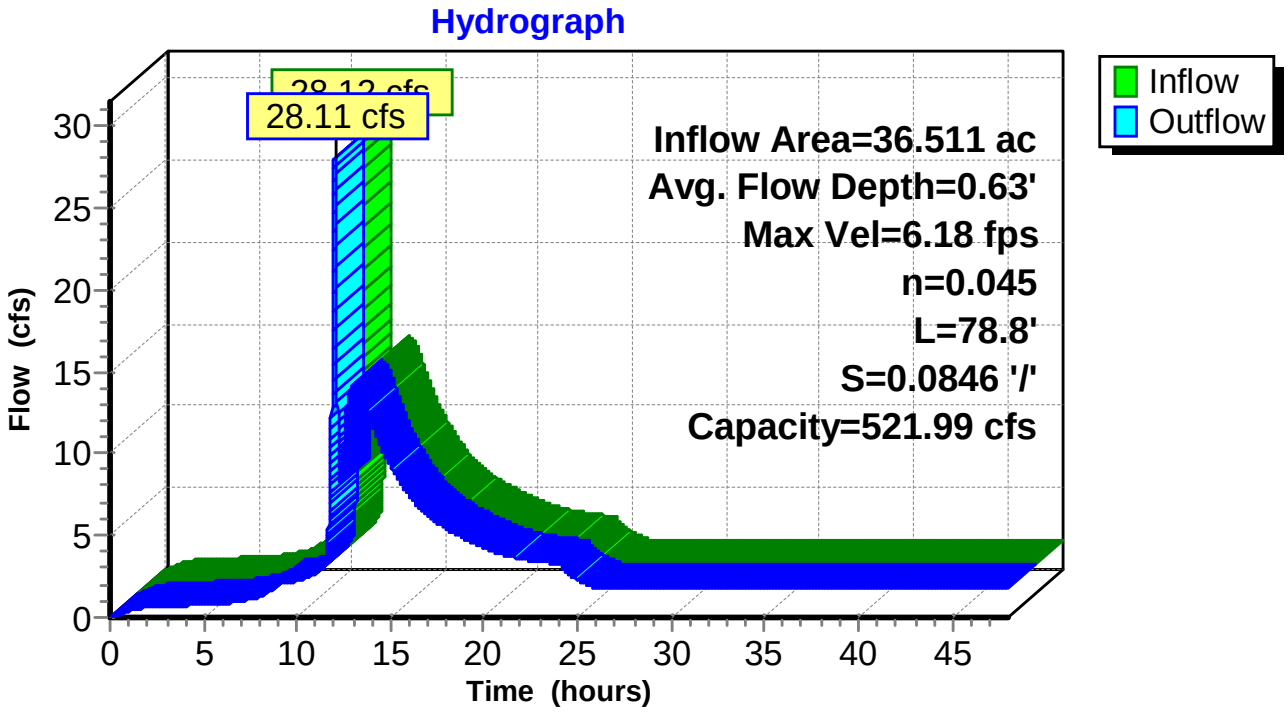
Inflow Area = 36.511 ac, 11.48% Impervious, Inflow Depth > 3.91" for 25 Year event
Inflow = 28.12 cfs @ 12.00 hrs, Volume= 11.901 af
Outflow = 28.11 cfs @ 12.00 hrs, Volume= 11.900 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.18 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.57 fps, Avg. Travel Time= 0.5 min

Peak Storage= 358 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 521.99 cfs

6.00' x 3.00' deep channel, n= 0.045
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 78.8' Slope= 0.0846 '/'
Inlet Invert= 422.28', Outlet Invert= 415.61'

Reach 67R: To Green River (WEST LOWER 3)



Hydrograph for Reach 67R: To Green River (WEST LOWER 3)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	422.28	0.00
1.00	0.40	24	422.33	0.40
2.00	0.61	31	422.34	0.61
3.00	0.68	33	422.35	0.68
4.00	0.72	34	422.35	0.72
5.00	0.77	36	422.35	0.77
6.00	0.82	37	422.36	0.82
7.00	1.01	43	422.37	1.01
8.00	1.29	50	422.38	1.29
9.00	2.09	67	422.42	2.09
10.00	2.26	70	422.42	2.25
11.00	2.77	80	422.44	2.76
12.00	**28.12**	**358**	**422.91**	**28.10**
13.00	14.22	228	422.70	14.22
14.00	11.91	203	422.66	11.92
15.00	9.22	172	422.61	9.23
16.00	7.43	149	422.57	7.44
17.00	6.19	133	422.54	6.20
18.00	5.40	122	422.52	5.41
19.00	4.79	113	422.50	4.79
20.00	4.24	105	422.49	4.24
21.00	3.83	98	422.47	3.83
22.00	3.57	94	422.47	3.57
23.00	3.39	91	422.46	3.39
24.00	3.25	88	422.46	3.25
25.00	2.28	71	422.42	2.28
26.00	1.81	61	422.40	1.81
27.00	1.74	60	422.40	1.74
28.00	1.74	60	422.40	1.74
29.00	1.74	60	422.40	1.74
30.00	1.74	60	422.40	1.74
31.00	1.74	60	422.40	1.74
32.00	1.74	60	422.40	1.74
33.00	1.74	60	422.40	1.74
34.00	1.74	60	422.40	1.74
35.00	1.74	60	422.40	1.74
36.00	1.74	60	422.40	1.74
37.00	1.74	60	422.40	1.74
38.00	1.74	60	422.40	1.74
39.00	1.74	60	422.40	1.74
40.00	1.74	60	422.40	1.74
41.00	1.74	60	422.40	1.74
42.00	1.74	60	422.40	1.74
43.00	1.74	60	422.40	1.74
44.00	1.74	60	422.40	1.74
45.00	1.74	60	422.40	1.74
46.00	1.74	60	422.40	1.74
47.00	1.74	60	422.40	1.74
48.00	1.74	60	422.40	1.74

Summary for Reach 77R: To Green River (WEST UPPER 1)

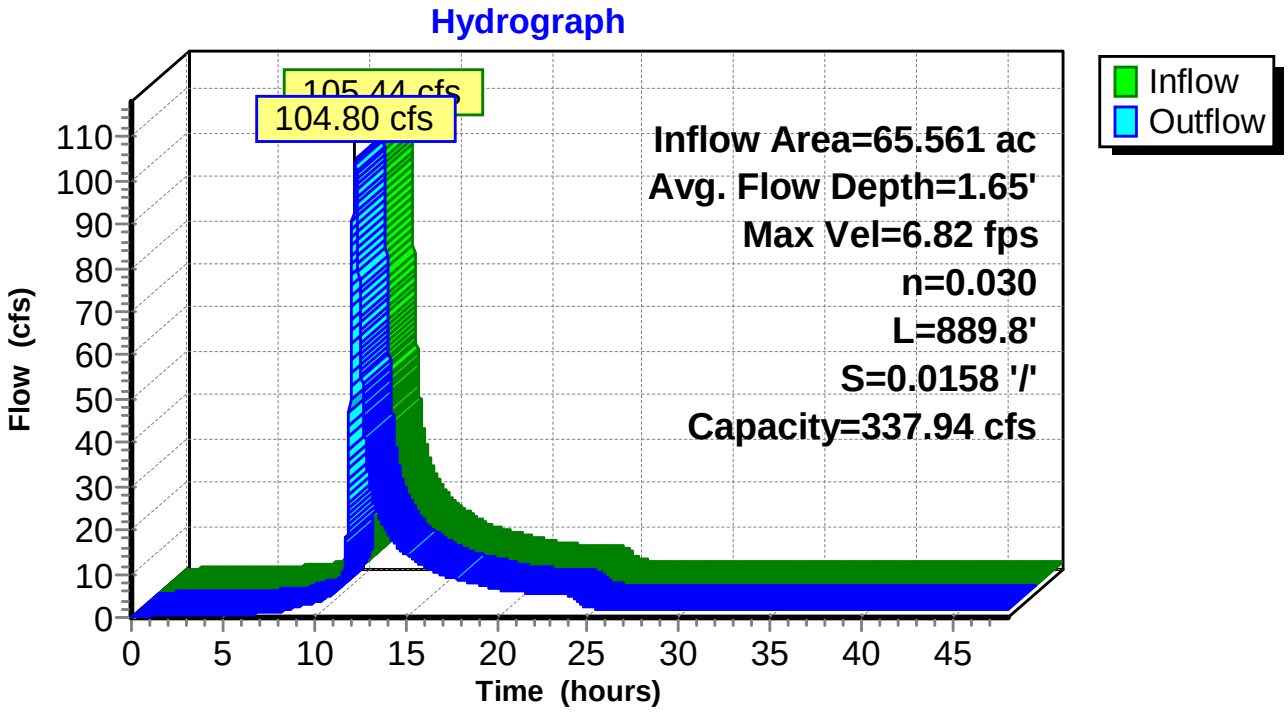
Inflow Area = 65.561 ac, 6.40% Impervious, Inflow Depth > 3.84" for 25 Year event
Inflow = 105.44 cfs @ 12.23 hrs, Volume= 20.992 af
Outflow = 104.80 cfs @ 12.25 hrs, Volume= 20.972 af, Atten= 1%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.82 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 2.15 fps, Avg. Travel Time= 6.9 min

