SCS ENGINEERS

Run-On and Run-Off Control Plan
Phase 1, Module 1
Phase 1, Module 2
Phase 1, Module 3
Phase 1, Module 4

Columbia Dry Ash Disposal Facility

Prepared for:

Wisconsin Power and Light Company
Columbia Energy Center
W8375 Murray Road
Pardeeville, Wisconsin 53954

Prepared by:

SCS ENGINEERS
2830 Dairy Drive
Madison, Wisconsin 53718-6751
(608) 224-2830

October 2018
File No. 25217156.00

Offices Nationwide
www.scsengineers.com

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I:\25217156.00\Deliverables\Run-on and Run-off Control Plan\181004_Columbia Run-On and Run-Off Control Plan Amendment.docx

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PE CERTIFICATION

I, Eric J. Nelson, hereby certify that this Run-On and Run-Off Control Plan meets the requirements of 40 CFR 257.81(c), was prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Wisconsin.

10/12/18

(signature) (date)

Eric J. Nelson

(printed or typed name)

License number E-37855-6

My license renewal date is July 31, 2020.

Pages or sheets covered by this seal:

Run-On and Run-Off Control Plan, October 2018

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Run-on and Run-off Control Plan for the Columbia (COL) Dry Ash Disposal Facility in accordance with 40 CFR 257.81(c) as follows.

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 [section 257.81]. 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 section 257.105(g)(3)."*

The COL facility includes an active coal combustion residue (CCR) landfill, which currently consists of four CCR units, all located in Phase 1 of the facility.

- Phase 1, Module 1 – This unit has received final cover over completed outer sideslope areas that will no longer receive additional CCR; intermediate cover has been placed over remaining areas.
- Phase 1, Module 2 – This unit has received intermediate cover over a majority of the in-place CCR.
- Phase 1, Module 3 – This unit is currently being filled.
- Phase 1, Module 4 – This unit was constructed in 2018 and is approved by the Wisconsin Department of Natural Resources (WDNR) to receive CCR.

Phase 1, Module 4 is a new CCR landfill, as defined at 40 CFR 257.53. Future CCR units (Phase 1, Modules 5-6 and Phase 2, Modules 7-13) are permitted with the WDNR, but have not been developed. When developed, the units will also be new CCR landfills, as defined at 40 CFR 257.53.

This plan applies to Phase 1, Modules 1–4 only. Future CCR units are not discussed further herein.

Figure 1 shows the site location. **Figure 2** shows the run-on and run-off drainage areas.

2.0 RUN-ON AND RUN-OFF CONTROL PLAN

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."

The entire facility has run-on and run-off control in place, as approved by the WDNR. Run-on is controlled by berms and swales around the perimeter of the landfill that divert storm water away from the landfill to a sedimentation basin.

(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."

Run-off from the active portions of the facility is handled as contact water and is collected by a leachate collection system and internal swales, which route the contact water run-off to a lined contact water basin. The contact water in the basin is used for dust control or other actions within the active landfill or, if needed, is transported with a water wagon to the Primary Ash Pond at the generating station where it may be discharged in accordance with a Wisconsin Pollutant Discharge Elimination System (WPDES) permit.

Run-off from areas of the existing CCR units where final or intermediate cover is in place is diverted into the perimeter drainage swales, which drain to the South Sedimentation Basin. Intermediate swales/berms and downslope channels on the final cover help minimize erosion of the final cover. These features divert water to the perimeter drainage system, and ultimately to the on-site detention/sedimentation basin. Per 40 CFR 257.81(b), this is consistent with the surface water requirements under 40 CFR 257.3-3.

In addition to these controls, a temporary rain cover will be installed to limit leachate and contact water production when needed. Storm water collected on the rain cover will be diverted to perimeter swales, and ultimately to the sedimentation basin. The rain cover will be removed in sections to accommodate waste placement. As the rain cover is removed, new diversion berms will be constructed to form the perimeter of a storm water containment area. The berms will prevent contact water from running onto the rain cover and will anchor or ballast the rain cover at the new limits. When the rain cover has been fully removed, run-off will be controlled by the limits of the developed modules, and all water inside the lined waste limits will be considered and handled as contact water.

2.1 DESIGN CRITERIA

The storm water features described above are designed to handle run-on and run-off from a 25-year, 24-hour storm event, as required by 40 CFR 257.81(a)(1) and (2).

Table 1. Storm Water Updates

Year Conducted	Description of Update	Included in Appendix A
Run-On and Runoff		
2000	Run-on calculations performed as part of the 2000 Plan of Operation Update; performed assuming 25-year, 24-hour precipitation depth of 4.7 inches, based on Technical Paper-40 (TP-40) precipitation data published in May 1961.	X
2010	Run-off calculations performed as part of the 2010 Plan of Operation Update; performed assuming 25-year, 24-hour precipitation depth of 4.7 inches, based on TP-40 precipitation data published in May 1961.	X
2015	Update to leachate/surface water pond calculations; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	X
2016	Update to run-on to a ditch along the north end of Module 3; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2016	Calculations to evaluate installation of a rain cover in Module 3; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	Superseded by Phase 1, Module 4
2017	Update to leachate/surface water pond calculations with consideration of Phase 1, Module 4 construction; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	X
2018	Calculations to evaluate installation of a rain cover in Module 4; performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	X
2018	Calculations to size swales and culverts to divert run-on as part of construction of Module 4, performed assuming 25-year, 24-hour precipitation depth of 4.9 inches, based on NOAA Atlas 14 precipitation data published in April 2013.	X

2.2 DESIGN WITH CALCULATIONS

Storm water management design calculations are contained in **Appendix A**. As described in **Section 2.1**, the calculations from the 2000 Plan of Operation Update and the 2018 update for the swale located north of Module 4 describe the storm water management design and provide calculations showing that the run-on control system will prevent flow onto the active portion of the CCR units during the peak discharge from a 25-year, 24-hour storm. The calculations from the 2010 Plan of Operation Update and subsequent updates in 2015 through 2018 describe the storm water management design and provide calculations showing that the run-off control system for the active portions of the CCR units will collect and control the water volume

resulting from a 25-year, 24-hour storm. The calculations were performed by or overseen by a professional engineer licensed in the State of Wisconsin.

2.3 CONSTRUCTION

Existing storm water management features were constructed to site specifications with construction oversight directed by a professional engineer licensed in the State of Wisconsin. Construction documentation reports for the storm water management features were prepared, submitted to the WDNR, and approved by the WDNR. This same approach for construction and documentation of storm water management features was used during Phase 1, Module 4 development in 2018.

3.0 CERTIFICATIONS

40 CFR 257.81(c)(5). *"The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section."*

Eric Nelson, PE, a licensed profession engineer in the State of Wisconsin, has overseen the preparation of this Run-on and Run-off Control Plan. A certification statement is provided on **page iii** of this plan.

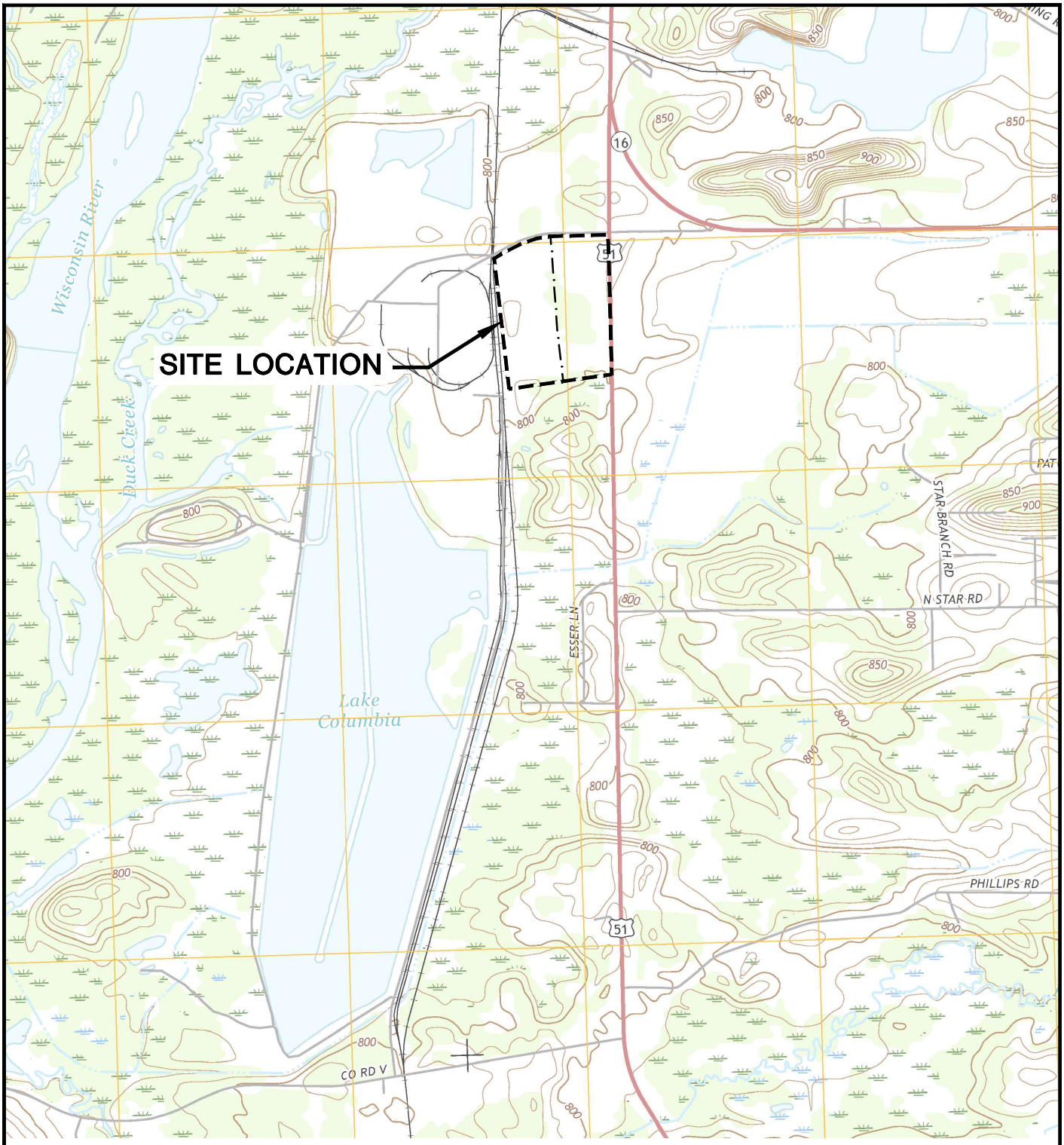
4.0 RECORDKEEPING AND PERIODIC UPDATES

40 CFR 257.81(d). *"The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in section 257.105(g), the notification requirements specified in section 257.106(g), and the internet requirements specified in section 257.107(g)."*

This Run-On and Run-Off Control Plan, and all periodic plans, will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website, as will all amendments. Periodic plan updates will be completed at least every 5 years per 40 CFR 257.81(c)(4).

WPL will notify the State Director when this Run-On and Run-Off Control Plan, and all periodic plans, are available in the facility's operating record and on the facility's website per 40 CFR 257.105(g), 257.106(g), and 257.107(g).

FIGURES



N

POYNETTE QUADRANGLE
WISCONSIN–COLUMBIA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2016
SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT COLUMBIA ENERGY CENTER W8375 MURRAY ROAD PARDEEVILLE, WISCONSIN 53954	SITE	RUN–ON AND RUN–OFF CONTROL PLAN COLUMBIA DRY ASH DISPOSAL FACILITY TOWN OF PACIFIC, WISCONSIN

SITE LOCATION MAP

PROJECT NO.	25216112.00	DRAWN BY:	AHB
DRAWN:	08/09/16	CHECKED BY:	RJG
REVISED:	08/09/16	APPROVED BY:	EN 10/06/16

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

FIGURE
1

I:\25216112.00\Drawings\Runo□Control\Site □o□.dwg, 10/6/2016 1:35:18 □M

DISCHARGE STRUCTURE

SW01

SOUTH SEDIMENTATION BASIN

C. M. ST. P. & P. RR.

WESTERN AREA DRAINS TO THE WEST AND SOUTH

SITE ENTRANCE

PLANT ENTRANCE ROAD

PHASE 1

MODULE 1

MODULE 2

MODULE 3

MODULE 4

FINAL COVER AREA DRAINS TO PERIMETER SWALES AND SOUTH SEDIMENTATION BASIN

PROPOSED RAIN COVER DRAINS TO PERIMETER SWALES AND TO SOUTH SEDIMENTATION BASIN

NORTHERN AREA DRAINS TO THE NORTH AND WEST

INTERMEDIATE COVER AREA DRAINS TO PERIMETER SWALES AND SOUTH SEDIMENTATION BASIN

LEACHATE/ SURFACE WATER POND

EASTERN AREA DRAINS TO SWALES AND SOUTH SEDIMENTATION BASIN

U.S.H. 51

BM19

LEGEND

- ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- 810 EXISTING GRADE (10' CONTOUR)
- EXISTING GRADE (2' CONTOUR)
- PAVED ROAD
- UNPAVED ROAD
- RAILROAD TRACKS
- VEGETATION
- FENCE
- SWALE
- EDGE OF WATER
- APPROXIMATE LIMITS OF EXISTING LEACHATE/SURFACE WATER POND LINER
- FINAL COVER LIMITS
- INTERMEDIATE COVER LIMITS
- CULVERT
- TRANSMISSION TOWER
- FINAL COVER DRAINAGE AREA
- INTERMEDIATE COVER DRAINAGE AREA
- ACTIVE DRAINAGE AREA
- PROPOSED RAIN COVER DRAINAGE AREA

NOTES:

1. BASE MAP CREATED FROM AERIAL SURVEY BY KBM, FLOWN DECEMBER 1, 2014, AND GROUND SURVEYS BY SCS ENGINEERS IN MAY 2016, JUNE 2016, OCTOBER 2016, NOVEMBER 2016, APRIL 2017, NOVEMBER 2017, JULY 2018, AND AUGUST 2018.

N

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25217156.00	DRAWN BY:	BJM/KP
DRAWN:	12/18/17	CHECKED BY:	BSS
REVISED:	08/31/18	APPROVED BY:	

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

CLIENT: WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

SITE: RUN-ON AND RUN-OFF CONTROL PLAN
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

RUN-ON AND RUN-OFF CONTROL PLAN

FIGURE 2

I:\25217156.00\Drawings\Module 4\...\figures\Runon runoff control plan.dwg, 8/31/2018 12:48:06 ...M

APPENDIX A

Storm Water Design Calculations

SURFACE WATER MANAGEMENT CALCULATIONS
COLUMBIA DRY ASH DISPOSAL FACILITY

PURPOSE:

The purpose of the surface water runoff calculations is to demonstrate that the surface water control features incorporated into the proposed design will collect and transfer surface water from the landfill in a controlled manner and will minimize erosion. The surface water runoff calculations were performed for the western half (Phase 1) of the landfill, which this 10-year Plan of Operation Update report addresses.

SITE GEOMETRY:

The surface water runoff from Phase 1 of the landfill will be routed to the existing South Sedimentation Basin. Diversion berms, downslope channels, and perimeter ditches are incorporated into the design to route the surface water to the southwestern corner of the landfill, where it is then routed to the South Sedimentation Basin. The South Sedimentation Basin was constructed during construction of Module 1 North. The south sedimentation pond discharges to a wetland area to the south of the pond.

METHODOLOGIES:

The following methods and procedures were used to demonstrate that the proposed surface water control features will collect and transfer surface water in controlled manner and minimize erosion potential:

Hydrograph Generation

Peak stormwater flows for the 25-year, 24-hour and 100-year, 24-hour storm events were calculated using the Quick TR-55 computer model developed by the National Resources Conservation Service (NRCS) (formerly known as the Soil Conservation Service (SCS)). The Quick TR-55 methods for computing hydrographs are based on the methodologies presented in the Urban Hydrology for Small Watersheds manual. The Quick TR-55 model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for a particular storm event, contributing drainage areas, runoff curve numbers, and time of concentration.

The time of concentration calculations combine overland flow time (i.e., sheet flow), shallow concentrated flow time, and channel flow time. Curve numbers for a specified drainage area were also calculated using the methodologies and tables presented in TR-55 (see **Reference** section at the end of this appendix).

Diversion Berm, Downslope Channels, and Perimeter Ditch Sizing

These control structures are sized to channel the peak storm runoff to the sedimentation basin while maintaining low enough velocities to limit the erosion potential. The proposed design allows storm water which comes into contact with the final cover to be routed by diversion berms and downslope channels to the perimeter ditches, which will then transport the water to the south sedimentation basin.

Diversion berm, downslope channels, and perimeter ditch locations and details are shown on the Plan Sheets. A portion of the perimeter ditch along the western side of the landfill was constructed as part of the construction of Module 1 North.

In conjunction with the graphical peak discharge methods as presented in TR-55, the Flowmaster computer modeling program was used to assist in the design of these control structures. This program allows the user to input the channel geometry, the slope of the channel, an estimated Manning's "n" value for the channel, and the peak flow in the channel. The program then determines the peak flow depth and the peak velocity for the given geometry of the control feature.

The diversion berms, downslope channels, and perimeter ditches were sized by calculating the peak flow each structure would have to manage in a worst-case design scenario (i.e., surface water runoff from the largest area of landfill final cover during the 25-year, 24-hour storm event). The drainage structure was modeled using the Flowmaster computer model to verify channel depth and velocity in the structure.

Sedimentation Pond Sizing

The sedimentation pond sizing process involved determining the proper ratio of surface area to flowrate that would allow a 15 micron particle size to settle out during a design storm event.

A table presented in the Erosion and Sediment Control Handbook (Goldman et al., 1986) provides the surface area-to-discharge ratios required to achieve settlement of the desired particle sizes (see the **Reference** section of this appendix).

The Pond Pack 6.0 computer program was used in conjunction with accepted formulas and engineering calculations to size the sedimentation basins. Calculations were performed to determine the performance of the basins as follows:

1. The inflow hydrograph for the basin was calculated as part of the hydrograph computations. The regulations require that sediment basins be sized for a 25-year, 6-hour storm event. Sediment basin calculations for the Alliant Columbia Ash Disposal Facility were based on the basin's peak discharge during the 25-year, 24-hour storm which equals or exceeds the basin inflow for average rainfall intensity of the 25-year, 6-hour storm.

2. Outlet structures were designed to provide the necessary detention of peak stormwater runoff from the final cover for the 25-year, 24-hour storm event.

3. The inflow hydrograph was routed through the sedimentation pond using the Pond Pack 6.0 program to determine the basin's peak water elevation and discharge during the 25-year, 24-hour storm.

4. The emergency spillways for the sedimentation basins were sized for the 100-year, 24-hour storm event.

ASSUMPTIONS:

Summarized below are some of the major assumptions and data used in the computations:

1. Due to the presence of a drainage layer in the proposed landfill final cover, the soil for the landfill area was modeled between a Type B and C soil to account for greater water infiltration

through the cover. The final cover was modeled as a grassland in good condition, which resulted in a runoff curve number of 67.5.

2. SCS Type II storm was selected according to SCS storm distribution maps for the United States.

3. A 2-year, 24-hour storm event in the vicinity of the facility equates to 2.7 inches according to figures provided in TR-55.