Peak Storage= 13,674 cf @ 12.25 hrs
Average Depth at Peak Storage= 1.65'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 337.94 cfs

6.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 889.8' Slope= 0.0158 '/'
Inlet Invert= 412.00', Outlet Invert= 397.97'

Reach 77R: To Green River (WEST UPPER 1)



Hydrograph for Reach 77R: To Green River (WEST UPPER 1)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	412.00	0.00
1.00	0.40	302	412.06	0.31
2.00	0.61	451	412.08	0.59
3.00	0.68	494	412.09	0.68
4.00	0.72	511	412.09	0.72
5.00	0.77	530	412.10	0.76
6.00	0.82	551	412.10	0.82
7.00	1.01	620	412.11	0.99
8.00	1.37	741	412.13	1.31
9.00	2.63	1,118	412.20	2.52
10.00	3.52	1,361	412.24	3.44
11.00	5.97	1,890	412.32	5.74
12.00	**71.58**	**9,463**	**413.25**	**62.45**
13.00	**31.35**	**5,989**	**412.87**	**32.39**
14.00	19.36	4,259	412.65	19.65
15.00	14.59	3,510	412.55	14.74
16.00	11.70	3,033	412.49	11.83
17.00	9.75	2,682	412.44	9.82
18.00	8.56	2,462	412.41	8.62
19.00	7.55	2,268	412.38	7.60
20.00	6.59	2,079	412.35	6.65
21.00	5.95	1,942	412.33	5.98
22.00	5.62	1,868	412.32	5.64
23.00	5.36	1,812	412.31	5.38
24.00	5.14	1,764	412.30	5.15
25.00	2.33	1,089	412.19	2.42
26.00	1.81	916	412.16	1.84
27.00	1.74	885	412.16	1.74
28.00	1.74	885	412.16	1.74
29.00	1.74	885	412.16	1.74
30.00	1.74	885	412.16	1.74
31.00	1.74	885	412.16	1.74
32.00	1.74	885	412.16	1.74
33.00	1.74	885	412.16	1.74
34.00	1.74	885	412.16	1.74
35.00	1.74	885	412.16	1.74
36.00	1.74	885	412.16	1.74
37.00	1.74	885	412.16	1.74
38.00	1.74	885	412.16	1.74
39.00	1.74	885	412.16	1.74
40.00	1.74	885	412.16	1.74
41.00	1.74	885	412.16	1.74
42.00	1.74	885	412.16	1.74
43.00	1.74	885	412.16	1.74
44.00	1.74	885	412.16	1.74
45.00	1.74	885	412.16	1.74
46.00	1.74	885	412.16	1.74
47.00	1.74	885	412.16	1.74
48.00	1.74	885	412.16	1.74

Summary for Reach 81R: To Green River (WEST UPPER 2 - EG)

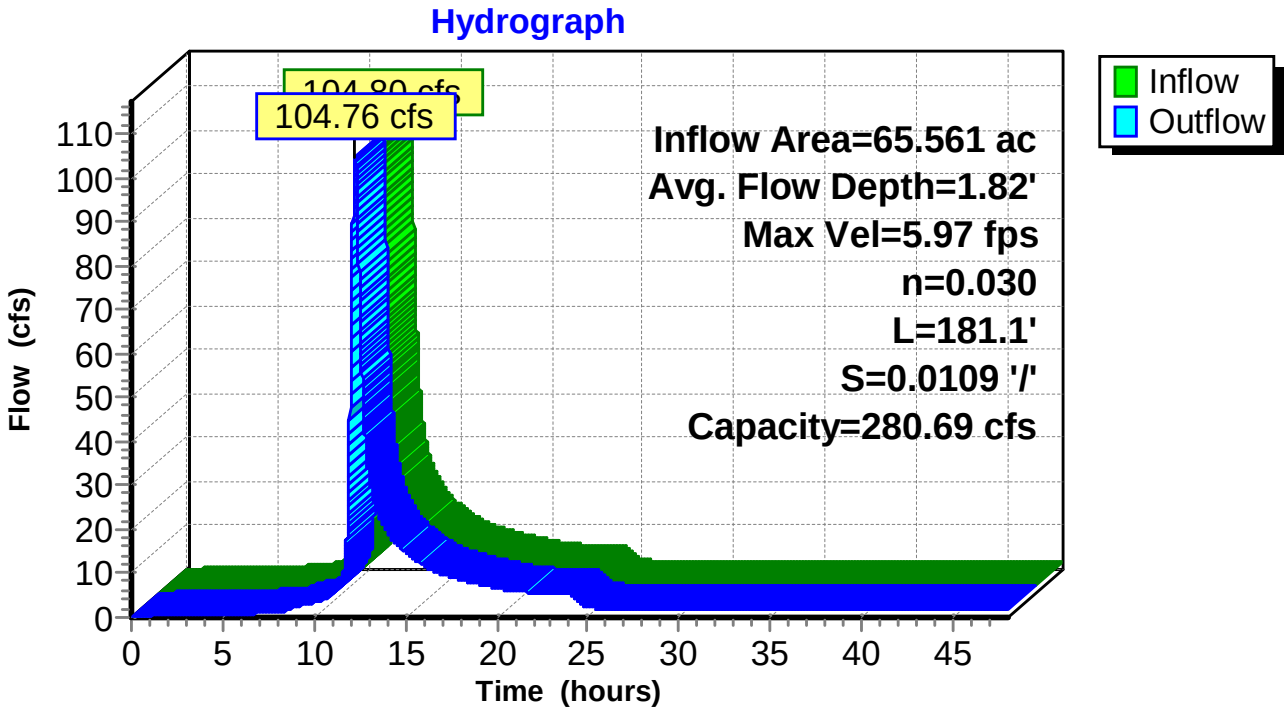
Inflow Area = 65.561 ac, 6.40% Impervious, Inflow Depth > 3.84" for 25 Year event
Inflow = 104.80 cfs @ 12.25 hrs, Volume= 20.972 af
Outflow = 104.76 cfs @ 12.26 hrs, Volume= 20.967 af, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.97 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.91 fps, Avg. Travel Time= 1.6 min

Peak Storage= 3,179 cf @ 12.26 hrs
Average Depth at Peak Storage= 1.82'
Bank-Full Depth= 3.00' Flow Area= 36.0 sf, Capacity= 280.69 cfs

6.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 18.00'
Length= 181.1' Slope= 0.0109 '/'
Inlet Invert= 391.97', Outlet Invert= 390.00'

Reach 81R: To Green River (WEST UPPER 2 - EG)



Hydrograph for Reach 81R: To Green River (WEST UPPER 2 - EG)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	391.97	0.00
1.00	0.31	66	392.03	0.29
2.00	0.59	103	392.06	0.59
3.00	0.68	112	392.07	0.67
4.00	0.72	116	392.07	0.72
5.00	0.76	121	392.08	0.76
6.00	0.82	126	392.08	0.81
7.00	0.99	141	392.09	0.98
8.00	1.31	168	392.12	1.30
9.00	2.52	254	392.19	2.50
10.00	3.44	311	392.23	3.42
11.00	5.74	431	392.32	5.69
12.00	**62.45**	**2,141**	**393.33**	**60.24**
13.00	**32.39**	**1,393**	**392.94**	**32.64**
14.00	19.65	985	392.70	19.71
15.00	14.74	810	392.59	14.77
16.00	11.83	700	392.51	11.86
17.00	9.82	618	392.46	9.83
18.00	8.62	567	392.42	8.63
19.00	7.60	522	392.39	7.61
20.00	6.65	478	392.36	6.66
21.00	5.98	446	392.34	5.98
22.00	5.64	429	392.32	5.64
23.00	5.38	416	392.31	5.38
24.00	5.15	405	392.31	5.16
25.00	2.42	251	392.19	2.44
26.00	1.84	210	392.15	1.84
27.00	1.74	203	392.15	1.74
28.00	1.74	203	392.15	1.74
29.00	1.74	203	392.15	1.74
30.00	1.74	203	392.15	1.74
31.00	1.74	203	392.15	1.74
32.00	1.74	203	392.15	1.74
33.00	1.74	203	392.15	1.74
34.00	1.74	203	392.15	1.74
35.00	1.74	203	392.15	1.74
36.00	1.74	203	392.15	1.74
37.00	1.74	203	392.15	1.74
38.00	1.74	203	392.15	1.74
39.00	1.74	203	392.15	1.74
40.00	1.74	203	392.15	1.74
41.00	1.74	203	392.15	1.74
42.00	1.74	203	392.15	1.74
43.00	1.74	203	392.15	1.74
44.00	1.74	203	392.15	1.74
45.00	1.74	203	392.15	1.74
46.00	1.74	203	392.15	1.74
47.00	1.74	203	392.15	1.74
48.00	1.74	203	392.15	1.74

Summary for Reach 97R: Cell 3: Drain to Outfall 16

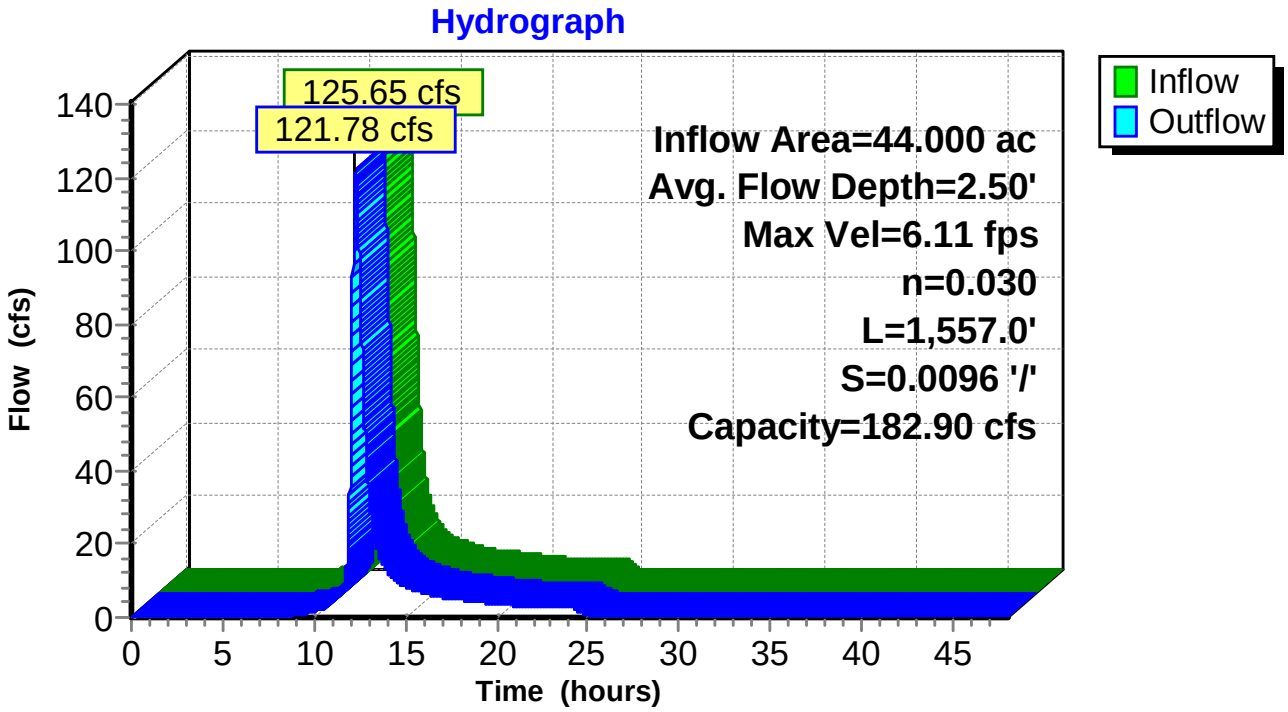
Inflow Area = 44.000 ac, 0.00% Impervious, Inflow Depth = 3.76" for 25 Year event
Inflow = 125.65 cfs @ 12.21 hrs, Volume= 13.772 af
Outflow = 121.78 cfs @ 12.27 hrs, Volume= 13.772 af, Atten= 3%, Lag= 3.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.11 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 1.89 fps, Avg. Travel Time= 13.7 min

Peak Storage= 31,043 cf @ 12.27 hrs
Average Depth at Peak Storage= 2.50'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 182.90 cfs

3.00' x 3.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 15.00'
Length= 1,557.0' Slope= 0.0096 '/'
Inlet Invert= 415.00', Outlet Invert= 400.00'

Reach 97R: Cell 3: Drain to Outfall 16



Hydrograph for Reach 97R: Cell 3: Drain to Outfall 16

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	415.00	0.00
1.00	0.00	0	415.00	0.00
2.00	0.00	0	415.00	0.00
3.00	0.00	0	415.00	0.00
4.00	0.00	0	415.00	0.00
5.00	0.00	0	415.00	0.00
6.00	0.00	0	415.00	0.00
7.00	0.00	0	415.00	0.00
8.00	0.12	69	415.01	0.02
9.00	0.79	720	415.14	0.57
10.00	1.88	1,452	415.26	1.67
11.00	4.74	2,715	415.45	4.20
12.00	**68.00**	**15,322**	**416.59**	**46.97**
13.00	**30.42**	**12,260**	**416.37**	**34.68**
14.00	11.84	5,861	415.81	12.54
15.00	8.23	4,417	415.66	8.43
16.00	6.53	3,761	415.58	6.71
17.00	5.42	3,271	415.52	5.50
18.00	4.81	3,010	415.49	4.88
19.00	4.20	2,749	415.45	4.28
20.00	3.59	2,473	415.41	3.67
21.00	3.23	2,279	415.39	3.25
22.00	3.11	2,215	415.38	3.12
23.00	2.99	2,157	415.37	3.00
24.00	2.87	2,099	415.36	2.88
25.00	0.17	642	415.13	0.48
26.00	0.00	157	415.03	0.05
27.00	0.00	54	415.01	0.02
28.00	0.00	19	415.00	0.01
29.00	0.00	6	415.00	0.00
30.00	0.00	2	415.00	0.00
31.00	0.00	1	415.00	0.00
32.00	0.00	0	415.00	0.00
33.00	0.00	0	415.00	0.00
34.00	0.00	0	415.00	0.00
35.00	0.00	0	415.00	0.00
36.00	0.00	0	415.00	0.00
37.00	0.00	0	415.00	0.00
38.00	0.00	0	415.00	0.00
39.00	0.00	0	415.00	0.00
40.00	0.00	0	415.00	0.00
41.00	0.00	0	415.00	0.00
42.00	0.00	0	415.00	0.00
43.00	0.00	0	415.00	0.00
44.00	0.00	0	415.00	0.00
45.00	0.00	0	415.00	0.00
46.00	0.00	0	415.00	0.00
47.00	0.00	0	415.00	0.00
48.00	0.00	0	415.00	0.00

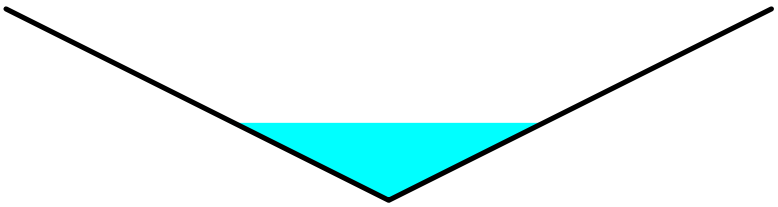
Summary for Reach 103R: Cell 4: Drain to Outfall 16

Inflow Area = 1.180 ac, 0.00% Impervious, Inflow Depth = 3.76" for 25 Year event
Inflow = 4.85 cfs @ 12.13 hrs, Volume= 0.369 af
Outflow = 4.10 cfs @ 12.22 hrs, Volume= 0.369 af, Atten= 15%, Lag= 5.5 min