4. A 25-year, 24-hour storm event in the vicinity of the facility equates to 4.7 inches according to precipitation data provided in TR-55.

5. A 100-year, 24-hour storm event in the vicinity of the facility equates to 5.9 inches according to precipitation data provided in TR-55.

6. Grass-lined berms and channels were designed for a maximum velocity of 4 feet per second (fps).

7. A Manning's "n" value of 0.045 was used to model a grass-lined berm or channel, as provided by the parameters set in the Flowmaster model.

8. Depths of channels were designed to be a minimum of 1 foot, with a minimum freeboard of 0.5 foot. Depths of diversion berms were designated to be a minimum of 2 feet, with a minimum of 0.5 foot of freeboard.

9. A 15-micron particle was targeted to be settled out of the water column. The 15-micron particle is classified as a medium-fine silt by the AASHTO Soil Classification System.

SURFACE WATER MANAGEMENT CALCULATIONS (CONTINUED)
COLUMBIA DRY ASH DISPOSAL FACILITY

RESULTS:

Based on the results of the surface water runoff computations presented in this appendix, the proposed surface water control features will adequately handle the runoff from a 25-year, 24-hour storm event while minimizing erosion. The drainage features will be constructed as shown on the Plan Sheets.

All diversion berms and perimeter ditches will maintain greater than 0.5 foot of freeboard during the design storm event. The sedimentation basins will settle out particles 15 microns and larger in diameter and will dewater in no less than three days. The detailed calculations are included with this appendix.

I:\1370\Reports\surface water calcs writeup.wpd

Time of Concentration Calculations

File.... I:\1370\Columbia.ppk
Title... Landfill runoff to south basin

Landfill Area (1/2)

::
TIME OF CONCENTRATION CALCULATOR
::

Landfill runoff to south basin

Segment #1: Tc: TR-55 Sheet
Description: final cover slope

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.050000	ft/ft

Avg.Velocity .17 ft/sec

Segment #1 Time: .0989 hrs

Segment #2: Tc: TR-55 Sheet
Description: final cover slope

Mannings n	.1900	
Hydraulic Length	60.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft

Avg.Velocity .32 ft/sec

Segment #2 Time: .0520 hrs

Segment #3: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	1530.00	ft
Slope	.020000	ft/ft

Unpaved

Avg.Velocity 2.28 ft/sec

Segment #3 Time: .1863 hrs

File.... I:\1370\Columbia.ppk
Title... Landfill runoff to south basin

Landfill Area (2/2)

Segment #4: Tc: TR-55 Channel
Description: perimeter ditch

Flow Area	32.0000	sq.ft
Wetted Perimeter	22.60	ft
Hydraulic Radius	1.42	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	320.00	ft
Avg.Velocity	4.85	ft/sec

Segment #4 Time: .0183 hrs

Total Tc: .3555 hrs

West peripheral area leading to west perimeter ditch (1/2)

Type.... Tc Calcs
Name.... PERIPH TO S BASI

File.... I:\1370\COLUMBIA.PPK
Title... Peripheral area to south basin (area outside of LF leading to basin)

::
TIME OF CONCENTRATION CALCULATOR
::

Peripheral area to south basin (area outside of LF leading to basin)

Segment #1: Tc: TR-55 Sheet
Description: flow into ditch

Mannings n	.1900	
Hydraulic Length	10.00	ft
2yr, 24hr P	2.7000	in
Slope	.330000	ft/ft
Avg.Velocity	.25	ft/sec

Segment #1 Time: .0111 hrs

Segment #2: Tc: TR-55 Channel
Description: flow along perimeter ditch

Flow Area	22.0000	sq.ft
Wetted Perimeter	17.60	ft
Hydraulic Radius	1.25	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	800.00	ft
Avg.Velocity	4.46	ft/sec

Segment #2 Time: .0498 hrs

Segment #3: Tc: TR-55 Channel
Description: flow along perimeter ditch

Flow Area	57.0000	sq.ft
Wetted Perimeter	29.00	ft
Hydraulic Radius	1.97	ft
Slope	.006000	ft/ft
Mannings n	.0300	
Hydraulic Length	1010.00	ft
Avg.Velocity	6.04	ft/sec

Segment #3 Time: .0465 hrs

Type.... Tc Calcs
Name.... PERIPH TO S BASI

West peripheral area leading to west perimeter ditch (2/2)

File.... I:\1370\COLUMBIA.PPK
Title... Peripheral area to south basin (area outside of LF leading to basin)

==========
Total Tc: .1073 hrs
==========

Type.... Tc Calcs
Name.... E PERIPHERAL

Northeast peripheral area leading to east perimeter ditch (1/1)

File.... I:\1370\COLUMBIA.PPK
Title... Eastern peripheral area (north of leachate basin) leading to east ditch

::
TIME OF CONCENTRATION CALCULATOR
::

Eastern peripheral area (north of leachate basin) leading to east ditch
---

Segment #1: Tc: TR-55 Sheet

Mannings n	.1900	
Hydraulic Length	40.00	ft
2yr, 24hr P	2.7000	in
Slope	.425000	ft/ft
Avg.Velocity	.37	ft/sec

Segment #1 Time: .0304 hrs

Segment #2: Tc: TR-55 Sheet

Mannings n	.1900	
Hydraulic Length	260.00	ft
2yr, 24hr P	2.7000	in
Slope	.023000	ft/ft
Avg.Velocity	.17	ft/sec

Segment #2 Time: .4362 hrs

Segment #3: Tc: TR-55 Shallow

Hydraulic Length	520.00	ft
Slope	.014000	ft/ft
Unpaved		
Avg.Velocity	1.91	ft/sec

Segment #3 Time: .0757 hrs

==========
Total Tc: .5423 hrs
==========

S/N: H0M0L0862791 BT 2, Inc
Pond Pack Ver: 8-01-98 (61) Compute Time: 14:58:36 Date: 08-29-2000

Type.... Tc Calcs
Name.... BASIN PERIPHERAL

Southeast/South peripheral area leading to south perimeter ditch (1/2)

File.... I:\1370\COLUMBIA.PPK
Title... South peripheral area to south perimeter ditch

::
TIME OF CONCENTRATION CALCULATOR
::

South peripheral area to south perimeter ditch

Segment #1: Tc: TR-55 Sheet

Mannings n	.1900
Hydraulic Length	300.00 ft
2yr, 24hr P	2.7000 in
Slope	.010000 ft/ft
Avg.Velocity	.12 ft/sec

Segment #1 Time: .6825 hrs

Segment #2: Tc: TR-55 Shallow

Hydraulic Length	110.00 ft
Slope	.096000 ft/ft
Unpaved	
Avg.Velocity	5.00 ft/sec

Segment #2 Time: .0061 hrs

Segment #3: Tc: TR-55 Shallow

Hydraulic Length	550.00 ft
Slope	.022000 ft/ft
Unpaved	
Avg.Velocity	2.39 ft/sec

Segment #3 Time: .0638 hrs

Type.... Tc Calcs
Name.... BASIN PERIPHERAL

Southeast/South peripheral area leading to south perimeter ditch (2/2)

File.... I:\1370\COLUMBIA.PPK
Title... South peripheral area to south perimeter ditch

Segment #4: Tc: TR-55 Channel
Description: flow along south perimeter ditch

Flow Area	100.0000	sq.ft
Wetted Perimeter	32.40	ft
Hydraulic Radius	3.09	ft
Slope	.012000	ft/ft
Mannings n	.0300	
Hydraulic Length	1030.00	ft
Avg.Velocity	11.53	ft/sec

Segment #4 Time: .0248 hrs

Total Tc: .7773 hrs

Equations used by PondPack to calculate Tc (1/2)

Tc Equations used...

==== SCS TR-55 Sheet Flow ==========

Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

Where: Tc = Time of concentration, hrs
n = Mannings n
Lf = Flow length, ft
P = 2yr, 24hr Rain depth, inches
Sf = Slope, ft/ft

==== SCS TR-55 Shallow Concentrated Flow ==========

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved surface:
V = 20.3282 * (Sf**0.5)

Tc = (Lf / V) / (3600sec/hr)

Where: V = Velocity, ft/sec
Sf = Slope, ft/ft
Tc = Time of concentration, hrs
Lf = Flow length, ft

Equations used by Pond Pack to calculate Tc (2/2)

==== SCS Channel Flow ==========

R = Aq / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

Tc = (Lf / V) / (3600sec/hr)

Where: R = Hydraulic radius
Aq = Flow area, sq.ft.
Wp = Wetted perimeter, ft
V = Velocity, ft/sec
Sf = Slope, ft/ft
n = Mannings n
Tc = Time of concentration, hrs
Lf = Flow length, ft

Hydrograph Generation

Type.... TR-55 Tabular Hyd.Input Data
Name.... TO SOUTH BASIN Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 25

To South Basin
25-yr, 24-hr Storm
(1/2)

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 63.400 acres or .099063 sq.mi.
Peak Discharge = 69 cfs
WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used	
Landfill area	29.600	67.5	.4000	.0000	4.70	1.63	I.20	.20
W peripheral	4.600	67.5	.1000	.0000	4.70	1.63	I.20	.20
Basin area	1.800	98.0	.1000	.0000	4.70	4.46	I.01	.10
NE peripheral	13.700	67.5	.5000	.0000	4.70	1.63	I.20	.20
SE/S periphera	13.700	67.5	.7500	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	* Tt (hrs)	Rounded Values Tc (hrs)	* Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
andfill area	.3600	.0000	.40	.00	Yes	--
peripheral	.1000	.0000	**	**	Yes	--
Basin area	.1000	.0000	**	**	No	Computed Ia/p < .1
E peripheral	.5400	.0000	.50	.00	Yes	--
E/S periphera	.7800	.0000	.75	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.
* Tc & Tt are available in the hydrograph tables.

Type.... TR-55 Tabular Hyd.Peaks
Name.... TO SOUTH BASIN Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 25

To South Basin
25-yr, 24-hr Storm
(2/2)

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Landfill area	40	12.3
W peripheral	11	12.1
Basin area	13	12.1
NE peripheral	17	12.4
SE/S periphera	13	12.6
Composite Watershed	69	12.4

To South Basin
100-yr, 24-hr

Type.... TR-55 Tabular Hyd.Input Data
Name.... TO SOUTH BASIN Tag: 100

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 100

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
100yr, 24hr Rainfall Depth = 5.90 in

Total Area = 63.400 acres or .099063 sq.mi.
Peak Discharge = 110 cfs
WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
Landfill area	29.600	67.5	.4000	.0000	5.90	2.50	I.16	.16
W peripheral	4.600	67.5	.1000	.0000	5.90	2.50	I.16	.16
Basin area	1.800	98.0	.1000	.0000	5.90	5.66	I.01	.10
E peripheral	13.700	67.5	.5000	.0000	5.90	2.50	I.16	.16
SE/S periphera	13.700	67.5	.7500	.0000	5.90	2.50	I.16	.16

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	* Tt (hrs)	Rounded Values Tc (hrs)	* Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
andfill area	.3600	.0000	.40	.00	Yes	--
W peripheral	.1000	.0000	**	**	Yes	--
Basin area	.1000	.0000	**	**	No	Computed Ia/p < .1
peripheral	.5400	.0000	.50	.00	Yes	--
E/S periphera	.7800	.0000	.75	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.
* Tc & Tt are available in the hydrograph tables.

Type.... TR-55 Tabular Hyd.Peaks
Name.... TO SOUTH BASIN Tag: 100

File.... I:\1370\COLUMBIA.PPK
Title... Runoff to south basin
HYG Dir = I:\1370\
HYG file = S BASIN.HYG south basin 100

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
100yr, 24hr Rainfall Depth = 5.90 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
Landfill area	65	12.3
W peripheral	18	12.1
Basin area	16	12.1
NE peripheral	27	12.4
SE/S periphera	21	12.6
Composite Watershed	110	12.4

Diversion Berm, Downslope Swale, and Perimeter Ditch Sizing Calculations

Worst-case diversion Berm C1

Type.... Tc Calcs
Name.... WORSTCASE DIV BE

File.... I:\1370\COLUMBIA.PPK
Title... Tc for worst case diversion berm sizing calcs

::
TIME OF CONCENTRATION CALCULATOR
::

Tc for worst case diversion berm sizing calcs

Segment #1: Tc: TR-55 Sheet
Description: final cover slope - 25%

Mannings n	.1900	
Hydraulic Length	95.00	ft
2yr, 24hr P	2.7000	in
Slope	.250000	ft/ft
Avg.Velocity	.35	ft/sec

Segment #1 Time: .0751 hrs

Segment #2: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	2090.00	ft
Slope	.020000	ft/ft
Unpaved		
Avg.Velocity	2.28	ft/sec

Segment #2 Time: .2544 hrs

==========
Total Tc: .3295 hrs
==========

Worst-case diversion berm

Type.... TR-55 Tabular Hyd.Input Data
Name.... WORSTCASE DIV BE Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case diversion berm sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORSTCASE DIV BE 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 4.600 acres or .007187 sq.mi.
Peak Discharge = 7 cfs

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
east side ph 1	4.600	67.5	.3000	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
east side ph 1	.3300	.0000	.30	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Worst-case diversion berm

Type.... TR-55 Tabular Hyd.Peaks
Name.... WORSTCASE DIV BE Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case diversion berm sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORSTCASE DIV BE 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
east side ph 1	7	12.2
Composite Watershed	7	12.2

Worksheet
Worksheet for Triangular Channel

Worst-case diversion berm

Project Description	
Worksheet	Triangular Channe
Flow Element	Triangular Channe
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	020000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	3.00	H : V
Discharge	7.00	cfs

Results		
Depth	0.75	ft
Flow Area	2.0	ft²
Wetted Perim	5.47	ft
Top Width	5.25	ft
Critical Depth	0.76	ft
Critical Slope	0.019122	ft/ft
Velocity	3.55	ft/s
Velocity Head	0.20	ft
Specific Energ	0.95	ft
Froude Numb	1.02	
Flow Type	Supercritical	

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Worst-case downslope channel

Type.... Tc Calcs
Name.... WORST CASE FLUME

File.... I:\1370\COLUMBIA.PPK
Title... Tc for worst case downslope flume sizing calcs

::
TIME OF CONCENTRATION CALCULATOR
::

Tc for worst case downslope flume sizing calcs

Segment #1: Tc: TR-55 Sheet
Description: final cover slope - 5%

Mannings n	.1900
Hydraulic Length	60.00 ft
2yr, 24hr P	2.7000 in
Slope	.050000 ft/ft
Avg.Velocity	.17 ft/sec

Segment #1 Time: .0989 hrs

Segment #2: Tc: TR-55 Sheet
Description: final cover slope - 25%

Mannings n	.1900
Hydraulic Length	60.00 ft
2yr, 24hr P	2.7000 in
Slope	.250000 ft/ft
Avg.Velocity	.32 ft/sec

Segment #2 Time: .0520 hrs

Segment #3: Tc: TR-55 Shallow
Description: diversion berm

Hydraulic Length	1790.00 ft
Slope	.020000 ft/ft
Unpaved	
Avg.Velocity	2.28 ft/sec

Segment #3 Time: .2179 hrs

==========
Total Tc: .3688 hrs
==========

Worst-case downslope channel

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case downslope flume sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORST CASE FLUME 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

Total Area = 7.500 acres or .011719 sq.mi.
Peak Discharge = 10 cfs

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
To SE flume	7.500	67.5	.4000	.0000	4.70	1.63	I.20	.20

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hrs)	Input Values * Tt (hrs)	Rounded Values Tc (hrs)	Rounded Values * Tt (hrs)	Ia/p Interpolated (Yes/No)	Ia/p Messages
To SE flume	.3700	.0000	.40	.00	Yes	--

* Travel time from subarea outfall to composite watershed outfall point.

Worst-case downslope channel

File.... I:\1370\COLUMBIA.PPK
Title... Hydrograph for worst-case downslope flume sizing calcs
HYG Dir = I:\1370\
HYG file = NONE STORED WORST CASE FLUME 25

TR-55 TABULAR HYDROGRAPH METHOD
TYPE II Distribution
25yr, 24hr Rainfall Depth = 4.70 in

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
To SE flume	10	12.3
Composite Watershed	10	12.3

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	downslope flume
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Worst-case downslope channel (SW channel)

Input Data		
Mannings Coeffic	0.040	
Slope	200000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	10.00	cfs

Results		
Depth	0.18	ft
Flow Area	1.9	ft²
Wetted Perim	11.16	ft
Top Width	11.10	ft
Critical Depth	0.30	ft
Critical Slope	0.035988	ft/ft
Velocity	5.17	ft/s
Velocity Head	0.41	ft
Specific Energ	0.60	ft
Froude Numb	2.18	
Flow Type	Supercritical	

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Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst-case west perimeter
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case west perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	5.00	ft
Discharge	31.00	cfs

Results		
Depth	1.13	ft
Flow Area	9.5	ft²
Wetted Perim	12.17	ft
Top Width	11.80	ft
Critical Depth	0.88	ft
Critical Slope	0.015659	ft/ft
Velocity	3.26	ft/s
Velocity Head	0.16	ft
Specific Energ	1.30	ft
Froude Numb	0.64	
Flow Type	Subcritical	

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Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst-case east perimeter
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case east perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	005000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	57.00	cfs

Results		
Depth	1.23	ft
Flow Area	16.9	ft²
Wetted Perim	17.79	ft
Top Width	17.39	ft
Critical Depth	0.91	ft
Critical Slope	0.014803	ft/ft
Velocity	3.38	ft/s
Velocity Head	0.18	ft
Specific Ener	1.41	ft
Froude Numb	0.61	
Flow Type	Subcritical	

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Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	worst case south perimeter
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Worst-case south perimeter ditch

Input Data		
Mannings Coeffic	0.030	
Slope	012000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	10.00	ft
Discharge	70.00	cfs

Results		
Depth	1.08	ft
Flow Area	14.4	ft²
Wetted Perim	16.85	ft
Top Width	16.50	ft
Critical Depth	1.03	ft
Critical Slope	0.014316	ft/ft
Velocity	4.88	ft/s
Velocity Head	0.37	ft
Specific Energ	1.45	ft
Froude Numb	0.92	
Flow Type	Subcritical	

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Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	ditch from SW corner of LF to S
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Ditch from SW corner of Landfill to South Basin

Input Data		
Mannings Coeffic	0.030	
Slope	006000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	15.00	ft
Discharge	69.00	cfs

Results		
Depth	1.07	ft
Flow Area	19.4	ft²
Wetted Perim	21.74	ft
Top Width	21.40	ft
Critical Depth	0.82	ft
Critical Slope	0.014896	ft/ft
Velocity	3.56	ft/s
Velocity Head	0.20	ft
Specific Energ	1.26	ft
Froude Numb	0.66	
Flow Type	Subcritical	

Basin Volume Computations

POND VOLUME CALCULATIONS

Planimeter scale: 1.00 ft/in

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
789.00	62411.000	1.4328	.0000	.000	.000
790.00	68355.000	1.5692	4.5014	1.500	1.500
792.00	74865.000	1.7187	4.9301	3.287	4.787
794.00	82150.000	1.8859	5.4049	3.603	8.390

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

Outlet Structure Data

Type.... Outlet Input Data
Name.... SOUTH BASIN2

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 789.50 ft
Increment = 1.00 ft
Max. Elev.= 794.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Weir-Rectangular	e1	--->	TW	793.000	794.000
Stand Pipe	s1	--->	c1	791.000	794.000
Orifice-Circular	o1	--->	c1	789.500	794.000
Culvert-Circular	c1	--->	TW	789.000	794.000

TW SETUP, DS Channel

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

OUTLET STRUCTURE INPUT DATA

Structure ID	= e1	
Structure Type	= Weir-Rectangular	
# of Openings	= 1	
Crest Elev.	= 793.00	ft
Weir Length	= 10.00	ft
Weir Coeff.	= 3.300000	

Weir TW effects (Use adjustment equation)

Structure ID	= s1	
Structure Type	= Stand Pipe	
# of Openings	= 1	
Invert Elev.	= 791.00	ft
Diameter	= 2.5000	ft
Orifice Area	= 4.9087	sq.ft
Orifice Coeff.	= .600	
Weir Length	= 7.85	ft
Weir Coeff.	= 3.300	
K, Submerged	= .000	
K, Reverse	= 1.000	
Kb,Barrel	= .000000	(per ft of full flow)
Barrel Length	= .00	ft
Mannings n	= .0000	

Structure ID	= o1	
Structure Type	= Orifice-Circular	
# of Openings	= 72	
Invert Elev.	= 789.50	ft
Diameter	= .0400	ft
Orifice Coeff.	= .600	

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

OUTLET STRUCTURE INPUT DATA

Structure ID = c1
Structure Type = Culvert-Circular

No. Barrels	=	1	
Barrel Diameter	=	1.2500	ft
Upstream Invert	=	789.00	ft
Dnstream Invert	=	788.50	ft
Horiz. Length	=	50.00	ft
Barrel Length	=	50.00	ft
Barrel Slope	=	.01000	ft/ft

OUTLET CONTROL DATA...