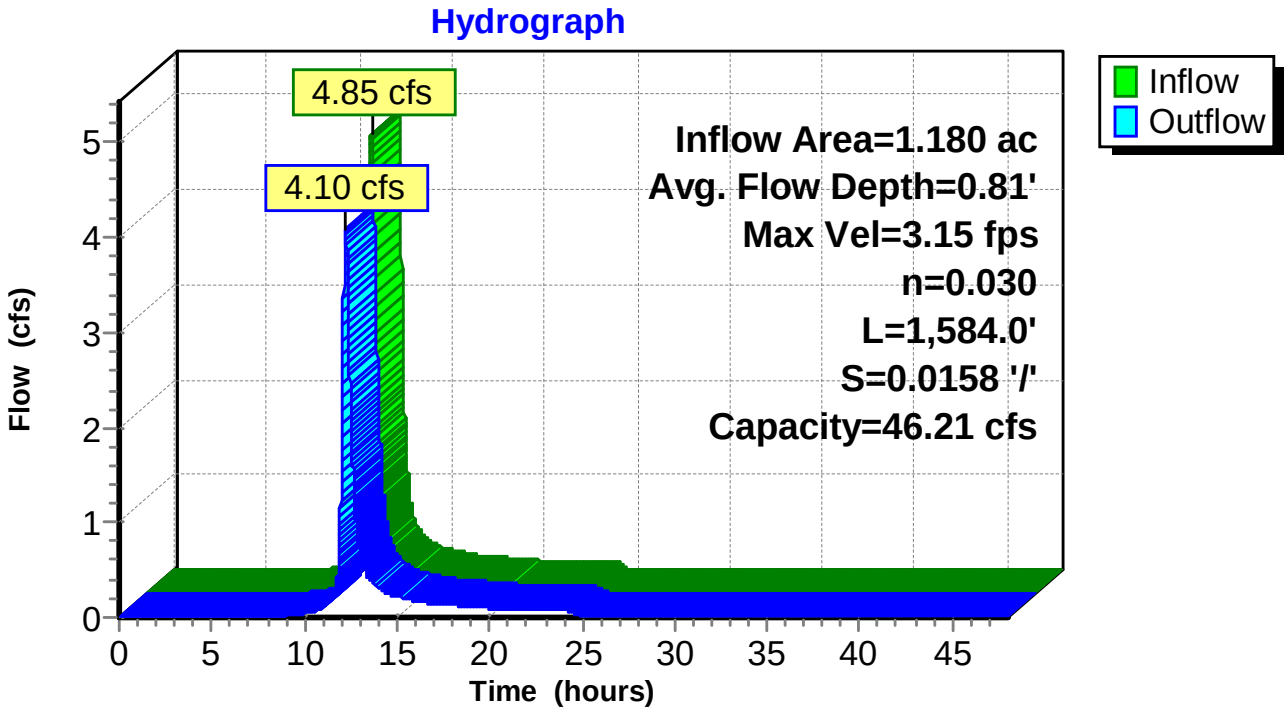
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.15 fps, Min. Travel Time= 8.4 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 24.9 min

Peak Storage= 2,061 cf @ 12.22 hrs
Average Depth at Peak Storage= 0.81'
Bank-Full Depth= 2.00' Flow Area= 8.0 sf, Capacity= 46.21 cfs

0.00' x 2.00' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 1,584.0' Slope= 0.0158 '/'
Inlet Invert= 420.00', Outlet Invert= 395.00'



Reach 103R: Cell 4: Drain to Outfall 16



Hydrograph for Reach 103R: Cell 4: Drain to Outfall 16

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	420.00	0.00
1.00	0.00	0	420.00	0.00
2.00	0.00	0	420.00	0.00
3.00	0.00	0	420.00	0.00
4.00	0.00	0	420.00	0.00
5.00	0.00	0	420.00	0.00
6.00	0.00	0	420.00	0.00
7.00	0.00	0	420.00	0.00
8.00	0.00	3	420.03	0.00
9.00	0.03	31	420.10	0.02
10.00	0.06	70	420.15	0.04
11.00	0.15	143	420.21	0.12
12.00	**3.21**	**1,039**	**420.57**	**1.65**
13.00	**0.52**	**542**	**420.41**	**0.69**
14.00	0.28	298	420.31	0.31
15.00	0.21	231	420.27	0.22
16.00	0.17	195	420.25	0.18
17.00	0.14	169	420.23	0.15
18.00	0.13	155	420.22	0.13
19.00	0.11	140	420.21	0.11
20.00	0.09	125	420.20	0.10
21.00	0.09	114	420.19	0.09
22.00	0.08	111	420.19	0.08
23.00	0.08	108	420.18	0.08
24.00	0.08	105	420.18	0.08
25.00	0.00	27	420.09	0.01
26.00	0.00	7	420.05	0.00
27.00	0.00	3	420.03	0.00
28.00	0.00	1	420.02	0.00
29.00	0.00	1	420.01	0.00
30.00	0.00	0	420.01	0.00
31.00	0.00	0	420.00	0.00
32.00	0.00	0	420.00	0.00
33.00	0.00	0	420.00	0.00
34.00	0.00	0	420.00	0.00
35.00	0.00	0	420.00	0.00
36.00	0.00	0	420.00	0.00
37.00	0.00	0	420.00	0.00
38.00	0.00	0	420.00	0.00
39.00	0.00	0	420.00	0.00
40.00	0.00	0	420.00	0.00
41.00	0.00	0	420.00	0.00
42.00	0.00	0	420.00	0.00
43.00	0.00	0	420.00	0.00
44.00	0.00	0	420.00	0.00
45.00	0.00	0	420.00	0.00
46.00	0.00	0	420.00	0.00
47.00	0.00	0	420.00	0.00
48.00	0.00	0	420.00	0.00

Letdown Design

Storm Water Calculations

AECOM

Job	TVA PAF: CCR Proposed Landfill (Cell 1)	Project No.	60549496	Sheet	1 of 3
Description	Letdown Design	Computed by	FS	Date	01/26/2018
		Checked by	YC	Date	02/15/2018

I. PURPOSE

The purpose of this analysis is to design the proposed landfill cap letdown channels as applicable at Tennessee Valley Authority's (TVA) Paradise Fossil Plant (PAF) consistent with CCR Rule.

II. SITE AND PROJECT DESCRIPTION

The letdown design was performed for the new proposed landfill facility located at TVA PAF in Muhlenberg County, Kentucky. The proposed site is designed as a new landfill through the EPA Final Coal Combustion Residuals (CCR) rule: Federal Register/ Vol. 80/ No. 74 / Part II. The following sections summarize the design criteria, procedure, assumptions, and results of the letdown design.

III. REGULATORY REQUIREMENTS / DESIGN CRITERIA

The below parts of the Final CCR Rule specify requirements for the design of the letdowns:

Rule §257.81(a)(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

Rule §257.81(a)(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

The results of the analysis presented herein show that the letdowns are designed to collect and control at least the peak flow resulting from a 25-year/24-hour storm so that storm water is diverted appropriately. The letdown channels will convey landfill run-off flow towards the perimeter channels. Proper channel lining will be selected based on anticipated velocities such that erosion within the letdowns will be significantly reduced.

IV. PROCEDURE

Design of the landfill site stormwater features was an iterative process beginning with basic assumptions and a proposed grading plan for the site. The hydraulic features of the letdowns were initially assumed and then confirmed through multiple iterations.

The AutoCAD Civil 3D software package was used to generate the proposed site grading plan and subsequently to determine drainage areas, volumes, and other site geometry. HydroCAD (version 10) modeling software was used to conduct the hydrologic and hydraulic calculations for this analysis with inputs based on the site geometry, rainfall data, and other design assumptions.

The model was used to generate peak flow rates, velocities, and water surface elevations at the outlets of the letdowns for the design storm conditions and based on upstream watershed features of the landfill and the letdown design parameters. The proposed letdowns will pass flows equal to and lesser than those generated by the 24-hour, 25-year storm.

The shear stress was calculated for each letdown reach to confirm the type of ditch lining selected. Actual shear stress was calculated by the following equation:

$\tau_{ac} = 62.4 * D * S$

where,

D = water surface depth, ft

S = channel slope, ft/ft

τ_{ac} = Actual shear stress, lbs/ft^2

V. NOTES/ASSUMPTIONS

The following is a list of key notes and assumptions made in completing this analysis.