Mannings n	=	.0130	
Ke	=	.9000	(forward entrance loss)
Kb	=	.023225	(per ft of full flow)
Kr	=	.9000	(reverse entrance loss)
HW Convergence	=	.001	+/- ft

INLET CONTROL DATA...

Equation form	=	1	
Inlet Control K	=	.0340	
Inlet Control M	=	1.5000	
Inlet Control c	=	.05530	
Inlet Control Y	=	.5400	
T1 ratio (HW/D)	=	1.258	
T2 ratio (HW/D)	=	1.420	
Slope Factor	=	-.500	

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control, interpolate between flows at T1 & T2...
At T1 Elev = 790.57 ft ---> Flow = 4.80 cfs
At T2 Elev = 790.77 ft ---> Flow = 5.49 cfs

Structure ID = TW
Structure Type = TW SETUP, DS Channel

FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...

Maximum Iterations=	30	
Min. TW tolerance =	.01	ft
Max. TW tolerance =	.01	ft
Min. HW tolerance =	.01	ft
Max. HW tolerance =	.01	ft

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = e1 (Weir-Rectangular)

Upstream ID = (Pond Water Surface)
DNstream ID = TW (Pond Outfall)

WS Elev,Device Q		Tail Water		Notes
WS Elev. ft	Q cfs	TW Elev Converge ft	+/-ft	Computation Messages
789.50	.00	Free Outfall		WS below an invert; no flow.
790.50	.00	Free Outfall		WS below an invert; no flow.
791.00	.00	Free Outfall		WS below an invert; no flow.
791.50	.00	Free Outfall		WS below an invert; no flow.
792.50	.00	Free Outfall		WS below an invert; no flow.
793.00	.00	Free Outfall		WS below an invert; no flow.
793.50	11.67	Free Outfall		H=.50; Htw=.00; Qfree=11.67;
794.00	33.00	Free Outfall		H=1.00; Htw=.00; Qfree=33.00;

Type.... Individual Outlet Curves
Name.... SOUTH BASIN2

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = s1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
DNstream ID = c1 (Culvert-Circular)

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	...	...	...	...	...	Free Outfall	
		WS below an invert; no flow.						
790.50	.00	...	...	...	...	...	Free Outfall	
		WS below an invert; no flow.						
791.00	.00	...	...	...	...	...	Free Outfall	
		WS below an invert; no flow.						
791.50	7.06	791.50	791.50	791.50	.000	.000	Free Outfall	
		DS HGL+Loss > crest: Flow set to Downstream outlet.						
792.50	8.78	792.50	792.50	792.50	.000	.000	Free Outfall	
		DS HGL+Loss > crest: Flow set to Downstream outlet.						
793.00	9.52	793.00	793.00	793.00	.000	.000	Free Outfall	
		DS HGL+Loss > crest: Flow set to Downstream outlet.						
793.50	10.21	793.50	793.50	793.50	.000	.000	Free Outfall	
		DS HGL+Loss > crest: Flow set to Downstream outlet.						
794.00	10.86	794.00	794.00	794.00	.000	.000	Free Outfall	
		DS HGL+Loss > crest: Flow set to Downstream outlet.						

File.... I:\1370\COLUMBIA.PPK
Title... south basin outlet structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = o1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
DNstream ID = c1 (Culvert-Circular)

NUMBER OF OPENINGS = 72
EACH FLOW = SUM OF OPENINGS x FLOW FOR ONE OPENING

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	...	...	...	...	...	Free Outfall	
		WS below an invert; no flow.						
790.50	.43	790.50	Free	789.42	.000	.000	Free Outfall	
		H =.98						
791.00	.53	791.00	Free	789.47	.000	.000	Free Outfall	
		H =1.48						
791.50	.00	791.50	791.50	791.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
792.50	.00	792.50	792.50	792.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
793.00	.00	793.00	793.00	793.00	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
793.50	.00	793.50	793.50	793.50	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				
794.00	.00	794.00	794.00	794.00	.000	.000	Free Outfall	
				Full riser flow. Q=0 this opening.				

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = c1 (Culvert-Circular)

Mannings open channel maximum capacity: 6.95 cfs
UPstream ID's= s1, o1
DNstream ID = TW (Pond Outfall)

Pond WS. Elev. ft	Device Q cfs	(into) HW HGL ft	Converge DS HGL ft	Next DS HGL ft	DS HGL Error +/-ft	Q SUM Error +/-cfs	DS Chan. TW ft	TW Error +/-ft
789.50	.00	789.00	Free	Free	.000	.000	Free Outfall	
790.50	.43	789.42	Free	Free	.000	.000	Free Outfall	
		CRIT.DEPTH CONTROL		Vh= .089ft	Dcr= .255ft		CRIT.DEPTH	
791.00	.53	789.47	Free	Free	.000	.000	Free Outfall	
		CRIT.DEPTH CONTROL		Vh= .100ft	Dcr= .283ft		CRIT.DEPTH	
791.50	7.06	791.50	Free	Free	.000	.000	Free Outfall	
		INLET CONTROL...		Submerged:	HW =2.50			
792.50	8.78	792.50	Free	Free	.000	.000	Free Outfall	
		INLET CONTROL...		Submerged:	HW =3.50			
793.00	9.52	793.00	Free	Free	.000	.000	Free Outfall	
		INLET CONTROL...		Submerged:	HW =4.00			
793.50	10.21	793.50	Free	Free	.000	.000	Free Outfall	
		INLET CONTROL...		Submerged:	HW =4.50			
794.00	10.86	794.00	Free	Free	.000	.000	Free Outfall	
		INLET CONTROL...		Submerged:	HW =5.00			

Pond Routing Summary

South Basin
25-yr, 24-hr Storm

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

LEVEL POOL ROUTING SUMMARY

HYG Dir = I:\1370\
Inflow HYG file = SBASIN.HYG - south basin 25
Outflow HYG file = NONE STORED - SOUTH BASIN2 OUT 25

Pond Node Data = south basin
Pond Volume Data = south basin
Pond Outlet Data = south basin2

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	789.00 ft
Starting Volume	=	.000 ac-ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.1000 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	69.00 cfs	at	12.4000 hrs
Peak Outflow	=	7.94 cfs	at	14.1000 hrs ← Peak discharge from basin
Peak Elevation	=	792.01 ft ← Peak water elevation		
Peak Storage	=	4.805 ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	8.872
- Infiltration	=	.000
- HYG Vol OUT	=	8.101
- Retained Vol	=	.769
Unrouted Vol	=	-.001 ac-ft (.016% of Inflow Volume)

WARNING: Inflow hydrograph truncated on left side.
WARNING: Outflow hydrograph truncated on right side.

BT² inc.

Sheet No.
Calc. No.
Rev. No.

Job No. 1370 Job Columbia Plan of Op Update By BLP Date 8/23/00

Client Alliant Subject Basin Calcs Chk'd. MRH Date 8-31-00

Basin Particle Size Settling Capability

Basin required to settle out ≥ 15 micron (0.015 mm) particle for a 25-yr, 24-hr storm event.

From calculations, peak discharge from basin is 7.94 cfs and peak water elevation is 792.0 ft. The corresponding surface area of the basin at elevation 792.0 is 74,865 sf (see Basin Volume Computations Sectio

The surface area to discharge ratio is therefore

$$\frac{74,865 \text{ sf}}{7.94 \text{ cfs}} = 9,429 \text{ sf/cfs}$$

From the Erosion and Sediment Control Handbook, the required surface area to discharge ratio to settle out a 15 micron particle is 3,125 sf/cfs.

9,429 cfs/sf > 3,125 sf/cfs, therefore the basin is adequately sized to settle out a 15 micron particle

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (1/7)

POND ROUTED TOTAL OUTFLOW HYG...
HYG file =
HYG ID = SOUTH BASIN2 OUT
HYG Tag = 25

Peak Discharge =	7.94 cfs
Time to Peak =	14.1000 hrs
HYG Volume =	8.101 ac-ft

WARNING: Hydrograph truncated on right side.

Basin dewatering time -
Begin discharge: 12.2
End discharge: 113.8 sa
Total discharge time: 101.6
or 4.2 days, whi
is greater than the
required minimum
of 3 days

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
11.0000	.00	.00	.00	.00	.00
11.5000	.00	.00	.00	.00	.00
12.0000	.00	.00	.10	.24	.39
12.5000	.48	.92	3.82	6.00	7.14
13.0000	7.31	7.44	7.55	7.64	7.72
13.5000	7.78	7.83	7.87	7.90	7.92
14.0000	7.93	7.94	7.94	7.94	7.93
14.5000	7.92	7.91	7.90	7.89	7.87
15.0000	7.84	7.82	7.80	7.77	7.75
15.5000	7.73	7.71	7.68	7.66	7.63
16.0000	7.60	7.57	7.54	7.51	7.48
16.5000	7.45	7.42	7.40	7.37	7.34
17.0000	7.31	7.28	7.26	7.23	7.20
17.5000	7.18	7.15	7.13	7.10	7.08
18.0000	6.96	6.77	6.60	6.44	6.28
18.5000	6.14	6.00	5.88	5.76	5.65
19.0000	5.55	5.45	5.36	5.27	5.19
19.5000	5.12	5.01	4.89	4.77	4.66
20.0000	4.55	4.46	4.36	4.28	4.20
20.5000	4.12	4.05	3.99	3.92	3.87
21.0000	3.81	3.76	3.71	3.67	3.63
21.5000	3.59	3.55	3.51	3.48	3.45
22.0000	3.42	3.40	3.37	3.35	3.33
22.5000	3.31	3.29	3.24	3.16	3.09
23.0000	3.02	2.95	2.89	2.84	2.78
23.5000	2.74	2.69	2.65	2.61	2.57
24.0000	2.53	2.47	2.37	2.29	2.21
24.5000	2.13	2.06	1.99	1.93	1.87
25.0000	1.82	1.77	1.72	1.67	1.60

Begin discharge

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (2/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
25.5000	1.50	1.40	1.32	1.23	1.15
26.0000	1.08	1.01	.95	.89	.83
26.5000	.78	.73	.69	.64	.60
27.0000	.56	.53	.53	.53	.53
27.5000	.53	.53	.53	.53	.53
28.0000	.53	.52	.52	.52	.52
28.5000	.52	.52	.52	.52	.52
29.0000	.52	.52	.52	.52	.52
29.5000	.52	.52	.52	.52	.52
30.0000	.51	.51	.51	.51	.51
30.5000	.51	.51	.51	.51	.51
31.0000	.51	.51	.51	.51	.51
31.5000	.51	.51	.51	.51	.50
32.0000	.50	.50	.50	.50	.50
32.5000	.50	.50	.50	.50	.50
33.0000	.50	.50	.50	.50	.50
33.5000	.50	.50	.50	.50	.49
34.0000	.49	.49	.49	.49	.49
34.5000	.49	.49	.49	.49	.49
35.0000	.49	.49	.49	.49	.49
35.5000	.49	.49	.49	.49	.48
36.0000	.48	.48	.48	.48	.48
36.5000	.48	.48	.48	.48	.48
37.0000	.48	.48	.48	.48	.48
37.5000	.48	.48	.48	.48	.48
38.0000	.47	.47	.47	.47	.47
38.5000	.47	.47	.47	.47	.47
39.0000	.47	.47	.47	.47	.47
39.5000	.47	.47	.47	.47	.47
40.0000	.47	.46	.46	.46	.46
40.5000	.46	.46	.46	.46	.46
41.0000	.46	.46	.46	.46	.46
41.5000	.46	.46	.46	.46	.46
42.0000	.46	.46	.46	.45	.45
42.5000	.45	.45	.45	.45	.45
43.0000	.45	.45	.45	.45	.45
43.5000	.45	.45	.45	.45	.45
44.0000	.45	.45	.45	.45	.45
44.5000	.44	.44	.44	.44	.44
45.0000	.44	.44	.44	.44	.44
45.5000	.44	.44	.44	.44	.44
46.0000	.44	.44	.44	.44	.44
46.5000	.44	.44	.44	.43	.43

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (3/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
47.0000	.43	.43	.43	.43	.43
47.5000	.43	.43	.43	.43	.43
48.0000	.43	.43	.43	.42	.42
48.5000	.42	.42	.42	.42	.42
49.0000	.42	.42	.42	.41	.41
49.5000	.41	.41	.41	.41	.41
50.0000	.41	.41	.41	.41	.40
50.5000	.40	.40	.40	.40	.40
51.0000	.40	.40	.40	.40	.40
51.5000	.39	.39	.39	.39	.39
52.0000	.39	.39	.39	.39	.39
52.5000	.39	.38	.38	.38	.38
53.0000	.38	.38	.38	.38	.38
53.5000	.38	.38	.38	.37	.37
54.0000	.37	.37	.37	.37	.37
54.5000	.37	.37	.37	.37	.37
55.0000	.36	.36	.36	.36	.36
55.5000	.36	.36	.36	.36	.36
56.0000	.36	.36	.35	.35	.35
56.5000	.35	.35	.35	.35	.35
57.0000	.35	.35	.35	.35	.34
57.5000	.34	.34	.34	.34	.34
58.0000	.34	.34	.34	.34	.34
58.5000	.34	.34	.33	.33	.33
59.0000	.33	.33	.33	.33	.33
59.5000	.33	.33	.33	.33	.33
60.0000	.33	.32	.32	.32	.32
60.5000	.32	.32	.32	.32	.32
61.0000	.32	.32	.32	.32	.31
61.5000	.31	.31	.31	.31	.31
62.0000	.31	.31	.31	.31	.31
62.5000	.31	.31	.31	.30	.30
63.0000	.30	.30	.30	.30	.30
63.5000	.30	.30	.30	.30	.30
64.0000	.30	.30	.30	.29	.29
64.5000	.29	.29	.29	.29	.29
65.0000	.29	.29	.29	.29	.29
65.5000	.29	.29	.29	.28	.28
66.0000	.28	.28	.28	.28	.28
66.5000	.28	.28	.28	.28	.28
67.0000	.28	.28	.28	.28	.27
67.5000	.27	.27	.27	.27	.27
68.0000	.27	.27	.27	.27	.27

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (4/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
68.5000	.27	.27	.27	.27	.27
69.0000	.26	.26	.26	.26	.26
69.5000	.26	.26	.26	.26	.26
70.0000	.26	.26	.26	.26	.26
70.5000	.26	.26	.25	.25	.25
71.0000	.25	.25	.25	.25	.25
71.5000	.25	.25	.25	.25	.25
72.0000	.25	.25	.25	.25	.24
72.5000	.24	.24	.24	.24	.24
73.0000	.24	.24	.24	.24	.24
73.5000	.24	.24	.24	.24	.24
74.0000	.24	.24	.24	.23	.23
74.5000	.23	.23	.23	.23	.23
75.0000	.23	.23	.23	.23	.23
75.5000	.23	.23	.23	.23	.23
76.0000	.23	.23	.22	.22	.22
76.5000	.22	.22	.22	.22	.22
77.0000	.22	.22	.22	.22	.22
77.5000	.22	.22	.22	.22	.22
78.0000	.22	.22	.21	.21	.21
78.5000	.21	.21	.21	.21	.21
79.0000	.21	.21	.21	.21	.21
79.5000	.21	.21	.21	.21	.21
80.0000	.21	.21	.20	.20	.20
80.5000	.20	.20	.20	.20	.20
81.0000	.20	.20	.20	.20	.20
81.5000	.20	.20	.20	.20	.20
82.0000	.20	.20	.20	.20	.19
82.5000	.19	.19	.19	.19	.19
83.0000	.19	.19	.19	.19	.19
83.5000	.19	.19	.19	.19	.19
84.0000	.19	.19	.19	.19	.19
84.5000	.19	.19	.18	.18	.18
85.0000	.18	.18	.18	.18	.18
85.5000	.18	.18	.18	.18	.18
86.0000	.18	.18	.18	.18	.18
86.5000	.18	.18	.18	.18	.18
87.0000	.18	.18	.17	.17	.17
87.5000	.17	.17	.17	.17	.17
88.0000	.17	.17	.17	.17	.17
88.5000	.17	.17	.17	.17	.17
89.0000	.17	.17	.17	.17	.17
89.5000	.17	.17	.17	.16	.16

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (5/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
90.0000	.16	.16	.16	.16	.16
90.5000	.16	.16	.16	.16	.16
91.0000	.16	.16	.16	.16	.16
91.5000	.16	.16	.16	.16	.16
92.0000	.16	.16	.16	.16	.16
92.5000	.15	.15	.15	.15	.15
93.0000	.15	.15	.15	.15	.15
93.5000	.15	.15	.15	.15	.15
94.0000	.15	.15	.15	.15	.15
94.5000	.15	.15	.15	.15	.15
95.0000	.15	.15	.15	.15	.14
95.5000	.14	.14	.14	.14	.14
96.0000	.14	.14	.14	.14	.14
96.5000	.14	.14	.14	.14	.14
97.0000	.14	.14	.14	.14	.14
97.5000	.14	.14	.14	.14	.14
98.0000	.14	.14	.14	.14	.14
98.5000	.14	.13	.13	.13	.13
99.0000	.13	.13	.13	.13	.13
99.5000	.13	.13	.13	.13	.13
100.0000	.13	.13	.13	.13	.13
100.5000	.13	.13	.13	.13	.13
101.0000	.13	.13	.13	.13	.13
101.5000	.13	.13	.13	.13	.12
102.0000	.12	.12	.12	.12	.12
102.5000	.12	.12	.12	.12	.12
103.0000	.12	.12	.12	.12	.12
103.5000	.12	.12	.12	.12	.12
104.0000	.12	.12	.12	.12	.12
104.5000	.12	.12	.12	.12	.12
105.0000	.12	.12	.12	.12	.12
105.5000	.12	.11	.11	.11	.11
106.0000	.11	.11	.11	.11	.11
106.5000	.11	.11	.11	.11	.11
107.0000	.11	.11	.11	.11	.11
107.5000	.11	.11	.11	.11	.11
108.0000	.11	.11	.11	.11	.11
108.5000	.11	.11	.11	.11	.11
109.0000	.11	.11	.11	.11	.11
109.5000	.11	.10	.10	.10	.10
110.0000	.10	.10	.10	.10	.10
110.5000	.10	.10	.10	.10	.10
111.0000	.10	.10	.10	.10	.10