- A design parameter minimum six (6) inches of freeboard was used.
- Within the HydroCAD program, the runoff was calculated using the SCS TR-20 method.
- Runoff curve numbers (CN) used in the analysis were as follows:
    - 74 for landfill vegetated cover and offsite areas, and

- 89 for access roads.

· The time of concentration was calculated using the Curve Number Method in HydroCAD which takes inputs for each drainage area of the longest hydraulic flow path and average land slope.

VI. SUMMARY OF RESULTS

The results of the letdowns design are summarized in Table 1 (see also Attachment B3 for the HydroCAD output report). The letdowns properly control and convey the water volume generated by the 24-hour, 25-year storm such that the average flow depth stays safely below the impounding sideslopes with greater than six inches of freeboard. A channel lining of Grouted RIPRAP was chosen for all letdowns as the peak velocity ranged from 4.83 to 7.61 fps and the actual shear stress ranged from 2.88 to 6.55 lbs/ft^2.

VII. CONCLUSIONS

The proposed grading of the landfill site (Cell 1) in combination with the design of the letdowns as presented above is sufficient to safely control and convey the 24-hour, 25-year storm as stipulated by EPA Final Coal Combustion Residuals (CCR) Rule: Federal Register/ Vol. 80/ No. 74 / Part II. The check dams and D_{50}=18" Grouted RIPRAP lining would be appropriate and recommended for this site. Refer to accompanying calculations used to design upstream (storm water terraces) and downstream (perimeter channels, culverts, and sediment basins) conveyance features.

VIII. ATTACHMENTS

Tables:

Table 1: Letdown Summary

Attachments:

Attachment B3: HydroCAD Report for Letdowns Design

IX. REFERENCES

EPA Final Coal Combustion Residuals (CCR) Rules: Federal Register/ Vol. 80/ No. 74 /Part II. Hazardous and Solid Waste Management System; Disposal of Coal, April 17, 2015

TABLE 1

Letdown Summary

Table 1 - Letdown Summary

	Channel Properties										Hydraulic Summary				
Letdown ID	**Mannings Coefficient**	**Depth (ft)**	**Left Side Slope (H:V)**	**Bottom Width (ft)**	**Right Side Slope (H:V)**	**Invert Elevation (ft)**	**Outlet Elevation (ft)**	**Length (ft)**	**Average Slope (%)**	**Average Slope (ft/ft)**	**25-YR/24-Hr. Inflow (cfs)**	**Max. Velocity (fps)**	**Average Water Surface Depth (ft)**	**Actual Shear Stress (lbs/ft^2)**	**Proposed Channel Lining**
53R: SW Letdown - EDITED	0.05	2	2	20	2	485.00	445.60	149.30	26.39%	0.2639	28.05	5.75	0.24	3.95	GROUTED RIPRAP (D_{50}=18")
60R: NW Letdown - EDITED	0.05	2	2	20	2	485.00	452.00	157.40	20.97%	0.2097	21.40	4.83	0.22	2.88	GROUTED RIPRAP (D_{50}=18")
93R: Temporary Letdown	0.05	2	2	5	2	460.00	452.00	38.10	21.00%	0.2100	23.06	7.61	0.50	6.55	GROUTED RIPRAP (D_{50}=18")

ATTACHMENT A3

HydroCAD Report for Letdown Design

Summary for Reach 53R: SW Letdown - EDITED

Inflow Area = 7.120 ac, 0.00% Impervious, Inflow Depth = 3.76" for 25 Year event
Inflow = 28.05 cfs @ 12.01 hrs, Volume= 2.228 af
Outflow = 28.02 cfs @ 12.02 hrs, Volume= 2.228 af, Atten= 0%, Lag= 0.3 min

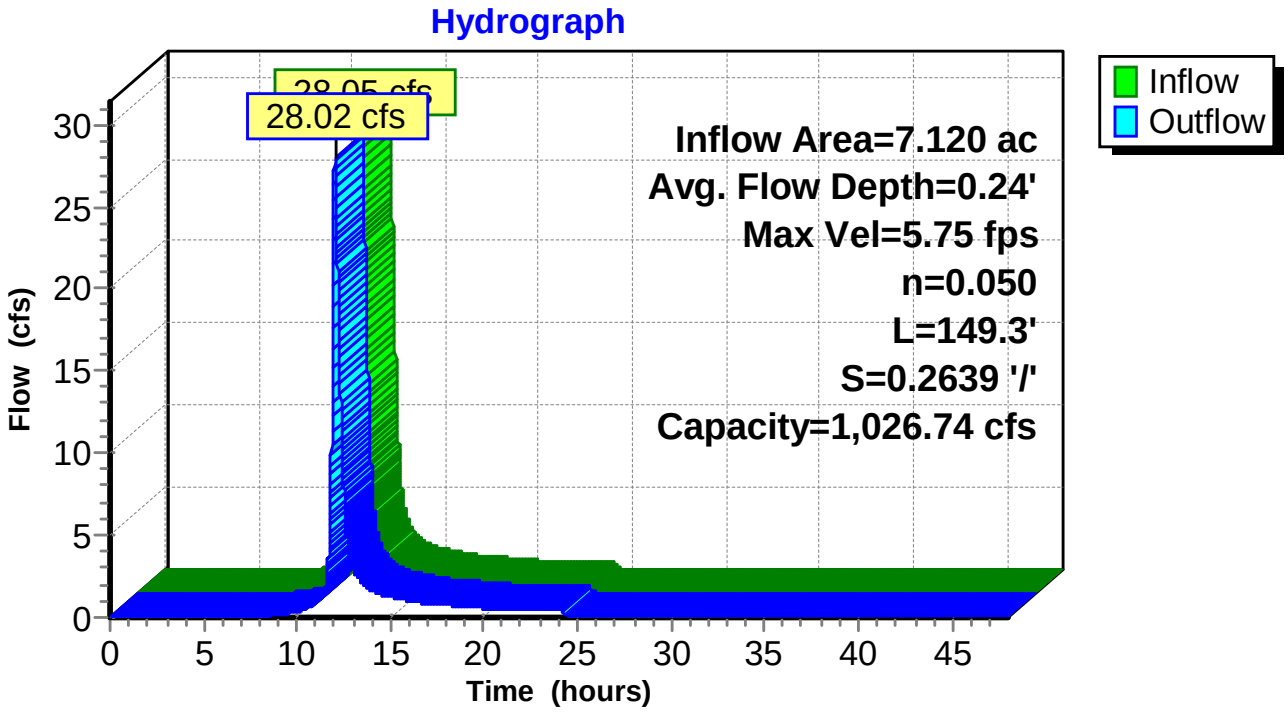
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.75 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.57 fps, Avg. Travel Time= 1.6 min

Peak Storage= 727 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 2.00' Flow Area= 48.0 sf, Capacity= 1,026.74 cfs

20.00' x 2.00' deep channel, n= 0.050
Side Slope Z-value= 2.0 '/' Top Width= 28.00'
Length= 149.3' Slope= 0.2639 '/'
Inlet Invert= 485.00', Outlet Invert= 445.60'

‡

Reach 53R: SW Letdown - EDITED



Hydrograph for Reach 53R: SW Letdown - EDITED

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	485.00	0.00
1.00	0.00	0	485.00	0.00
2.00	0.00	0	485.00	0.00
3.00	0.00	0	485.00	0.00
4.00	0.00	0	485.00	0.00
5.00	0.00	0	485.00	0.00
6.00	0.00	0	485.00	0.00
7.00	0.00	0	485.00	0.00
8.00	0.04	4	485.00	0.03
9.00	0.17	21	485.01	0.16
10.00	0.37	47	485.02	0.36
11.00	0.96	90	485.03	0.95
12.00	**27.87**	**722**	**485.24**	**27.70**
13.00	**2.98**	**187**	**485.06**	**3.01**
14.00	1.65	130	485.04	1.66
15.00	1.26	110	485.04	1.26
16.00	0.99	93	485.03	0.99
17.00	0.85	84	485.03	0.85
18.00	0.75	79	485.03	0.76
19.00	0.66	73	485.02	0.66
20.00	0.56	66	485.02	0.56
21.00	0.52	64	485.02	0.52
22.00	0.50	63	485.02	0.50
23.00	0.48	62	485.02	0.48
24.00	0.46	60	485.02	0.46
25.00	0.00	0	485.00	0.00
26.00	0.00	0	485.00	0.00
27.00	0.00	0	485.00	0.00
28.00	0.00	0	485.00	0.00
29.00	0.00	0	485.00	0.00
30.00	0.00	0	485.00	0.00
31.00	0.00	0	485.00	0.00
32.00	0.00	0	485.00	0.00
33.00	0.00	0	485.00	0.00
34.00	0.00	0	485.00	0.00
35.00	0.00	0	485.00	0.00
36.00	0.00	0	485.00	0.00
37.00	0.00	0	485.00	0.00
38.00	0.00	0	485.00	0.00
39.00	0.00	0	485.00	0.00
40.00	0.00	0	485.00	0.00
41.00	0.00	0	485.00	0.00
42.00	0.00	0	485.00	0.00
43.00	0.00	0	485.00	0.00
44.00	0.00	0	485.00	0.00
45.00	0.00	0	485.00	0.00
46.00	0.00	0	485.00	0.00
47.00	0.00	0	485.00	0.00
48.00	0.00	0	485.00	0.00

Summary for Reach 60R: NW Letdown - EDITED

Inflow Area = 4.820 ac, 0.00% Impervious, Inflow Depth = 3.76" for 25 Year event
Inflow = 21.40 cfs @ 12.10 hrs, Volume= 1.509 af
Outflow = 21.36 cfs @ 12.11 hrs, Volume= 1.509 af, Atten= 0%, Lag= 0.4 min

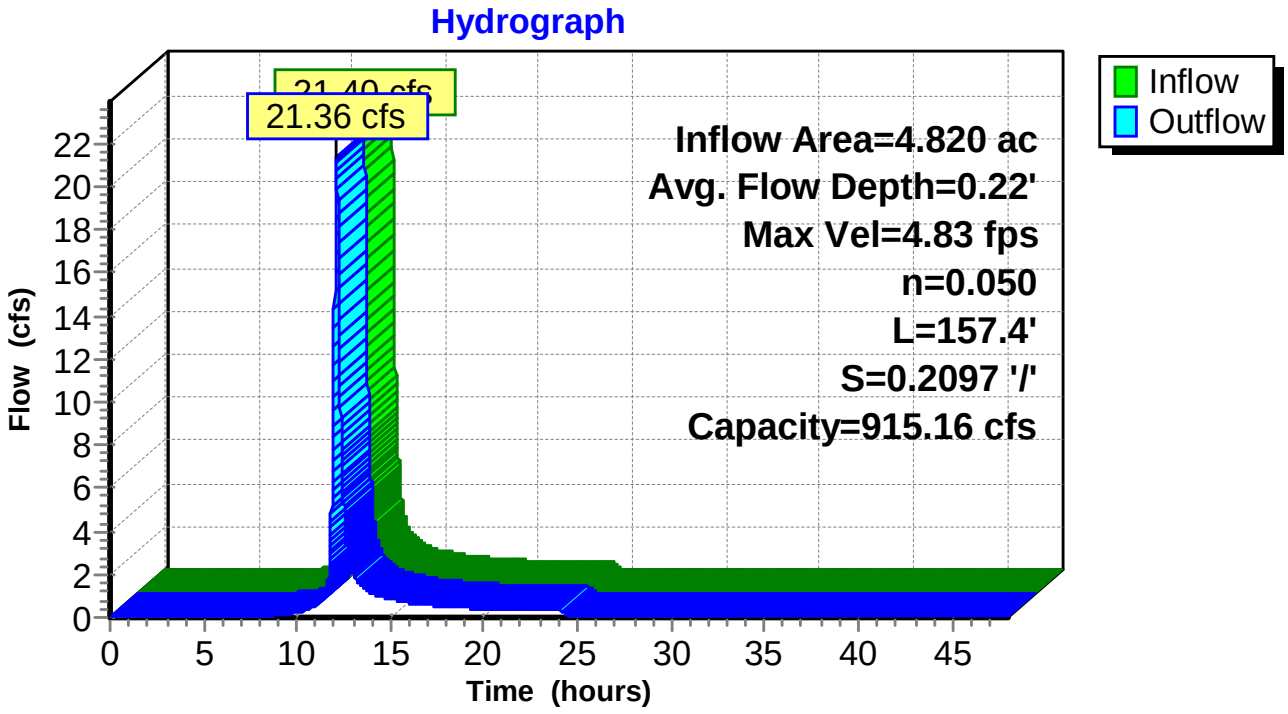
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.83 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 2.0 min

Peak Storage= 696 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 2.00' Flow Area= 48.0 sf, Capacity= 915.16 cfs

20.00' x 2.00' deep channel, n= 0.050
Side Slope Z-value= 2.0 '/' Top Width= 28.00'
Length= 157.4' Slope= 0.2097 '/'
Inlet Invert= 485.00', Outlet Invert= 452.00'

‡

Reach 60R: NW Letdown - EDITED



Hydrograph for Reach 60R: NW Letdown - EDITED

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	485.00	0.00
1.00	0.00	0	485.00	0.00
2.00	0.00	0	485.00	0.00
3.00	0.00	0	485.00	0.00
4.00	0.00	0	485.00	0.00
5.00	0.00	0	485.00	0.00
6.00	0.00	0	485.00	0.00
7.00	0.00	0	485.00	0.00
8.00	0.02	3	485.00	0.02
9.00	0.11	16	485.01	0.10
10.00	0.24	37	485.01	0.23
11.00	0.63	79	485.03	0.62
12.00	**15.75**	**566**	**485.18**	**15.19**
13.00	**1.99**	**164**	**485.05**	**2.01**
14.00	1.13	117	485.04	1.14
15.00	0.86	96	485.03	0.86
16.00	0.67	83	485.03	0.68
17.00	0.58	76	485.02	0.58
18.00	0.51	71	485.02	0.51
19.00	0.45	66	485.02	0.45
20.00	0.38	60	485.02	0.38
21.00	0.35	55	485.02	0.35
22.00	0.34	53	485.02	0.34
23.00	0.32	51	485.02	0.32
24.00	0.31	49	485.02	0.31
25.00	0.00	0	485.00	0.00
26.00	0.00	0	485.00	0.00
27.00	0.00	0	485.00	0.00
28.00	0.00	0	485.00	0.00
29.00	0.00	0	485.00	0.00
30.00	0.00	0	485.00	0.00
31.00	0.00	0	485.00	0.00
32.00	0.00	0	485.00	0.00
33.00	0.00	0	485.00	0.00
34.00	0.00	0	485.00	0.00
35.00	0.00	0	485.00	0.00
36.00	0.00	0	485.00	0.00
37.00	0.00	0	485.00	0.00
38.00	0.00	0	485.00	0.00
39.00	0.00	0	485.00	0.00
40.00	0.00	0	485.00	0.00
41.00	0.00	0	485.00	0.00
42.00	0.00	0	485.00	0.00
43.00	0.00	0	485.00	0.00
44.00	0.00	0	485.00	0.00
45.00	0.00	0	485.00	0.00
46.00	0.00	0	485.00	0.00
47.00	0.00	0	485.00	0.00
48.00	0.00	0	485.00	0.00