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (6/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
111.5000	.10	.10	.10	.10	.10
112.0000	.10	.10	.10	.10	.10
112.5000	.10	.10	.10	.10	.10
113.0000	.10	.10	.10	.10	.10
113.5000	.10	.10	.10	.10 End discharge	.09
114.0000	.09	.09	.09	.09	.09
114.5000	.09	.09	.09	.09	.09
115.0000	.09	.09	.09	.09	.09
115.5000	.09	.09	.09	.09	.09
116.0000	.09	.09	.09	.09	.09
116.5000	.09	.09	.09	.09	.09
117.0000	.09	.09	.09	.09	.09
117.5000	.09	.09	.09	.09	.09
118.0000	.09	.09	.09	.09	.09
118.5000	.09	.09	.09	.08	.08
119.0000	.08	.08	.08	.08	.08
119.5000	.08	.08	.08	.08	.08
120.0000	.08	.08	.08	.08	.08
120.5000	.08	.08	.08	.08	.08
121.0000	.08	.08	.08	.08	.08
121.5000	.08	.08	.08	.08	.08
122.0000	.08	.08	.08	.08	.08
122.5000	.08	.08	.08	.08	.08
123.0000	.08	.08	.08	.08	.08
123.5000	.08	.08	.08	.08	.08
124.0000	.08	.08	.08	.07	.07
124.5000	.07	.07	.07	.07	.07
125.0000	.07	.07	.07	.07	.07
125.5000	.07	.07	.07	.07	.07
126.0000	.07	.07	.07	.07	.07
126.5000	.07	.07	.07	.07	.07
127.0000	.07	.07	.07	.07	.07
127.5000	.07	.07	.07	.07	.07
128.0000	.07	.07	.07	.07	.07
128.5000	.07	.07	.07	.07	.07
129.0000	.07	.07	.07	.07	.07
129.5000	.07	.07	.07	.07	.07
130.0000	.07	.07	.07	.07	.07
130.5000	.07	.06	.06	.06	.06
131.0000	.06	.06	.06	.06	.06
131.5000	.06	.06	.06	.06	.06
132.0000	.06	.06	.06	.06	.06
132.5000	.06	.06	.06	.06	.06

Type.... Pond Routed HYG (total out)
Name.... SOUTH BASIN2 Tag: 25

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin Outflow Hydrograph (7/7)

WARNING: Hydrograph truncated on right side.

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
133.0000	.06	.06	.06	.06	.06
133.5000	.06	.06	.06	.06	.06
134.0000	.06	.06	.06	.06	.06
134.5000	.06	.06	.06	.06	.06
135.0000	.06	.06	.06	.06	.06
135.5000	.06	.06	.06	.06	.06
136.0000	.06	.06	.06	.06	.06
136.5000	.06	.06	.06	.06	.06
137.0000	.06	.06	.06	.06	.06
137.5000	.06	.06	.06	.06	.05
138.0000	.05	.05	.05	.05	.05
138.5000	.05	.05	.05	.05	.05
139.0000	.05	.05	.05	.05	.05
139.5000	.05	.05	.05	.05	.05
140.0000	.05	.05	.05	.05	.05
140.5000	.05	.05	.05	.05	.05
141.0000	.05	.05	.05	.05	.05
141.5000	.05	.05	.05	.05	.05
142.0000	.05	.05	.05	.05	.05
142.5000	.05	.05	.05	.05	.05
143.0000	.05	.05	.05	.05	.05
143.5000	.05	.05	.05	.05	.05
144.0000	.05	.05	.05	.05	.05
144.5000	.05	.05	.05	.05	.05
145.0000	.05	.05	.05	.05	.05
145.5000	.05	.05	.05	.05	.05
146.0000	.05	.05	.05	.05	.05
146.5000	.05	.05	.04	.04	.04
147.0000	.04	.04	.04	.04	.04
147.5000	.04	.04	.04	.04	.04
148.0000	.04	.04	.04	.04	.04
148.5000	.04	.04	.04	.04	.04
149.0000	.04	.04	.04	.04	.04
149.5000	.04	.04	.04	.04	.04
150.0000	.04	.04	.04	.04	.04
150.5000	.04	.04	.04	.04	.04
151.0000	.04	.04	.04	.04	.04
151.5000	.04	.04	.04	.04	.04
152.0000	.04	.04	.04	.04	.04
152.5000	.04	.04	.04	.04	.04
153.0000	.04	.04	.04	.04	.04
153.5000	.04	.04	.04	.04	.04
154.0000	.04	.04	.04	.04	.04

File.... I:\1370\COLUMBIA.PPK
Title... routing of hydrograph through south basin

South Basin
100-yr, 24-hr storm

LEVEL POOL ROUTING SUMMARY

HYG Dir = I:\1370\
Inflow HYG file = SBASIN.HYG - south basin 100
Outflow HYG file = NONE STORED - SOUTH BASIN2 OUT 100

Pond Node Data = south basin
Pond Volume Data = south basin
Pond Outlet Data = south basin2

No Infiltration

INITIAL CONDITIONS

Starting WS Elev	=	789.00 ft
Starting Volume	=	.000 ac-ft
Starting Outflow	=	.00 cfs
Starting Infiltr.	=	.00 cfs
Starting Total Qout	=	.00 cfs
Time Increment	=	.1000 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY

Peak Inflow	=	110.00 cfs	at	12.4000 hrs
Peak Outflow	=	16.79 cfs	at	13.7000 hrs ← Peak discharge from basin
Peak Elevation	=	793.29 ft ← Peak water elevation		
Peak Storage	=	7.080 ac-ft		

MASS BALANCE (ac-ft)

+ Initial Vol	=	.000
+ HYG Vol IN	=	13.207
- Infiltration	=	.000
- HYG Vol OUT	=	12.435
- Retained Vol	=	.770
Unrouted Vol	=	-.001 ac-ft (.011% of Inflow Volume)

WARNING: Inflow hydrograph truncated on left side.
WARNING: Outflow hydrograph truncated on right side.

References

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

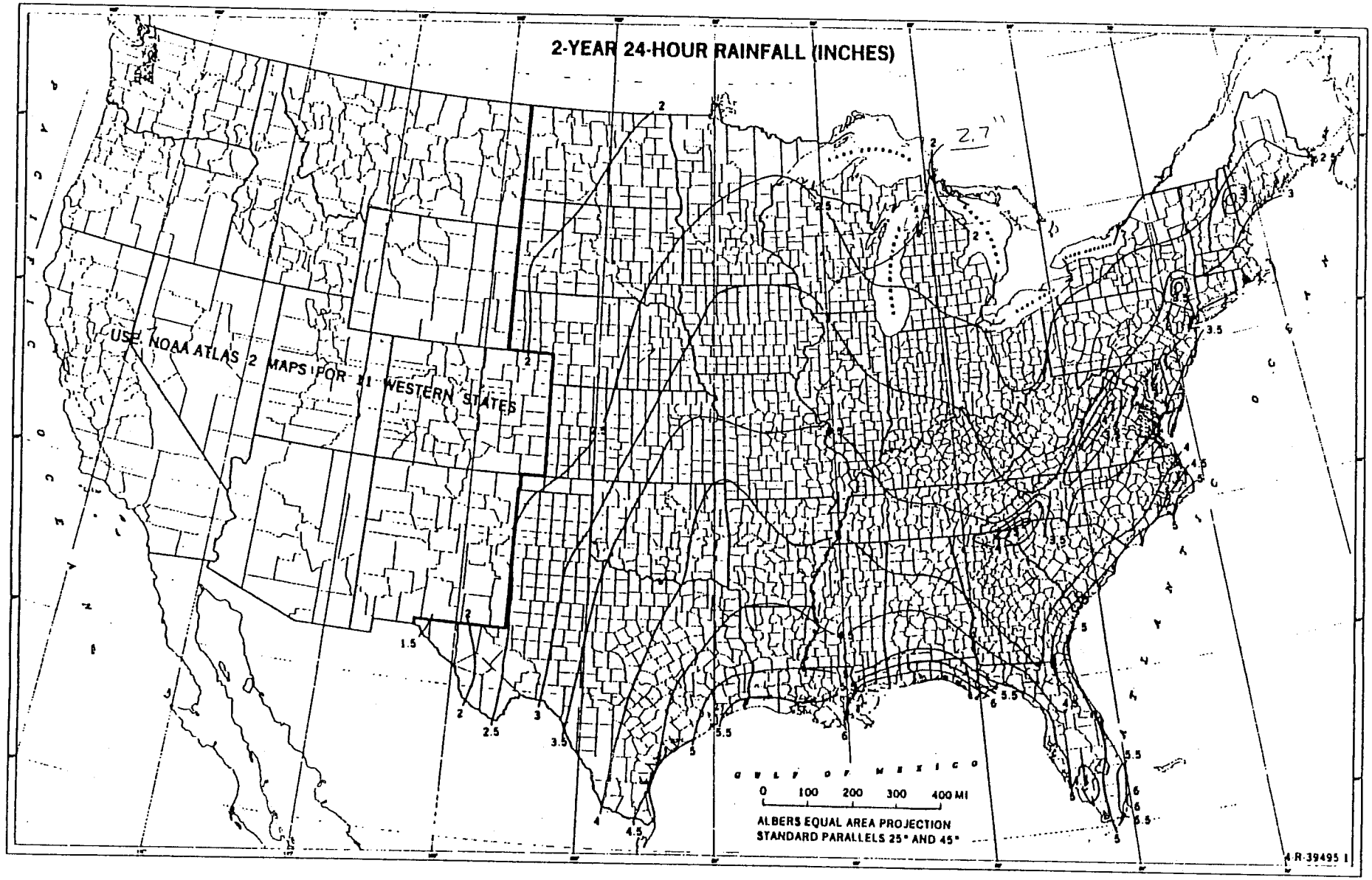

Figure B-3.—Two-year, 24-hour rainfall.

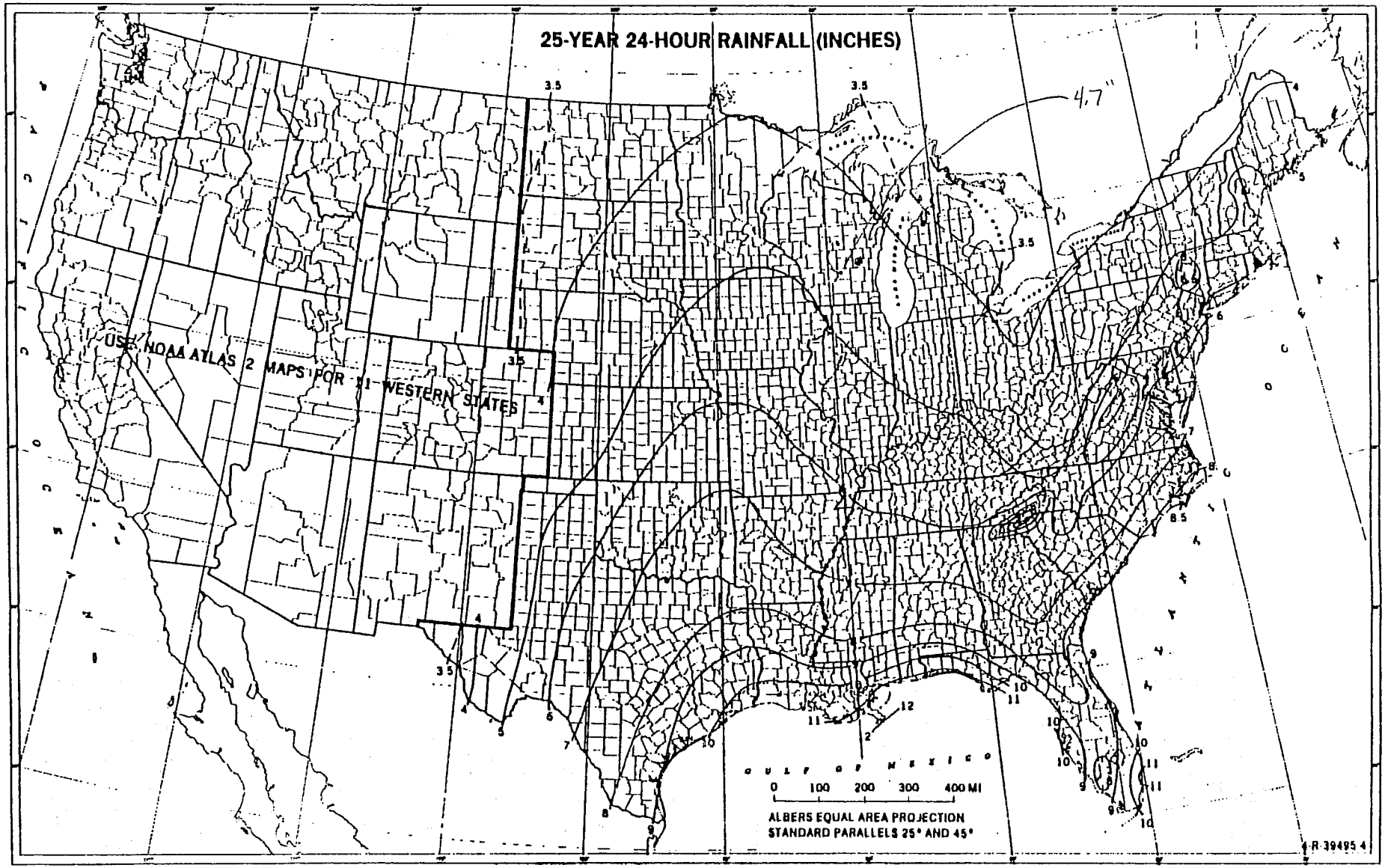

Figure B-6.—Twenty-five-year, 24-hour rainfall.

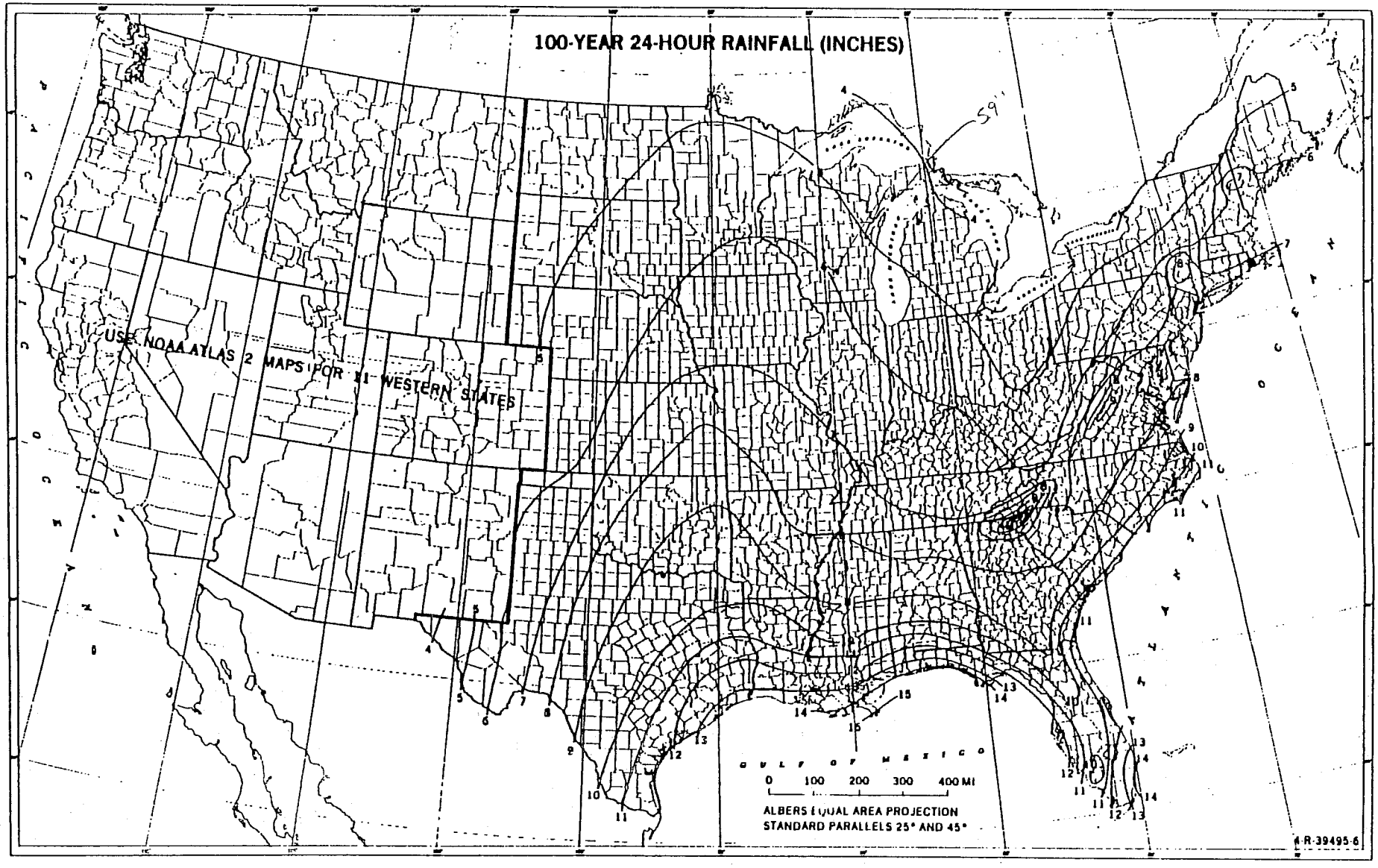

Figure B-8.—One-hundred-year, 24-hour rainfall.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft^2 per ft^3/sec discharge	(m^2 per m^3/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)

0.015 <

→ Ave = 3,125 sf/cfs

weight composed of particles in the 0.01- to 0.02-mm range. A surface area 4 times larger would be needed to capture 5 percent more of this soil.

A balance between the cost-effectiveness of a certain basin size and the desire to capture fine particles must be achieved. It is desirable to capture the very small soil particles (clays and fine silts) because they cause turbidity and other water quality problems. However, Table 8.1 shows that a basin would have to be very large to capture particles smaller than 0.02 mm, particularly clay particles 0.005 mm and smaller. Because of the high cost of trapping very small particles, the authors recommend 0.02 as the design particle size for sediment basins except in areas with coarse soils, where a larger design particle may be used. The 0.02-mm particle is classified as a medium silt by the AASHTO soil classification system.