Summary for Reach 93R: Temporary Letdown

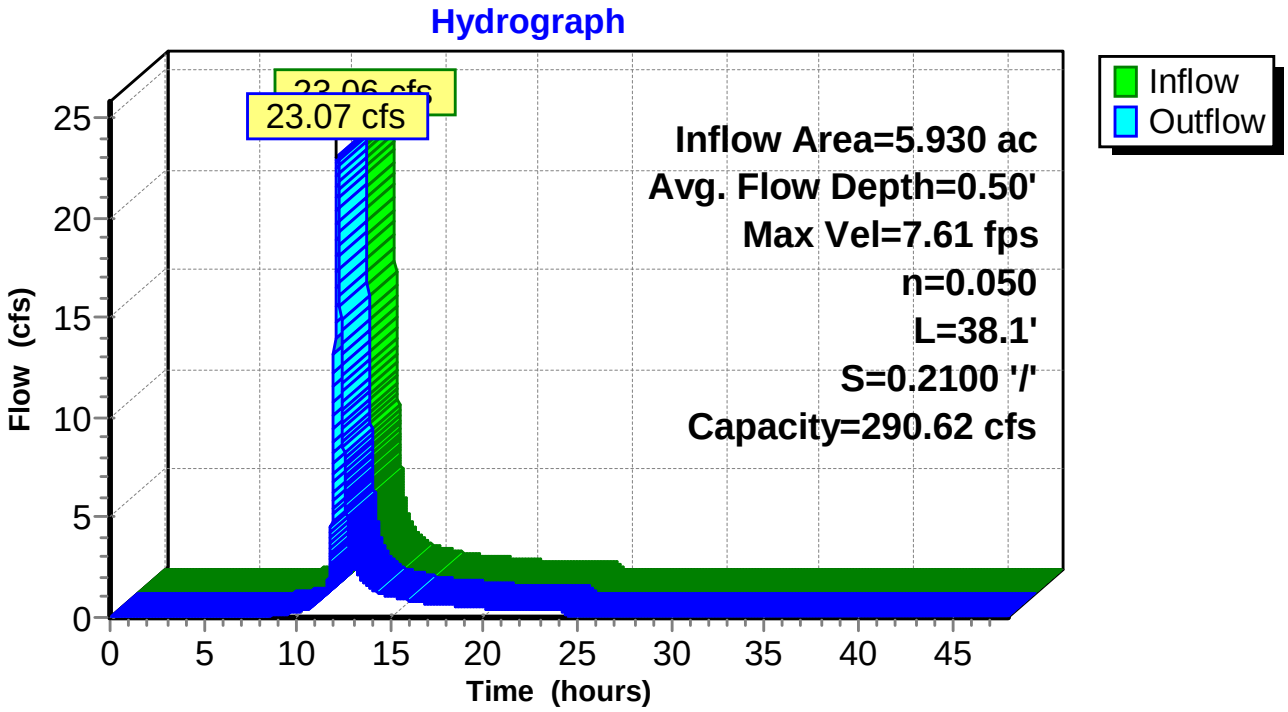
Inflow Area = 5.930 ac, 0.00% Impervious, Inflow Depth = 3.76" for 25 Year event
Inflow = 23.06 cfs @ 12.16 hrs, Volume= 1.856 af
Outflow = 23.07 cfs @ 12.16 hrs, Volume= 1.856 af, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.61 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.16 fps, Avg. Travel Time= 0.3 min

Peak Storage= 115 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.50'
Bank-Full Depth= 2.00' Flow Area= 18.0 sf, Capacity= 290.62 cfs

5.00' x 2.00' deep channel, n= 0.050
Side Slope Z-value= 2.0 '/' Top Width= 13.00'
Length= 38.1' Slope= 0.2100 '/'
Inlet Invert= 460.00', Outlet Invert= 452.00'

Reach 93R: Temporary Letdown



Hydrograph for Reach 93R: Temporary Letdown

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	460.00	0.00
1.00	0.00	0	460.00	0.00
2.00	0.00	0	460.00	0.00
3.00	0.00	0	460.00	0.00
4.00	0.00	0	460.00	0.00
5.00	0.00	0	460.00	0.00
6.00	0.00	0	460.00	0.00
7.00	0.00	0	460.00	0.00
8.00	0.02	1	460.00	0.02
9.00	0.12	4	460.02	0.12
10.00	0.28	7	460.04	0.28
11.00	0.73	13	460.06	0.72
12.00	**14.03**	**83**	**460.38**	**13.94**
13.00	**2.75**	**29**	**460.14**	**2.75**
14.00	1.44	19	460.10	1.44
15.00	1.07	16	460.08	1.07
16.00	0.85	14	460.07	0.85
17.00	0.72	13	460.06	0.72
18.00	0.64	12	460.06	0.64
19.00	0.55	11	460.06	0.55
20.00	0.47	10	460.05	0.47
21.00	0.43	9	460.05	0.43
22.00	0.42	9	460.05	0.42
23.00	0.40	9	460.05	0.40
24.00	0.38	9	460.04	0.38
25.00	0.00	0	460.00	0.00
26.00	0.00	0	460.00	0.00
27.00	0.00	0	460.00	0.00
28.00	0.00	0	460.00	0.00
29.00	0.00	0	460.00	0.00
30.00	0.00	0	460.00	0.00
31.00	0.00	0	460.00	0.00
32.00	0.00	0	460.00	0.00
33.00	0.00	0	460.00	0.00
34.00	0.00	0	460.00	0.00
35.00	0.00	0	460.00	0.00
36.00	0.00	0	460.00	0.00
37.00	0.00	0	460.00	0.00
38.00	0.00	0	460.00	0.00
39.00	0.00	0	460.00	0.00
40.00	0.00	0	460.00	0.00
41.00	0.00	0	460.00	0.00
42.00	0.00	0	460.00	0.00
43.00	0.00	0	460.00	0.00
44.00	0.00	0	460.00	0.00
45.00	0.00	0	460.00	0.00
46.00	0.00	0	460.00	0.00
47.00	0.00	0	460.00	0.00
48.00	0.00	0	460.00	0.00

Terrace Design

Storm Water Calculations

AECOM

Job	TVA PAF: CCR Proposed Landfill (Cell 1)	Project No.	60549496	Sheet	1 of 3
Description	Terrace Design	Computed by	FS	Date	01/26/2018
		Checked by	YC	Date	02/15/2018

I. PURPOSE

The purpose of this analysis is to design the proposed landfill cap terrace channels as applicable at Tennessee Valley Authority's (TVA) Paradise Fossil Plant (PAF) consistent with CCR Rule..

II. SITE AND PROJECT DESCRIPTION

The terrace design was performed for the new proposed landfill facility (Cell 1) located at TVA PAF in Muhlenberg County, Kentucky. The proposed site is designed as a new landfill through the EPA Final Coal Combustion Residuals (CCR) rule: Federal Register/ Vol. 80/ No. 74 / Part II.

The following sections summarize the design criteria, procedure, assumptions, and results of the terrace design.

III. REGULATORY REQUIREMENTS / DESIGN CRITERIA

The below parts of the Final CCR rule specify requirements for the design of terraces.

Rule §257.81(a)(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

Rule §257.81(a)(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.

The result of the analysis presented herein show that the terrace is designed to collect and control at least the peak flow resulting from a 25-year/24-hour storm so that storm water is diverted appropriately. The terrace channel will convey landfill cell 1 run-off flow towards the letdown channels. Proper channel lining will be selected based on anticipated velocities such that erosion within the terrace channels will be significantly reduced.

IV. PROCEDURE

Design of the landfill site stormwater features was an iterative process beginning with basic assumptions and a proposed grading plan for the site. The hydraulic features of the terraces were initially assumed and then confirmed through analysis.

The AutoCAD Civil 3D software package was used to generate the proposed site grading plan and subsequently to determine drainage areas, volumes, and other site geometry. HydroCAD (version 10) modeling software was used to conduct the hydrologic and hydraulic calculations for this analysis with inputs based on the site geometry, rainfall data, and other design assumptions.

A select terrace was modeled based on drainage area/length and channel slope.

The model was used to generate peak flow rates, velocities, and water surface elevations at the outlets of the letdowns for the design storm conditions and based on upstream watershed features of the landfill cap surface and the terrace design parameters. The proposed terrace will pass all flows equal to and lesser than those generated by the 24-hour, 25-year storm.

The shear stress was calculated for each letdown reach to confirm the type of ditch lining selected. Actual shear stress was calculated by the following equation:

$\tau_{ac} = 62.4 * D * S$

where,

D = water surface depth, ft

S = channel slope, ft/ft

τ_{ac} = Actual shear stress, lbs/ft^2

V. NOTES/ASSUMPTIONS

The following is a list of key notes and assumptions made in completing this analysis.

- The terrace was designed based on the worst case velocity and depth among the selected candidates in order to be conservative.
- A design parameter minimum six (6) inches of freeboard was used.

- Within the HydroCAD program, the runoff was calculated using the SCS TR-20 method.
- Runoff curve numbers (CN) used in the analysis were as follows:
    - 74 for landfill vegetated cover.
- The time of concentration was calculated using the Sheet Flow Method in HydroCAD which takes inputs for each drainage area of the longest hydraulic flow path, land slope, and surface description.

VI. SUMMARY OF RESULTS

The result of the terrace design is summarized in Table 1 (see also Attachment B4 for the HydroCAD output report). The terrace properly controls and conveys the water volume generated by the 24-hour, 25-year storm such that the average flow depth stays safely below the impounding sideslopes with much greater than six (6) inches of freeboard. A channel lining of grass was chosen for terrace as the peak velocity is 3.42 fps and the actual shear stress is 0.79 lbs/ft^2.

VII. CONCLUSIONS

The proposed grading of the landfill site (Cell 1) in combination with the design of the terrace as presented above is sufficient to safely control and convey the 24-hour, 25-year storm as stipulated by the CCR Rule. Refer to accompanying calculations used to design downstream conveyance features (letdowns, perimeter channels, culverts, and sediment basins).

VIII. ATTACHMENTS

Tables:
Table 1: Terrace Summary

Attachments:
Attachment B4: HydroCAD report for Terrace Design

IX. REFERENCES

EPA Final Coal Combustion Residuals (CCR) Rules: Federal Register/ Vol. 80/ No. 74 /Part II. Hazardous and Solid Waste Management System; Disposal of Coal, April 17, 2015

TABLE 1

Terrace Summary

Table 1 - Terrace Summary

	Channel Properties									Hydraulic Summary				Proposed Channel Lining
Channel ID	Mannings Coefficient	Depth (ft)	Left Side Slope (H:V)	Right Side Slope (H:V)	Invert Elevation	Outlet Elevation	Length	Average Slope (%)	Average Slope (ft/ft)	25-YR/24-Hr. Flow (cfs)	Max. Velocity (fps)	Average Water Surface Depth (ft)	Actual Shear Stress (lbs/ft^2)	
T1	0.03	2	7.5	3	490.00	460.00	2207	1.36%	0.0136	24.38	3.42	0.93	0.79	Grass

Attachment A4

HydroCAD report for Terrace Design

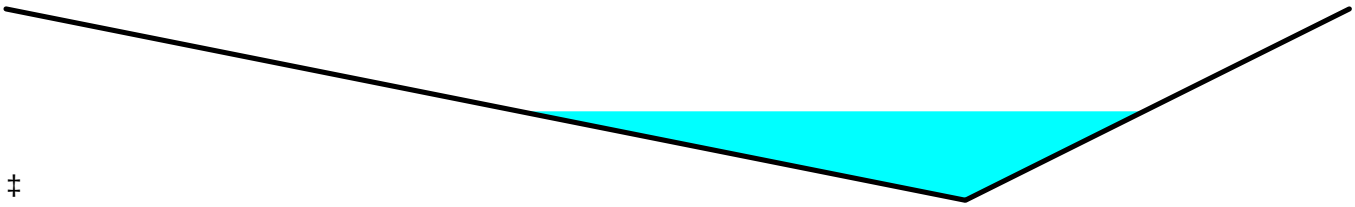
Summary for Reach T1: Terrace 1

Inflow Area = 3.400 ac, 0.00% Impervious, Inflow Depth = 3.76" for 25 Year event
Inflow = 24.38 cfs @ 11.95 hrs, Volume= 1.064 af
Outflow = 15.55 cfs @ 12.01 hrs, Volume= 1.064 af, Atten= 36%, Lag= 3.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.42 fps, Min. Travel Time= 10.8 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 39.3 min

Peak Storage= 10,039 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.93'
Bank-Full Depth= 2.00' Flow Area= 21.0 sf, Capacity= 119.55 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 7.5 3.0 '/' Top Width= 21.00'
Length= 2,207.0' Slope= 0.0136 '/'
Inlet Invert= 490.00', Outlet Invert= 460.00'



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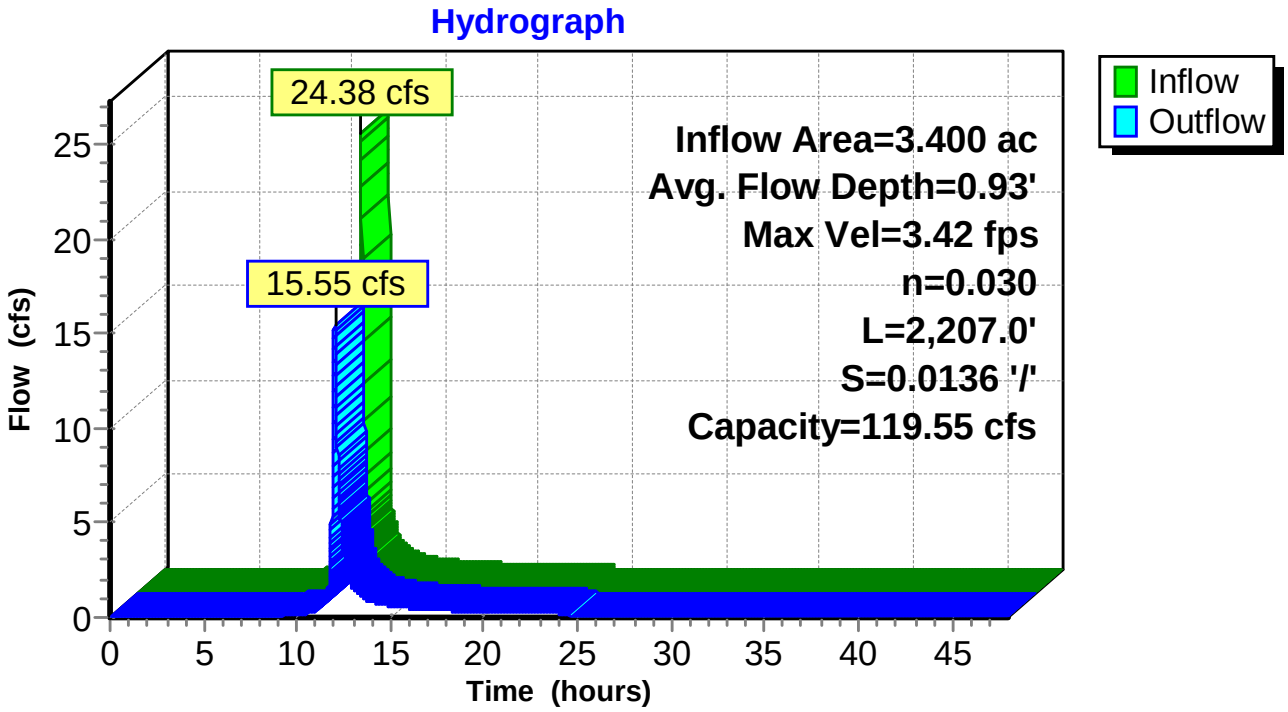
Reach T1: Terrace 1



Hydrograph for Reach T1: Terrace 1

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
0.00	0.00	0	490.00	0.00
1.00	0.00	0	490.00	0.00
2.00	0.00	0	490.00	0.00
3.00	0.00	0	490.00	0.00
4.00	0.00	0	490.00	0.00
5.00	0.00	0	490.00	0.00
6.00	0.00	0	490.00	0.00
7.00	0.00	0	490.00	0.00
8.00	0.02	24	490.04	0.01
9.00	0.10	141	490.11	0.05
10.00	0.20	303	490.16	0.15
11.00	**0.55**	651	490.24	0.41
12.00	**17.79**	**9,996**	**490.93**	**15.46**
13.00	1.18	**1,773**	**490.39**	**1.54**
14.00	0.72	1,111	490.31	0.83
15.00	0.58	892	490.28	0.62
16.00	0.45	749	490.25	0.49
17.00	0.40	661	490.24	0.41
18.00	0.35	604	490.23	0.37
19.00	0.30	546	490.22	0.32
20.00	0.26	485	490.20	0.27
21.00	0.25	452	490.20	0.25
22.00	0.24	438	490.19	0.24
23.00	0.23	426	490.19	0.23
24.00	0.22	413	490.19	0.22
25.00	0.00	100	490.09	0.03
26.00	0.00	36	490.06	0.01
27.00	0.00	17	490.04	0.00
28.00	0.00	9	490.03	0.00
29.00	0.00	5	490.02	0.00
30.00	0.00	3	490.01	0.00
31.00	0.00	2	490.01	0.00
32.00	0.00	1	490.01	0.00
33.00	0.00	1	490.00	0.00
34.00	0.00	1	490.00	0.00
35.00	0.00	0	490.00	0.00
36.00	0.00	0	490.00	0.00
37.00	0.00	0	490.00	0.00
38.00	0.00	0	490.00	0.00
39.00	0.00	0	490.00	0.00
40.00	0.00	0	490.00	0.00
41.00	0.00	0	490.00	0.00
42.00	0.00	0	490.00	0.00
43.00	0.00	0	490.00	0.00
44.00	0.00	0	490.00	0.00
45.00	0.00	0	490.00	0.00
46.00	0.00	0	490.00	0.00
47.00	0.00	0	490.00	0.00
48.00	0.00	0	490.00	0.00