8.2d Basin Discharge Rate

The peak discharge, calculated by the rational or another approved method, is used to size the basin riser. During any major storm, a sediment basin should fill with water to the top of its riser and then discharge at the rate of inflow to the basin. A sediment basin is not designed with a large water storage volume as is a reservoir. If the inflow exceeds the design peak flow used to size the riser, the overflow should discharge down an emergency spillway.

8.2e Design Runoff Rate

In the equation for surface area of a sediment basin, the discharge rate Q is a variable to be chosen by the designer. The above discussion of basin discharge rate shows that the discharge rate is, to a large extent, equal to the inflow. The riser is sized to handle the peak inflow to the basin. The authors suggest determining the surface area by the *average runoff of a 10-year, 6-hr storm* instead

of the peak flow. A substantial savings in size, and therefore cost, is obtained, and basin efficiency is not significantly decreased.

Consider a basin designed to capture the 0.02-mm particle at the average runoff rate. The average rainfall per hour is 17 percent of the total rainfall in a 6-hr storm (Sec. 4.1f). On a site with soils with a moderately high clay content, under ideal settling conditions this basin would retain about 62 percent of the eroded soil (i.e., 62 percent of the soil, by weight, is composed of 0.02-mm or larger particles).

If the surface area of this basin were instead designed for the peak flow, it would be roughly 3 times larger. According to data from the U.S. Bureau of Reclamation (10), 25 percent of the total rainfall in a 6-hr storm falls in a ½-hr period (Fig. 4.2). Since the rainfall intensity i value is in units of inches (or millimeters) per hour, the peak flow can be calculated by using an i value of 50 percent of the 6-hr total. Since basin surface area is directly proportional to the discharge rate ($A = 1.2Q/V_s$) and the peak discharge rate in a 6-hr storm is 2.9 times the average rate (50% = 2.9 × 17%), the surface area sized for the peak flow would be about 3 times the surface area sized for the average flow. The basin sized for the peak flow would capture, during most of the storm except the peak, particles with approximately one-third the settling velocity of the design particle. Since the 0.02-mm particle settles at 0.00096 ft/sec (0.00029 m/sec), particles with a settling velocity of 0.00032 ft/sec (0.000098 m/sec) would then be captured. These are approximately 0.01-mm particles.

Suppose a basin on a site with clayey soils were sized by using the peak runoff rate. For the purpose of illustration, suppose the soil composition were typical of the San Francisco Bay Area as in the preceding example (62 percent of particles, by weight, greater than 0.02 mm and 5 percent, by weight, from 0.01 to 0.02 mm). A basin with a large surface area based on the peak runoff would capture the 0.01- to 0.02-mm particles as well as particles greater than 0.02 mm, or 67 percent of the eroded material. The basin efficiency would be increased 8 percent (5/62) by tripling the surface area. Thus it is generally much more cost-effective to size a basin by using the average runoff rather than the peak, and basin efficiency will not be significantly lower.

8.2f Settling Depth

If a basin is too shallow, water flowing rapidly through the basin may resuspend settled particles and decrease efficiency of capture. A similar problem occurs in grit-settling chambers at sewage treatment plants, where velocity must be controlled to prevent particle resuspension. An equation that describes scour in a grit chamber (2) is:

$$V_{scour} = \frac{1.486}{n} \times \left[r^{1/6} \times k(S_s - 1) \times \frac{d}{304.8} \right]^{1/2}$$

Source: Goldman, S.J., et al. 1986. Erosion and Sediment Control Handbook. New York McGraw-Hill 1986

542,000 N

542,500 N

543,000 N

543,500 N

2,124,000 E

2,124,500 E

C. M. ST. P. & P. RR.

PIPELINE

199,619 SF

West peripheral area

1,168,435 SF

121,578

1530' @ 21°

SWAMP ELEV. 827

W.L. 794.1

LEGEND

PROPOSED LIMITS OF FILL	PAVED ROAD
APPROVED LIMITS OF FILL	UNPAVED ROAD
EXISTING SPOT ELEVATION	VEGETATION
EXISTING GRADES (5' INTERVAL)	RAILROAD TRACKS
EXISTING GRADES (1' INTERVAL)	FENCE
EDGE OF WATER	CULVERT

Areas obtained from AutoCADD

60 0 60

SCALE: 1" = 60'

N

PROPOSED FINAL GRADES

PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN

PROJECT NO. 1370	
DRAWN BY: RR/KP	BT² inc.
CHECKED BY: MRH	SHEET 4 OF 8
DRAWN: 07/28/00 REVISED: 08/16/00	
J:\1370\PO UPDATE\1370FG04.DWG	

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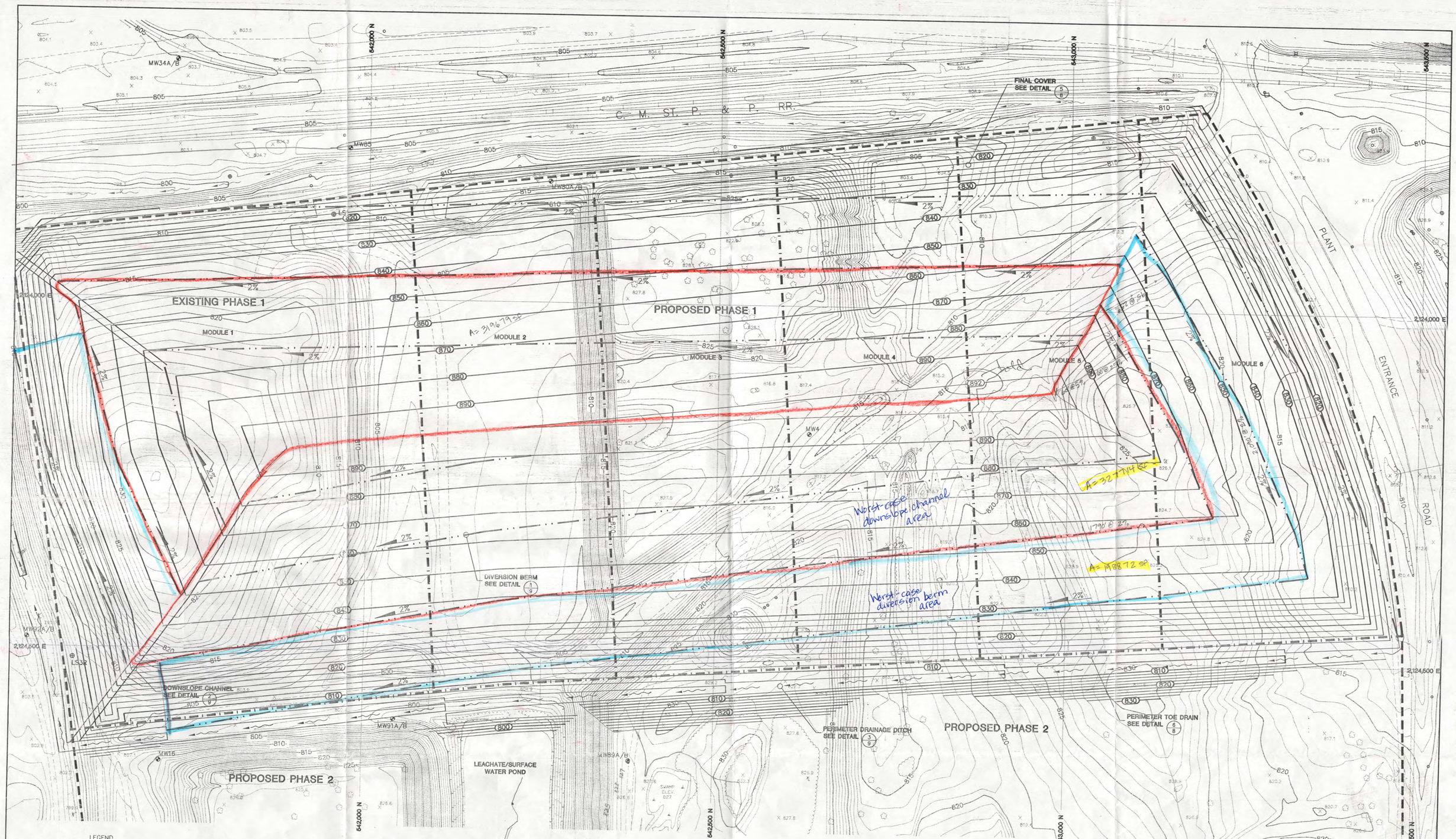

LEGEND

- PHASE/MODULE LIMIT
- APPROVED LIMITS OF FILL
- EXISTING SPOT ELEVATION
- EXISTING GRADES (5' INTERVAL)
- EXISTING GRADES (1' INTERVAL)
- EDGE OF WATER
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- RAILROAD TRACKS
- FENCE
- CULVERT
- PROPOSED FINAL GRADES (5' INTERVAL)
- PROPOSED FINAL GRADES (1' INTERVAL)
- PROPOSED DIVERSION BERM
- PROPOSED DOWNSLOPE CHANNEL
- DRAINAGE DITCH

60 0 60
SCALE: 1" = 60'

N

DRAFT

PROPOSED FINAL GRADES

PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN

PROJECT NO. 1370	
DRAWN BY: RR/KP	
CHECKED BY: MRH	
DRAWN: 07/28/00 REVISED: 08/25/00	
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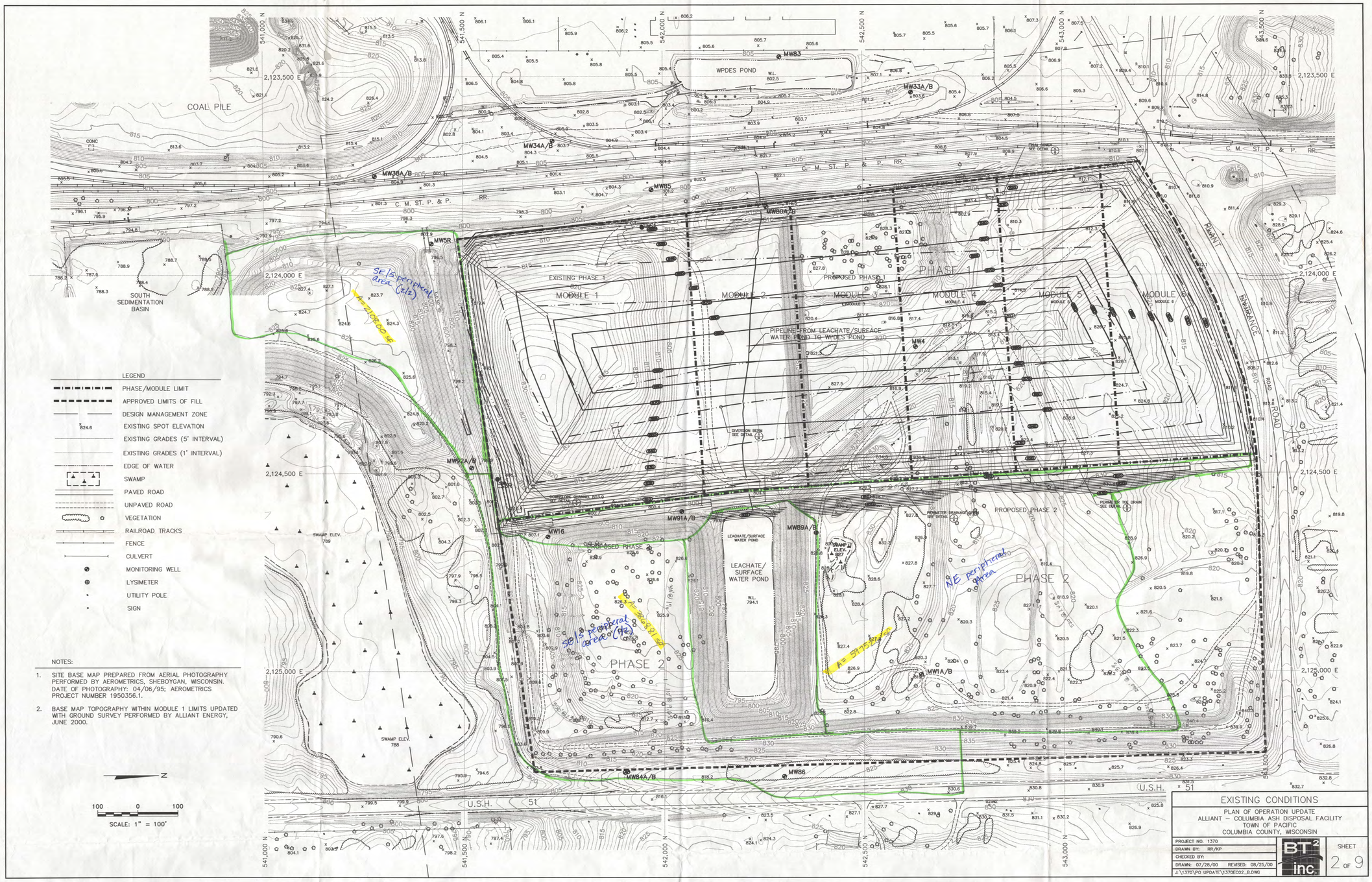
BT² inc.

SHEET 4 OF 9

#1370 ON



LEGEND

- PHASE/MODULE LIMIT
- APPROVED LIMITS OF FILL
- DESIGN MANAGEMENT ZONE
- EXISTING SPOT ELEVATION (824.6)
- EXISTING GRADES (5' INTERVAL)
- EXISTING GRADES (1' INTERVAL)
- EDGE OF WATER
- SWAMP
- PAVED ROAD
- UNPAVED ROAD
- VEGETATION
- RAILROAD TRACKS
- FENCE
- CULVERT
- MONITORING WELL
- LYSIMETER
- UTILITY POLE
- SIGN

NOTES:

1. SITE BASE MAP PREPARED FROM AERIAL PHOTOGRAPHY PERFORMED BY AEROMETRICS, SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY: 04/06/95; AEROMETRICS PROJECT NUMBER 1950356.1.
2. BASE MAP TOPOGRAPHY WITHIN MODULE 1 LIMITS UPDATED WITH GROUND SURVEY PERFORMED BY ALLIANT ENERGY, JUNE 2000.

N

100 0 100

SCALE: 1" = 100'

EXISTING CONDITIONS

PLAN OF OPERATION UPDATE
ALLIANT – COLUMBIA ASH DISPOSAL FACILITY
TOWN OF PACIFIC
COLUMBIA COUNTY, WISCONSIN

PROJECT NO. 1370	SHEET 2 OF 9
DRAWN BY: RR/KP	
CHECKED BY:	
DRAWN: 07/28/00 REVISED: 08/25/00	
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BT² inc.

#1370 ON

Surface Water Runoff Capacity Evaluation
Leachate/Surface Water Pond

Purpose:
To purpose of these calculations is to:

- Evaluate the capacity of the leachate/surface water pond to accommodate the runoff from a 25-year, 25-hour storm event for various stages of Phase 1 development.
- Determine the maximum operating level the pond must be maintained at to accommodate the runoff from the 25-year, 24-hour storm during various stages of development.

Approach:

- Delineate the watershed to the leachate/surface water pond at various stages of development of Phase 1.
- Gather the leachate/surface water pond design information.
- Use the HydroCAD model to generate the runoff hydrographs for the 25-year, 24 hour storm and route the runoff to the leachate/surface water pond. Perform this modeling for each stage of development of Phase 1 (current condition through Module 6 development).
- Use the results of the HydroCAD modeling to determine the maximum operating level of the pond during various stages of development.

Assumptions:

- See the attached figure for approximate watersheds to the leachate/surface water pond for each stage of development.
- Active/open landfill areas were assumed to be impermeable (curve number = 98).
- Areas outside of the modules that drain to the leachate/surface water pond were assumed to have a curve number of 49.
- Three modules were assumed to be open at any stage of development.
- Runoff from areas with final cover will be routed to the sedimentation basin and are therefore not included in the runoff to the leachate/surface water pond.
- The bottom of the pond is at 792, and the top of the lined portion of the pond extends to 798, based on the Plan of Operation pond design.

Results:
The attached table (see Sheet 2) summarizes the results of the evaluation. If operated at the levels indicated on the table, the existing leachate/surface water pond has sufficient capacity to accommodate the runoff from a 25-year, 24-hour storm event at each stage of Phase 1 development. Detailed HydroCAD modeling results are attached.

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Table 3.4
Leachate/Suface Water Pond Capacity Evaluation Summary

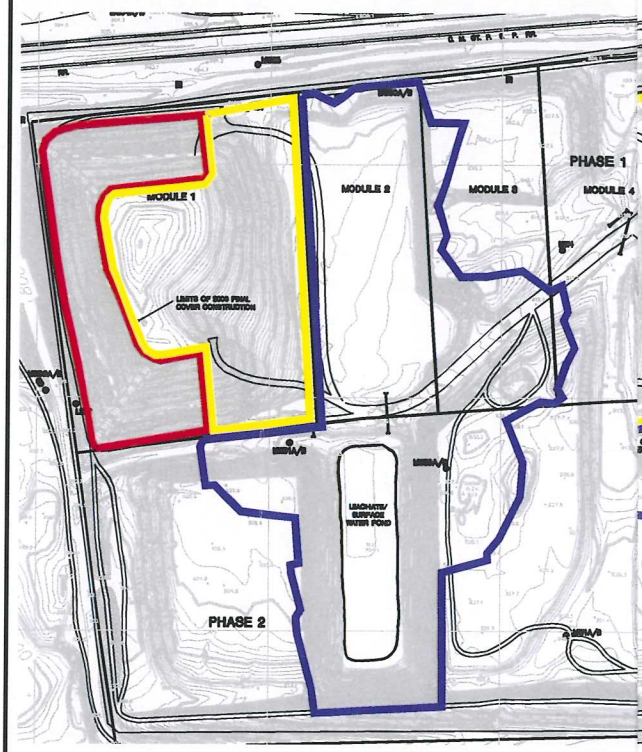
Description	Bottom of Pond	Top of Pond (i.e.,Top of Liner)	Peak Water Elevation (25-yr, 24-hr storm)	Freeboard	Max Operating Water Level
Existing Conditions	792	798	795.15	2.85	794.85
Mod 2 Constructed	792	798	796.14	1.86	793.86
Mod 3 Constructed	792	798	797.17	0.83	792.83
Mod 4 Constructed (Mod 1 Closed)	792	798	796.82	1.18	793.18
Mod 5 Constructed (Mods 1, 2 Closed)	792	798	796.85	1.15	793.15
Mod 6 Constructed (Mods 1, 2, 3 Closed)	792	798	796.5	1.5	793.5

Notes:

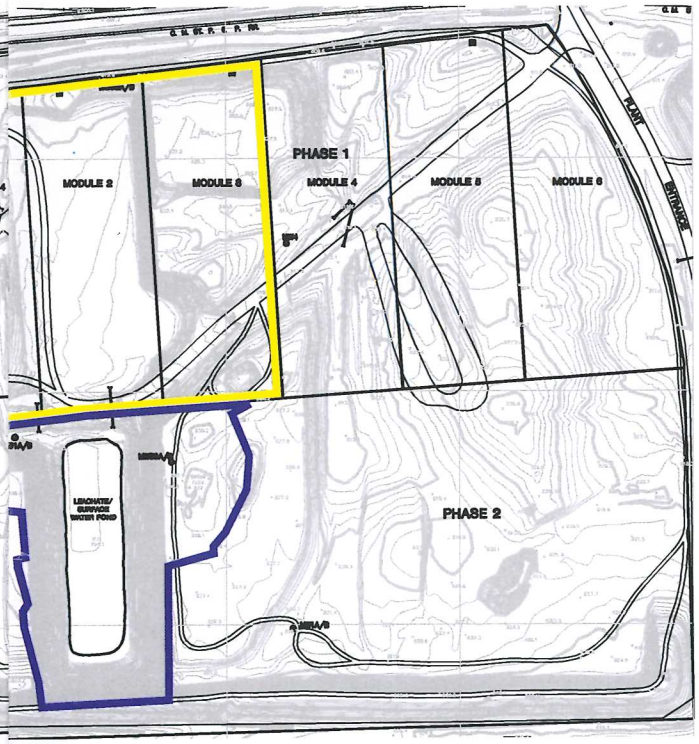
1. See attached figure for contributing watershed areas during each stage of development.
2. Bottom and top of pond elevations from Plan of Operation.
3. Peak water elevation (25-year, 24-hour storm) from stormwater modelling results.
4. Freboard = Top of Pond - Peak Water Elevation
5. Max Operating Water Level = Bottom of Pond + Freeboard. This is the maximum elevation the water should be maintained at to still accommodate the runoff from a 25-year, 24-hour storm within the lined pond area.

I:\4071\Calculations\Leachate Pond\[Pond_Volume_Planning_Calcs_100909.xls]Sheet1

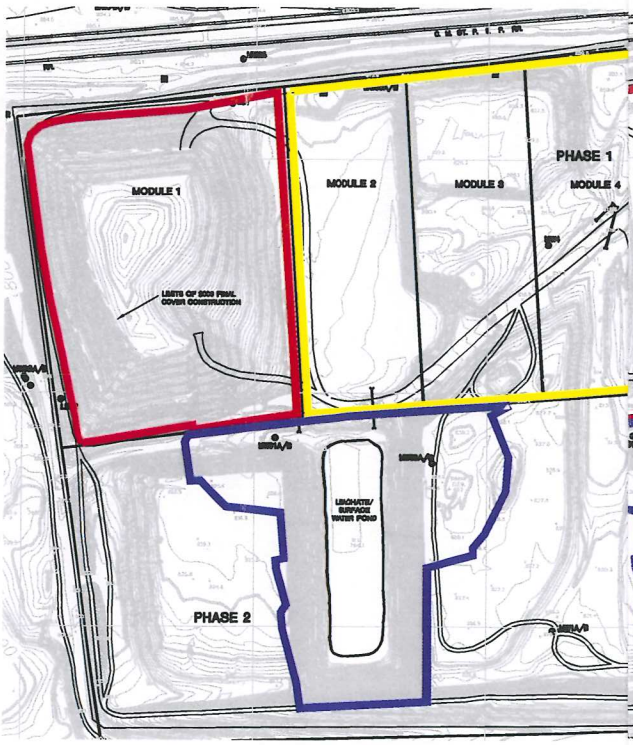
2/11



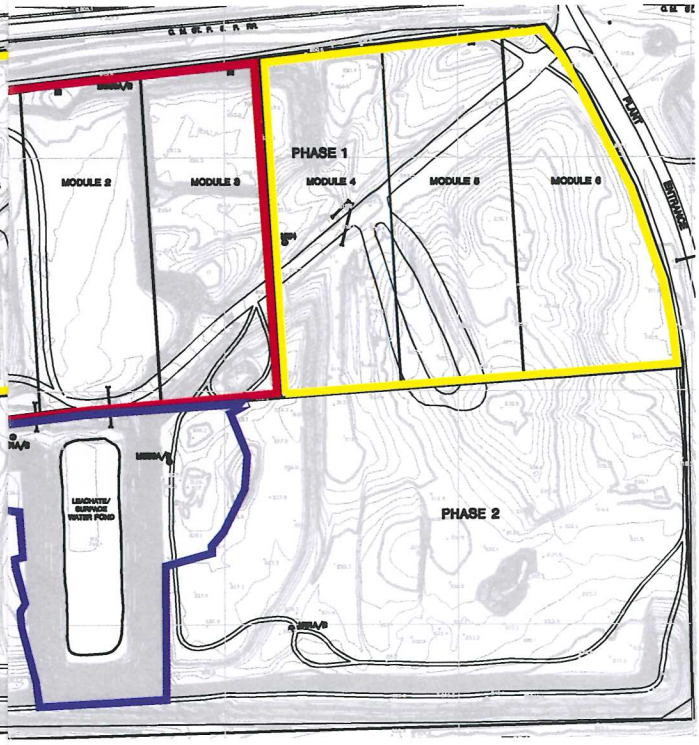
EXISTING CONDITIONS



MODULE 3 CONSTRUCTED



MODULE 4 CONSTRUCTED



MODULE 6 CONSTRUCTED

FINAL COVER AREA
OPEN MODULE AREA (IMPERMEABLE)
WATERSHED/AREA OUTSIDE OF CONSTRU

N

400 0 400

SCALE: 1" = 400'

PROJECT NO.	4071	DRAWN BY:	PE	LEACHATE POND PLANNING	FIGURE 1
DRAWN:	09/20/10	CHECKED BY:	BF		
REVISED:	09/20/10	APPROVED BY:			

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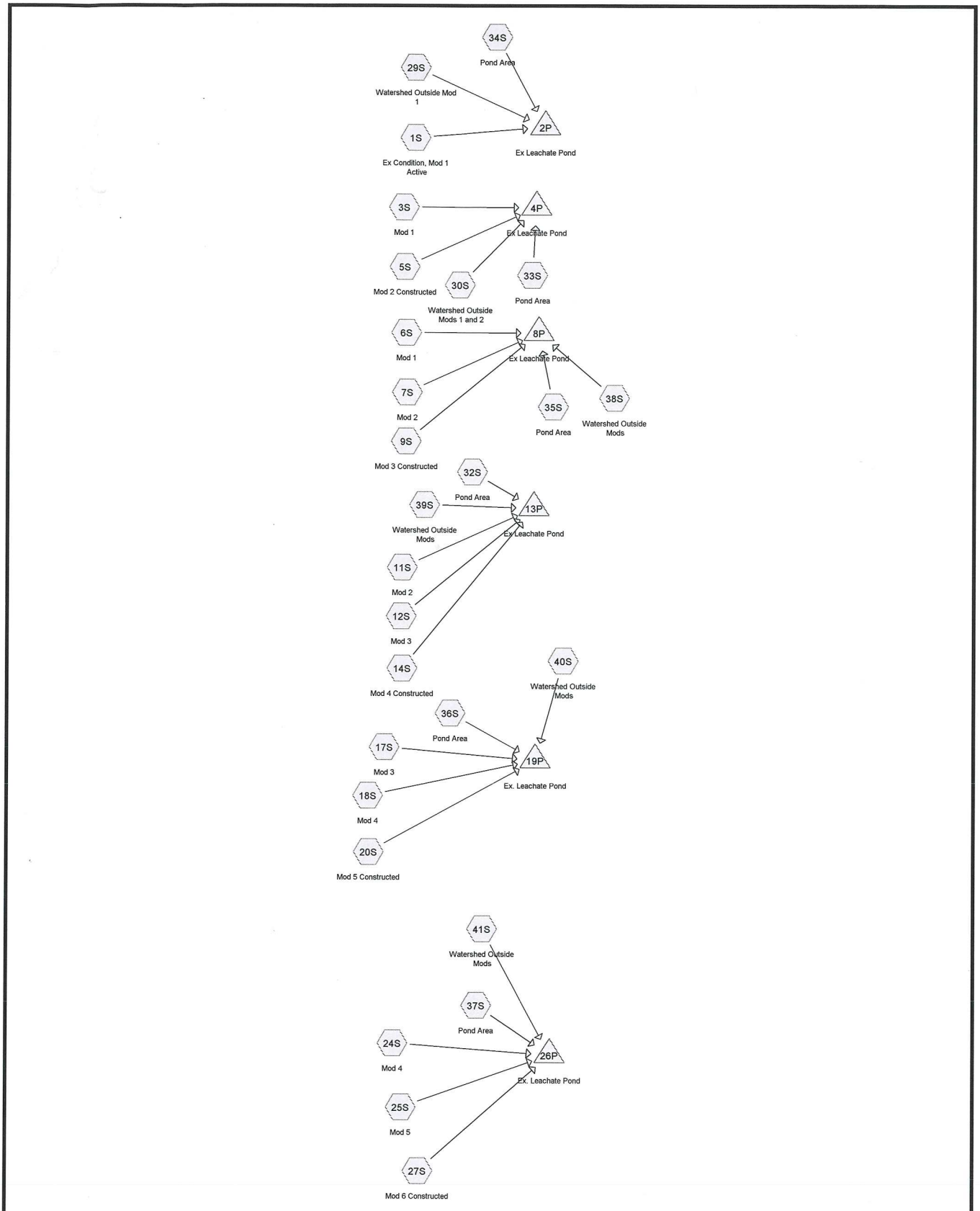


Drainage Diagram for Existing Conditions_rev1
Prepared by BT Squared, Printed 10/29/2010
HydroCAD® 8.50 s/n 005804 © 2007 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Ex Condition, Mod 1 Active

Runoff = 29.59 cfs @ 12.06 hrs, Volume= 2.015 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	5.900	98	Mod 1, no cover
	5.900		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Summary for Subcatchment 3S: Mod 1

Runoff = 29.59 cfs @ 12.06 hrs, Volume= 2.015 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	5.900	98	Mod 1 no cover
	5.900		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Summary for Subcatchment 5S: Mod 2 Constructed

Runoff = 21.25 cfs @ 12.06 hrs, Volume= 1.447 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	184,600	98	Mod 2, no cover
	184,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Summary for Subcatchment 6S: Mod 1

Runoff = 29.59 cfs @ 12.06 hrs, Volume= 2.015 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	5.900	98	Mod 1 no cover
	5.900		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Summary for Subcatchment 7S: Mod 2

Runoff = 21.25 cfs @ 12.06 hrs, Volume= 1.447 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	184,600	98	Mod 2 final cover
	184,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Summary for Subcatchment 9S: Mod 3 Constructed

Runoff = 19.31 cfs @ 12.11 hrs, Volume= 1.506 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	192,125	98	Mod 3 no cover
	192,125		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 11S: Mod 2

Runoff = 21.25 cfs @ 12.06 hrs, Volume= 1.447 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	184,600	98	Mod 2 final cover
	184,600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Summary for Subcatchment 12S: Mod 3

Runoff = 19.31 cfs @ 12.11 hrs, Volume= 1.506 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	192,125	98	Mod 3
	192,125		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 14S: Mod 4 Constructed

Runoff = 17.23 cfs @ 12.17 hrs, Volume= 1.518 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	193,700	98	Mod 4 no cover
	193,700		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Summary for Subcatchment 17S: Mod 3

Runoff = 19.31 cfs @ 12.11 hrs, Volume= 1.506 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	192,125	98	Mod 3
	192,125		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Summary for Subcatchment 18S: Mod 4

Runoff = 17.23 cfs @ 12.17 hrs, Volume= 1.518 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	193,700	98	Mod 4
	193,700		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Summary for Subcatchment 20S: Mod 5 Constructed

Runoff = 15.25 cfs @ 12.23 hrs, Volume= 1.499 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	191,250	98	Mod 5 no cover
	191,250		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Estimated**

Summary for Subcatchment 24S: Mod 4

Runoff = 17.23 cfs @ 12.17 hrs, Volume= 1.518 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	193,700	98	Mod 4
	193,700		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Summary for Subcatchment 25S: Mod 5

Runoff = 15.25 cfs @ 12.23 hrs, Volume= 1.499 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	191,250	98	Mod 5
	191,250		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Estimated**

Summary for Subcatchment 27S: Mod 6 Constructed

Runoff = 9.37 cfs @ 12.28 hrs, Volume= 1.014 af, Depth> 4.09"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (sf)	CN	Description
*	129,500	98	Mod 6 no cover
	129,500		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.0					**Direct Entry, Estimated**

Summary for Subcatchment 29S: Watershed Outside Mod 1

Runoff = 3.43 cfs @ 12.12 hrs, Volume= 0.321 af, Depth> 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	8.700	49	Watershed Outside Mod 1
	8.700		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Summary for Subcatchment 30S: Watershed Outside Mods 1 and 2

Runoff = 1.78 cfs @ 12.12 hrs, Volume= 0.166 af, Depth> 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	4.500	49	Watershed outside Mods 1 and 2
	4.500		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Summary for Subcatchment 32S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 30.05 cfs @ 11.89 hrs, Volume= 1.367 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	4.000	98	
	4.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 33S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 30.05 cfs @ 11.89 hrs, Volume= 1.367 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	4.000	98	
	4.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 34S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 30.05 cfs @ 11.89 hrs, Volume= 1.367 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	4.000	98	
	4.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 35S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 30.05 cfs @ 11.89 hrs, Volume= 1.367 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	4.000	98	
	4.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 36S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 30.05 cfs @ 11.89 hrs, Volume= 1.367 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	4.000	98	
	4.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 37S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 30.05 cfs @ 11.89 hrs, Volume= 1.367 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	4.000	98	
	4.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 38S: Watershed Outside Mods

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.53 cfs @ 11.99 hrs, Volume= 0.086 af, Depth> 0.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	2.300	49	Watershed area outside Modules
	2.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment 39S: Watershed Outside Mods

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 1.83 cfs @ 11.92 hrs, Volume= 0.086 af, Depth> 0.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	2.300	49	Watershed area outside Modules
	2.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 5**

Summary for Subcatchment 40S: Watershed Outside Mods

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.53 cfs @ 11.99 hrs, Volume= 0.086 af, Depth> 0.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	2.300	49	Watershed area outside Modules
	2.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Subcatchment 41S: Watershed Outside Mods

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.53 cfs @ 11.99 hrs, Volume= 0.086 af, Depth> 0.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.70"

	Area (ac)	CN	Description
*	2.300	49	Watershed area outside Modules
	2.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Summary for Pond 2P: Ex Leachate Pond

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.600 ac, 53.23% Impervious, Inflow Depth > 2.39" for 25-yr event
Inflow = 45.48 cfs @ 11.90 hrs, Volume= 3.703 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 795.15' @ 20.00 hrs Surf.Area= 55,552 sf Storage= 161,220 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	331,470 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	47,000	0	0
793.00	49,640	48,320	48,320
794.00	52,350	50,995	99,315
795.00	55,131	53,741	153,056
796.00	57,985	56,558	209,614
797.00	60,910	59,448	269,061
798.00	63,908	62,409	331,470

Summary for Pond 4P: Ex Leachate Pond

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.638 ac, 75.86% Impervious, Inflow Depth > 3.22" for 25-yr event
Inflow = 57.35 cfs @ 11.91 hrs, Volume= 4.995 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 796.14' @ 20.00 hrs Surf.Area= 58,382 sf Storage= 217,505 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	331,470 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	47,000	0	0
793.00	49,640	48,320	48,320
794.00	52,350	50,995	99,315
795.00	55,131	53,741	153,056
796.00	57,985	56,558	209,614
797.00	60,910	59,448	269,061
798.00	63,908	62,409	331,470

Summary for Pond 8P: Ex Leachate Pond

[82] Warning: Early inflow requires earlier time span

Inflow Area = 20.848 ac, 88.97% Impervious, Inflow Depth > 3.70" for 25-yr event
Inflow = 73.20 cfs @ 12.07 hrs, Volume= 6.421 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 797.17' @ 20.00 hrs Surf.Area= 61,426 sf Storage= 279,584 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	331,470 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	47,000	0	0
793.00	49,640	48,320	48,320
794.00	52,350	50,995	99,315
795.00	55,131	53,741	153,056
796.00	57,985	56,558	209,614
797.00	60,910	59,448	269,061
798.00	63,908	62,409	331,470

Summary for Pond 13P: Ex Leachate Pond

[82] Warning: Early inflow requires earlier time span

Inflow Area = 19.395 ac, 88.14% Impervious, Inflow Depth > 3.67" for 25-yr event
Inflow = 59.07 cfs @ 12.10 hrs, Volume= 5.924 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Peak Elev= 796.82' @ 20.00 hrs Surf.Area= 60,374 sf Storage= 257,959 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	331,470 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	47,000	0	0
793.00	49,640	48,320	48,320
794.00	52,350	50,995	99,315
795.00	55,131	53,741	153,056
796.00	57,985	56,558	209,614
797.00	60,910	59,448	269,061
798.00	63,908	62,409	331,470

Summary for Pond 19P: Ex. Leachate Pond

[82] Warning: Early inflow requires earlier time span

Inflow Area = 19.548 ac, 88.23% Impervious, Inflow Depth > 3.67" for 25-yr event
Inflow = 53.67 cfs @ 12.15 hrs, Volume= 5.975 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 796.85' @ 20.00 hrs Surf.Area= 60,482 sf Storage= 260,174 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	331,470 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	47,000	0	0
793.00	49,640	48,320	48,320
794.00	52,350	50,995	99,315
795.00	55,131	53,741	153,056
796.00	57,985	56,558	209,614
797.00	60,910	59,448	269,061
798.00	63,908	62,409	331,470

Summary for Pond 26P: Ex. Leachate Pond

[82] Warning: Early inflow requires earlier time span

Inflow Area = 18.110 ac, 87.30% Impervious, Inflow Depth > 3.63" for 25-yr event
Inflow = 44.18 cfs @ 12.21 hrs, Volume= 5.483 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 796.50' @ 20.00 hrs Surf.Area= 59,437 sf Storage= 238,762 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	331,470 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	47,000	0	0
793.00	49,640	48,320	48,320
794.00	52,350	50,995	99,315
795.00	55,131	53,741	153,056
796.00	57,985	56,558	209,614
797.00	60,910	59,448	269,061
798.00	63,908	62,409	331,470

SCS ENGINEERS					
		SHEET NO.	1 of 2		
Job No.	25215024	CALC. NO.			
Job:	Columbia Energy Center	REV. NO.			
Client	WPL	BY	BLP	DATE	6/9/15
Subject	Leachate/Surface Water Pond Evaluation	CHK'D.	MRH	DATE	6/9/15

Purpose:
The purpose of the leachate/surface water pond evaluation is to determine the following based on the as-built leachate/surface water pond top of liner elevation of 796.97 (see Background section below):

- The amount of intermediate/final cover area required during each remaining phase of development (Modules 3 – 6) in order to store the 25-year 24-hour storm at/below the top of the pond liner (elevation 796.97).
- The largest storm event the leachate/surface water pond can store during each remaining phase (Modules 3-6) of development with no additional intermediate/final cover installed, while maintaining the pond peak water elevation at/below the top of the liner (elevation 796.97).

Background:
During construction of Module 2, the top of the the leachate/surface water pond liner was determined to be at elevation 796.97, which is below the design elevation of 798. The Surface Water Runoff Capacity Evaluation, Leachate/Surface Water Pond calculations included in the 2010 Plan of Operation Update were based on the design elevation of 798.

Approach:
- Start with the HydroCAD storm water model from the 2010 Plan of Operation Update, and perform the following:
    - Review drainage areas based on latest topography (December 2014 aerial survey) and modify accordingly.
    - Update the pond stage-storage data based on as-built drawings. As-built contours were digitized into a CAD drawing, and the surface area of each contour measured in AutoCAD.
    - Set a standing water elevation in the pond at 6 inches off of the bottom (i.e., elevation 792.5).
    - Update Plan of Operation Update precipitation depths and distribution using NOAA Atlas 14 and associated hydrograph distributions developed for Wisconsin.
    - Run the HydroCAD model for the following scenarios with Module 3 constructed and active/open:
        - Model Run 1A: Modify the Module 1 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 1B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.
    - Run the HydroCAD model for the following scenarios during Module 4 constructed and active/open:

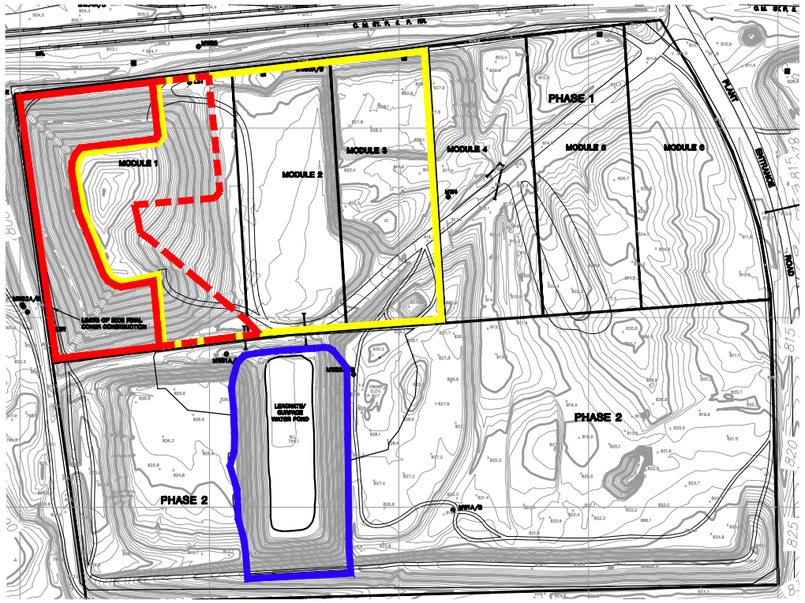
        - Model Run 2A: Modify the Module 2 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 2B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.
    - Run the HydroCAD model for the following scenarios during Module 5 constructed and active/open:
        - Model Run 3A: Modify the Module 3 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 3B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.
    - Run the HydroCAD model for the following scenarios during Module 6 constructed and active/open:
        - Model Run 4A: Modify the Module 4 open/active area draining to the pond until the maximum peak water elevation of 769.97 or less is obtained in the pond for a 25-year, 24-hour storm event.
        - Model Run 4B: Run the model at various precipitation depths to determine the maximum storm event the pond can store without additional intermediate/final cover.

Assumptions:

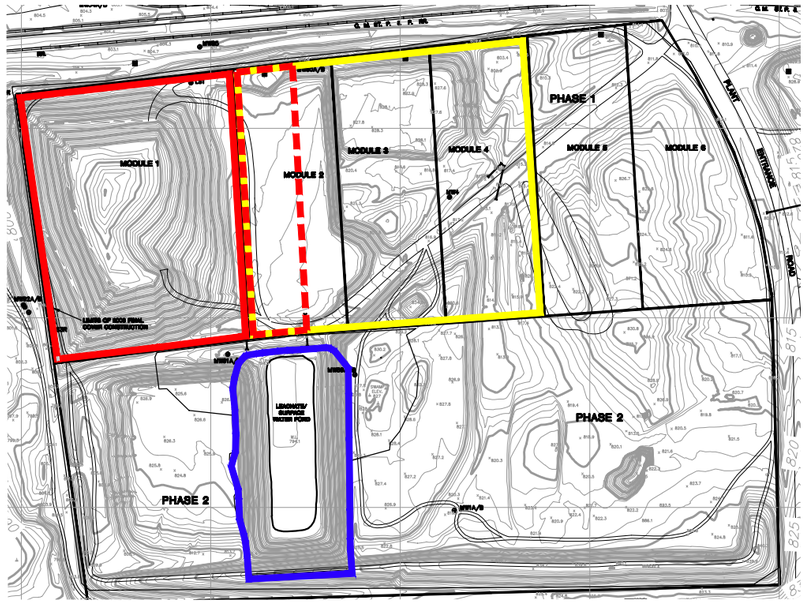
- See attached Figure 1 for approximate watersheds to the leachate/surface water pond. Modifications were made to the watersheds presented in the 2010 Plan of Operation Update to account for changes in topography and drainage patterns outside the limits of waste since the 2010 Plan of Operation Update.
- Active/open landfill areas were assumed to be impermeable (CN=98).
- Runoff from areas with intermediate or final cover will be routed to the sedimentation basin and are therefore not included in the runoff to the leachate/surface water pond.
- Three modules were assumed to be open at any stage of development.
- The bottom of the pond is at 792. The starting water level in the pond prior to the modeled storm event is 6 inches (elevation 792.5).

Results:

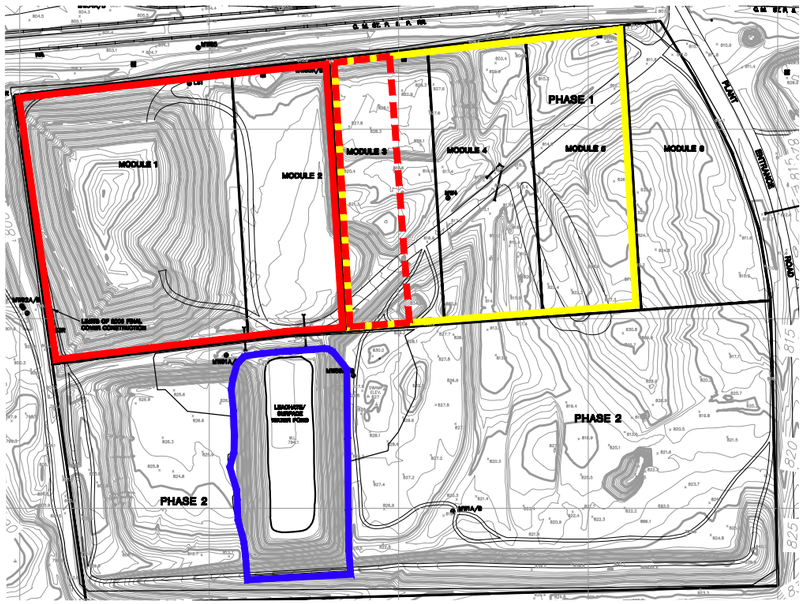
See attached summary table for each model run. See attached HydroCAD model results for detailed input/output for each of the above model runs.



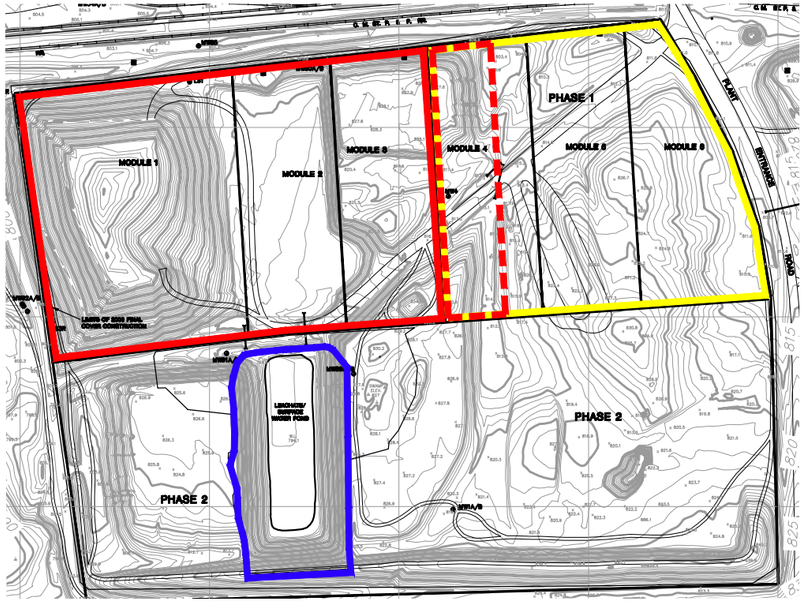
MODULE 3 CONSTRUCTED



MODULE 4 CONSTRUCTED



MODULE 5 CONSTRUCTED



MODULE 6 CONSTRUCTED

ADDITIONAL INTERMEDIATE/FINAL COVER AREA
FINAL COVER AREA
OPEN MODULE AREA (IMPERMEABLE)
WATERSHED/AREA OUTSIDE OF CONSTRUCTED MODULES

400 0 400

SCALE: 1" = 400'

PROJECT NO.	25214194	DRAWN BY:	PEG/JMO
DRAWN:	09/20/10	CHECKED BY:	BP
REVISED:	06/09/15	APPROVED BY:	

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

CLIENT: Wisconsin Power and Light Company

SITE: WISCONSON POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

LEACHATE POND PLANNING

FIGURE 1

I:\25215024\Drawings\ ea ate ond lanning.dwg , 6/9/2015 6:00:42 M

Leachate/Suface Water Pond Capacity Evaluation Summary
Columbia Energy Center

Module Summary

Module	Module Size (ac)
Module 1	9.00
1 (Currently Open/Active)	*5.31*
1 (Currently Closed)	*3.69*
Module 2	4.27
Module 3	4.33
Module 4	4.39
Module 5	4.46
Module 6	4.38

Evaluation Summary

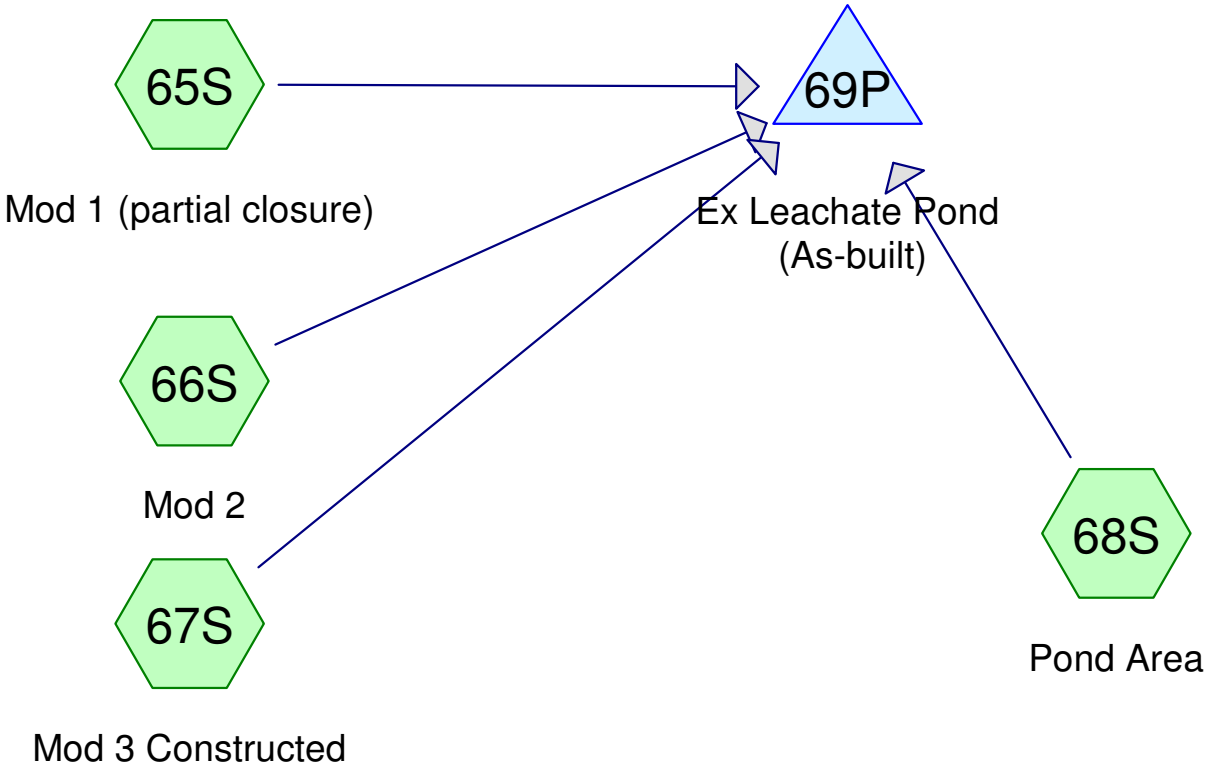
Description [1]	Modules Open/Active [4]	Total Area of Modules (see Module Summary table above)	Bottom of Pond [2]	Top of Pond (i.e.,Top of Liner/Maximum Allowable Water Elevation In Pond) [2]	Standing Water Elevation in Pond Prior to Start of Storm Event [2]	Peak Water Elevation (25-yr, 24-hr storm) [3]	Intermediate/Final Cover Area Required Within 3 Open/Active Modules to Maintain Maximum Allowable Pond Water Elevation [4,5]	Maximum Precipitation Depth Pond Can Accommodate Without Additional Intermediate/Final Cover while Maintainin Maximum Allowable Pond Water Elevation [6]
Mod 3 Constructed (Portion of Mod 1 is Currently Closed)	1, 2, 3	17.6	792	796.97	792.5	796.97	3.43 acres	4.0" (10-year event)
Mod 4 Constructed (Mod 1 Closed)	2, 3, 4	12.99	792	796.97	792.5	796.97	2.51 acres	4.21" (approximately 10-year event)
Mod 5 Constructed (Mods 1, 2 Closed)	3, 4, 5	13.18	792	796.97	792.5	796.97	2.70 acres	4.16" (approximately 10-year event)
Mod 6 Constructed (Mods 1, 2, 3 Closed)	4, 5, 6	13.23	792	796.97	792.5	796.97	2.75 acres	4.15" (approximately 10-year event)

Notes:

1. See attached Figure 1 for contributing watershed areas during each stage of development.
2. Bottom of pond elevation from Plan of Operation. Top of Pond from survey performed during Module 2 construction. Six inches of water assumed to be standing in pond prior to storm event.
3. Peak water elevation (25-year, 24-hour storm) from stormwater modelling results (attached).
4. Three modules were assumed to be open at any give stage of development.
5. Intermediate/Final cover area required determined by adjusting amount of open/active area until the maximum water elevation of 796.97 was obtained. Area reported is in addition to existing final cover area in Module 1.
6. Below is a summary of the precipitation depths associated with various design storm events:

   5-year, 24-hour storm event = 3.38"
   10-year, 24-hour storm event = 3.97"
   25-year, 24-hour storm event = 4.90"

Model Run 1A



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 65S: Mod 1 (partial closure) Runoff Area=1.880 ac 100.00% Impervious Runoff Depth=4.66"
Tc=15.0 min CN=98 Runoff=8.85 cfs 0.731 af

Subcatchment 66S: Mod 2 Runoff Area=4.270 ac 100.00% Impervious Runoff Depth=4.66"
Tc=15.0 min CN=98 Runoff=20.09 cfs 1.659 af

Subcatchment 67S: Mod 3 Constructed Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=17.76 cfs 1.683 af

Subcatchment 68S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 69P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=260,152 cf Inflow=55.31 cfs 5.612 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.612 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 65S: Mod 1 (partial closure)

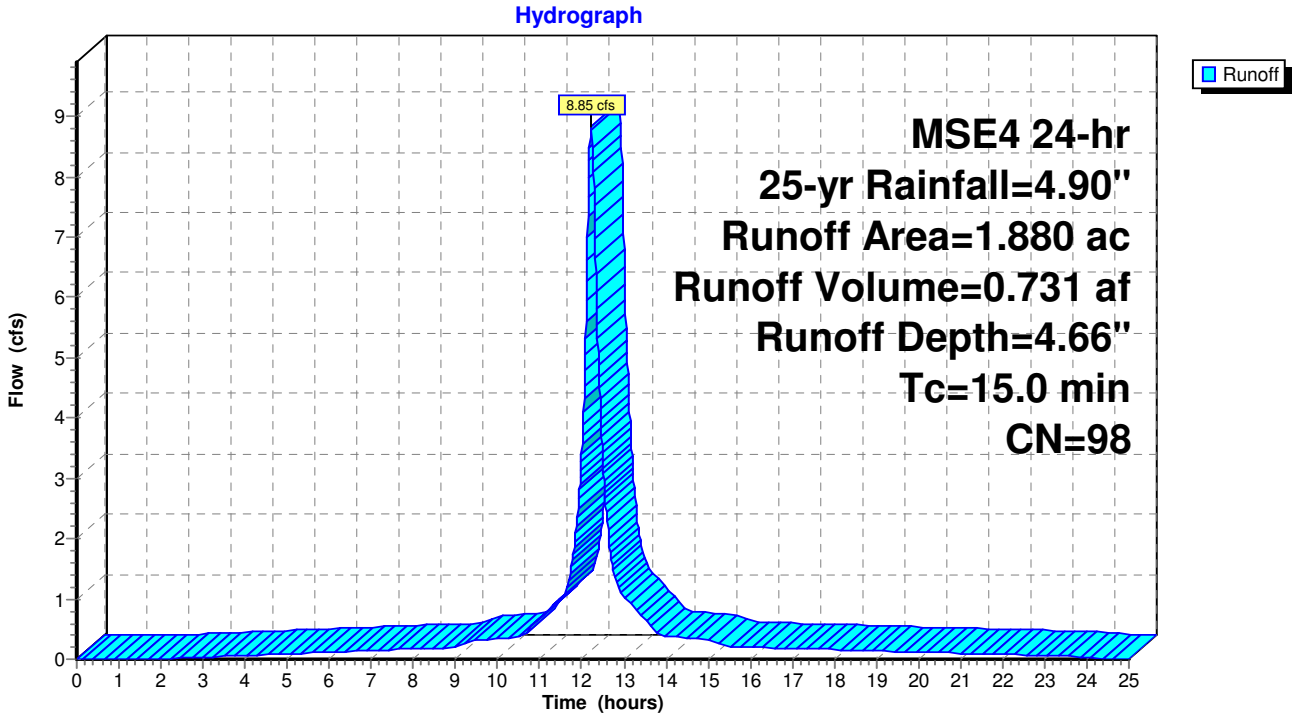
Runoff = 8.85 cfs @ 12.22 hrs, Volume= 0.731 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.880	98	Mod 1 no cover
	1.880		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Subcatchment 65S: Mod 1 (partial closure)



Summary for Subcatchment 66S: Mod 2

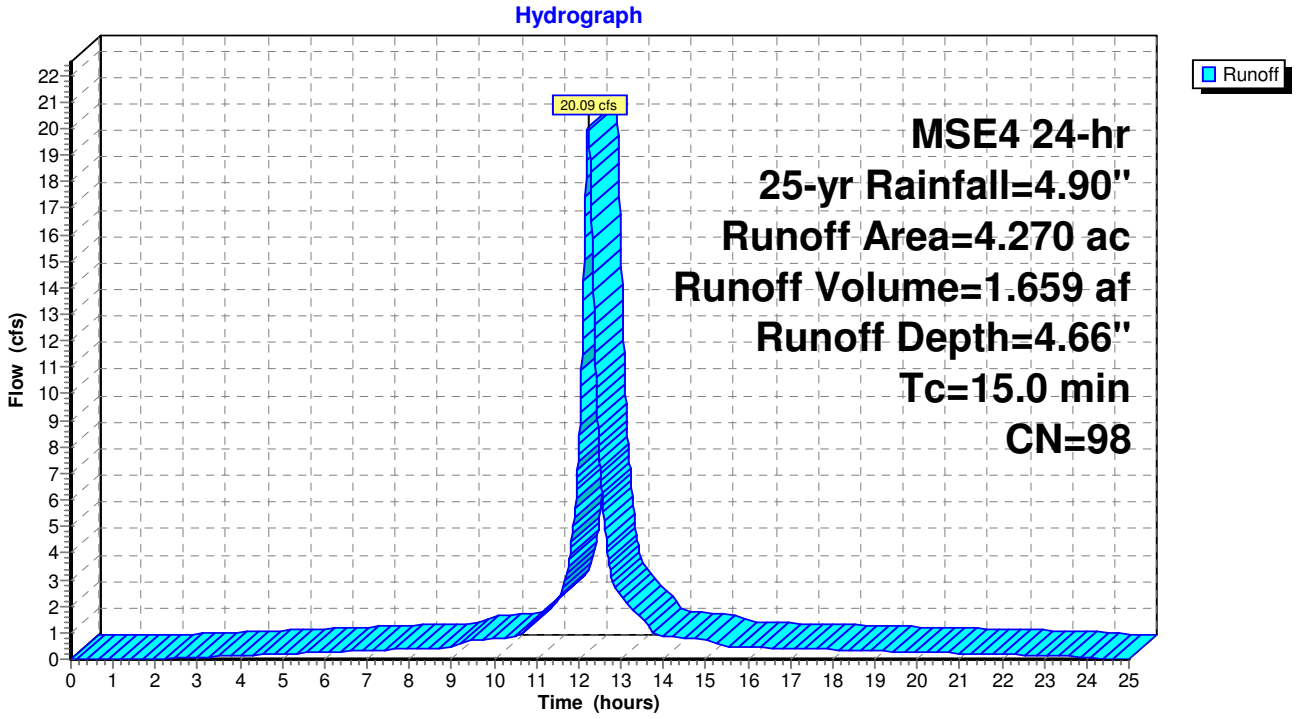
Runoff = 20.09 cfs @ 12.22 hrs, Volume= 1.659 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.270	98	Mod 2 final cover
	4.270		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Subcatchment 66S: Mod 2



Summary for Subcatchment 67S: Mod 3 Constructed

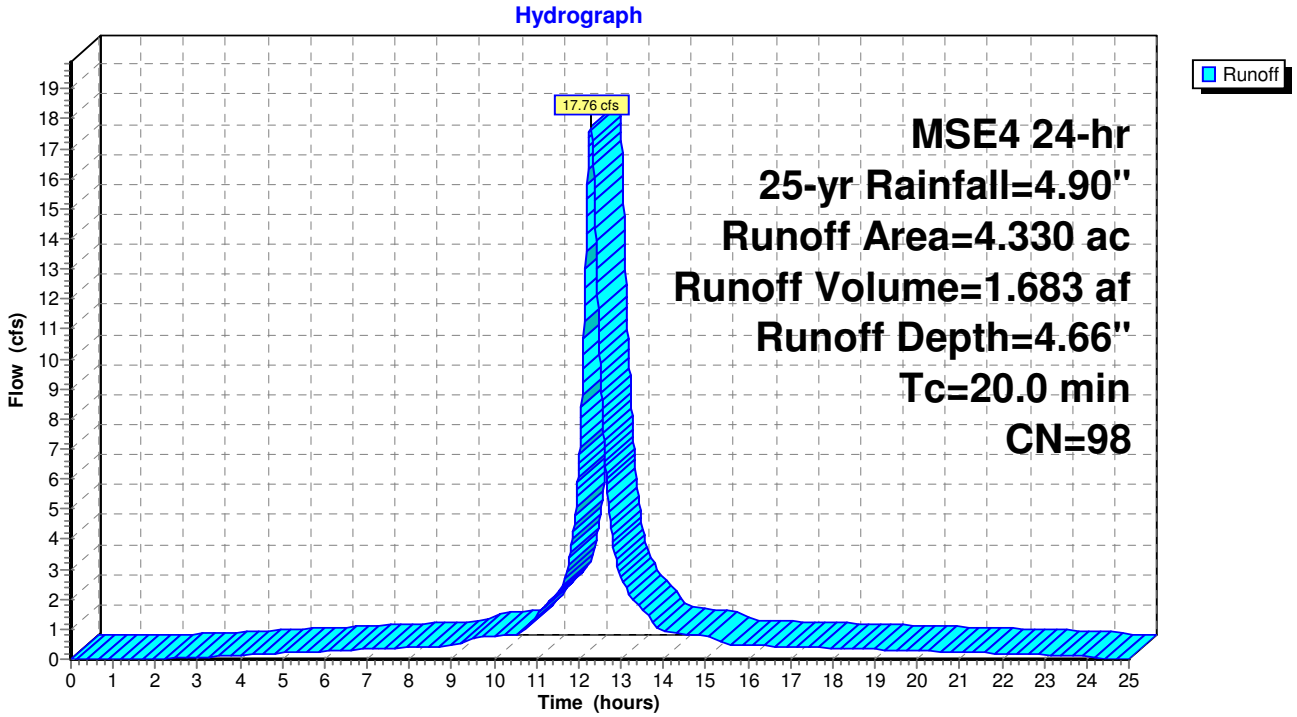
Runoff = 17.76 cfs @ 12.29 hrs, Volume= 1.683 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.330	98	Mod 3 no cover
	4.330		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 67S: Mod 3 Constructed



Summary for Subcatchment 68S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

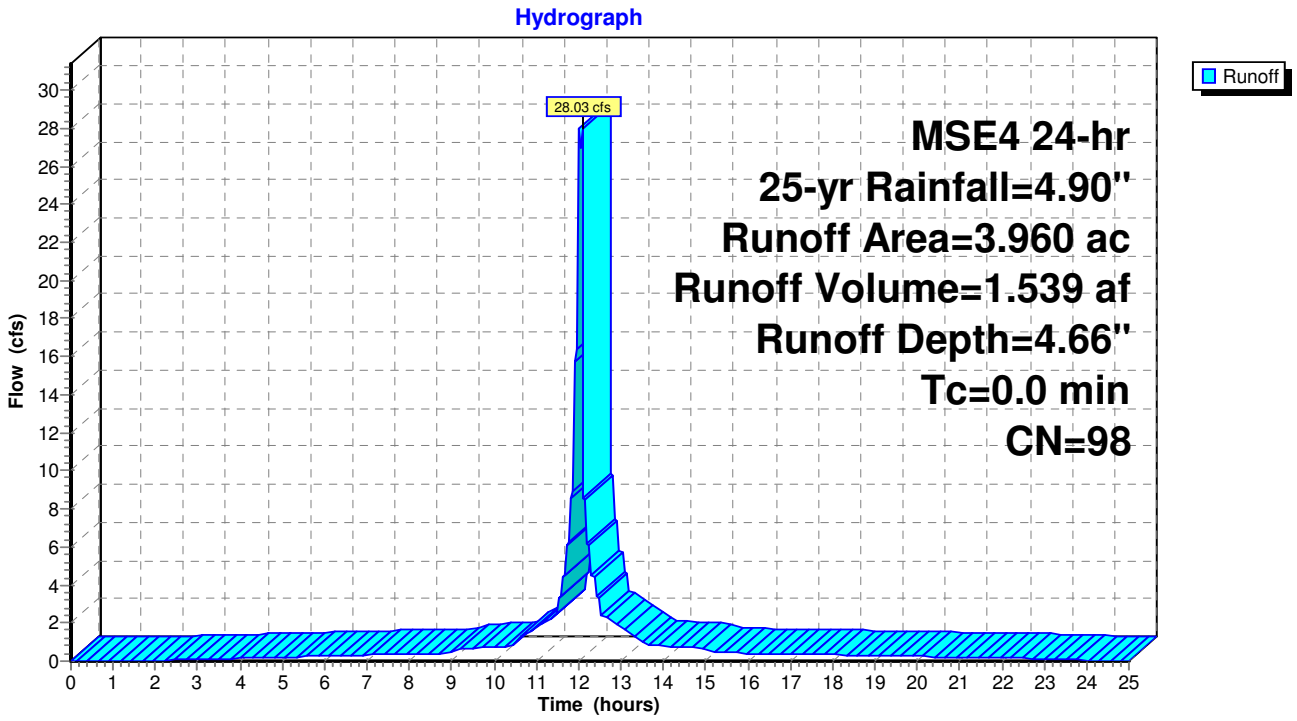
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 68S: Pond Area



Summary for Pond 69P: Ex Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr event
Inflow = 55.31 cfs @ 12.09 hrs, Volume= 5.612 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

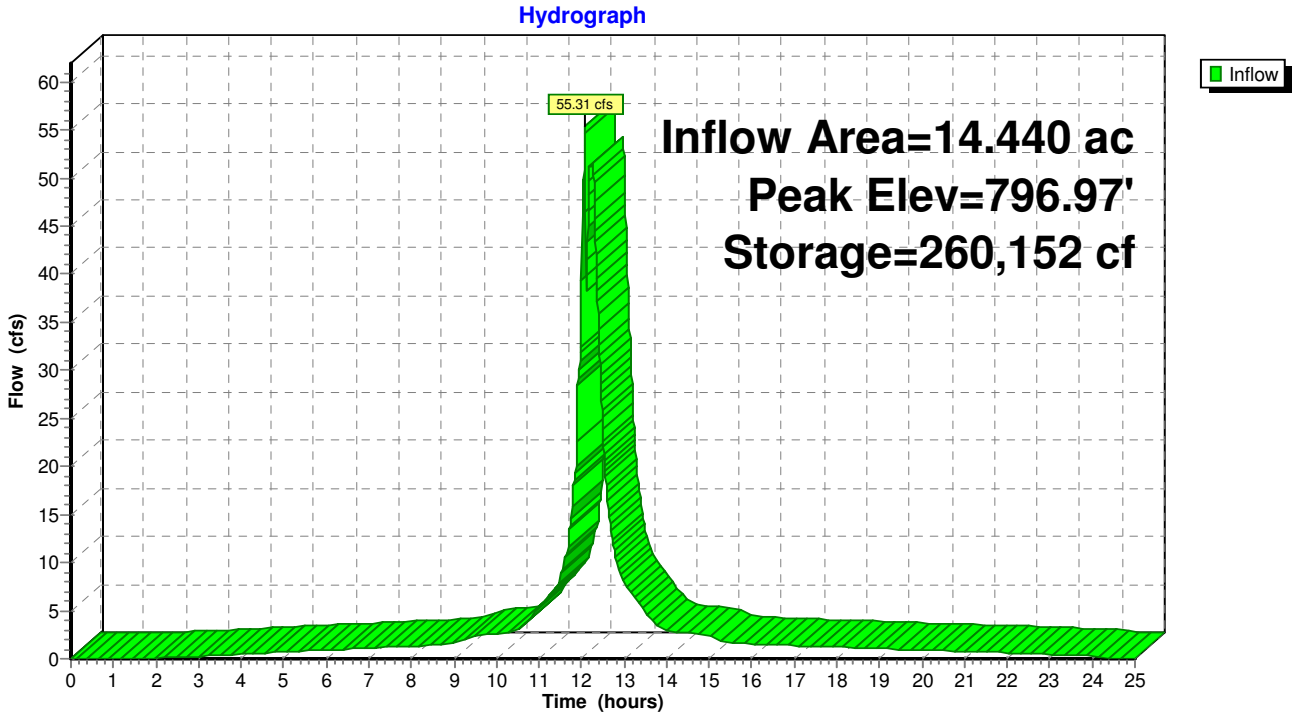
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,516 sf Storage= 260,152 cf (244,438 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

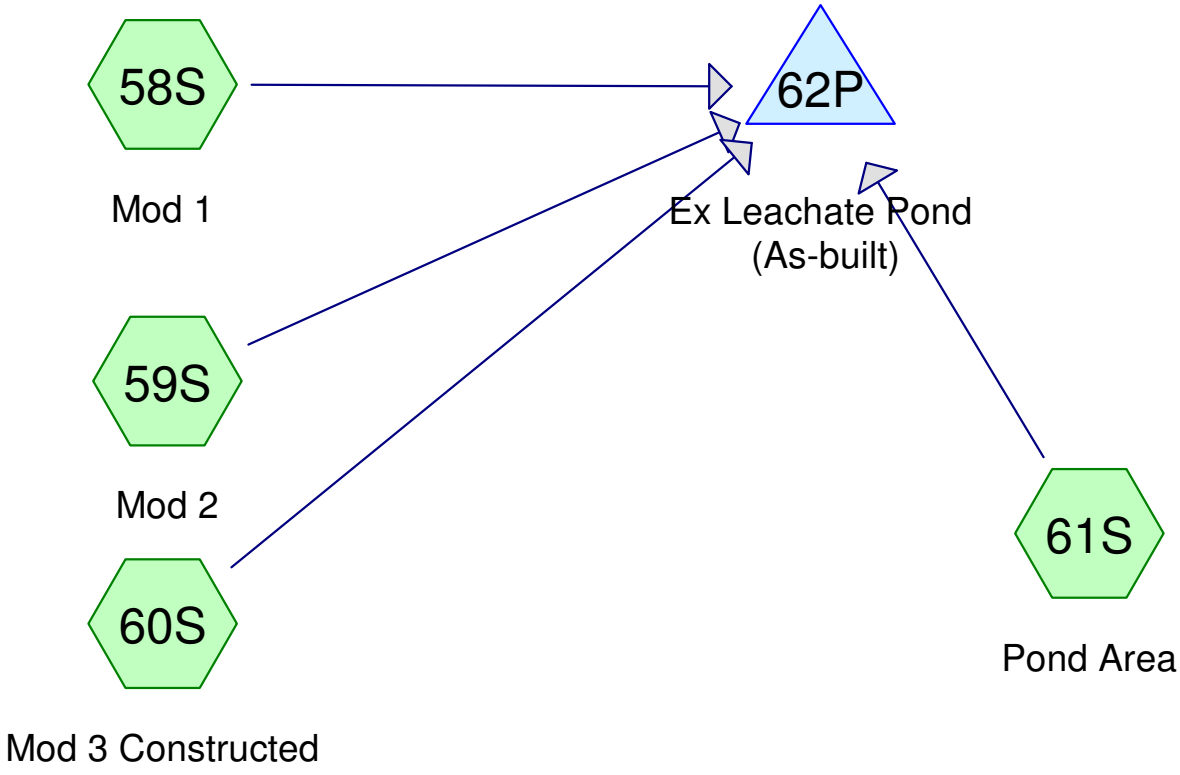
Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 69P: Ex Leachate Pond (As-built)



Model Run 1B



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 58S: Mod 1 Runoff Area=5.310 ac 100.00% Impervious Runoff Depth=3.77"
Tc=15.0 min CN=98 Runoff=20.33 cfs 1.666 af

Subcatchment 59S: Mod 2 Runoff Area=4.270 ac 100.00% Impervious Runoff Depth=3.77"
Tc=15.0 min CN=98 Runoff=16.35 cfs 1.340 af

Subcatchment 60S: Mod 3 Constructed Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=3.77"
Tc=20.0 min CN=98 Runoff=14.46 cfs 1.359 af

Subcatchment 61S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.77"
Tc=0.0 min CN=98 Runoff=22.83 cfs 1.242 af

Pond 62P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=259,949 cf Inflow=55.25 cfs 5.607 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 17.870 ac Runoff Volume = 5.607 af Average Runoff Depth = 3.77"
0.00% Pervious = 0.000 ac 100.00% Impervious = 17.870 ac

Summary for Subcatchment 58S: Mod 1

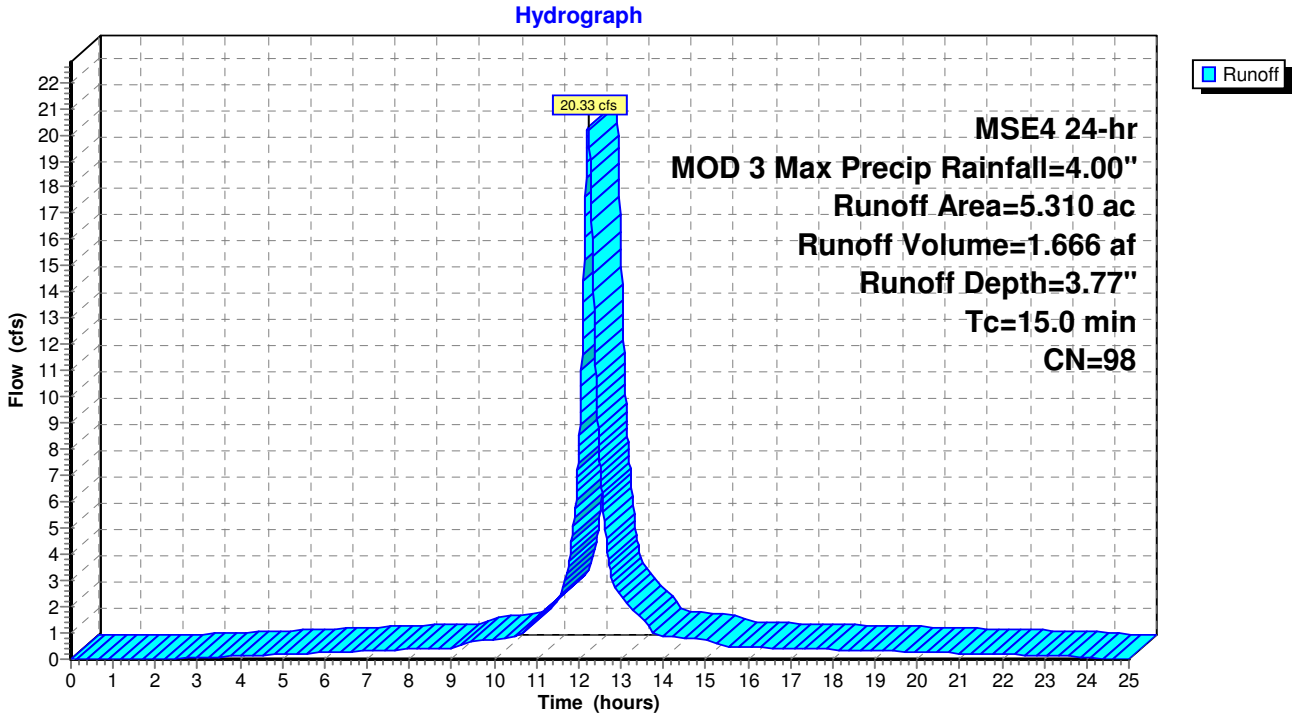
Runoff = 20.33 cfs @ 12.22 hrs, Volume= 1.666 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	5.310	98	Mod 1 no cover
	5.310		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Subcatchment 58S: Mod 1



Summary for Subcatchment 59S: Mod 2

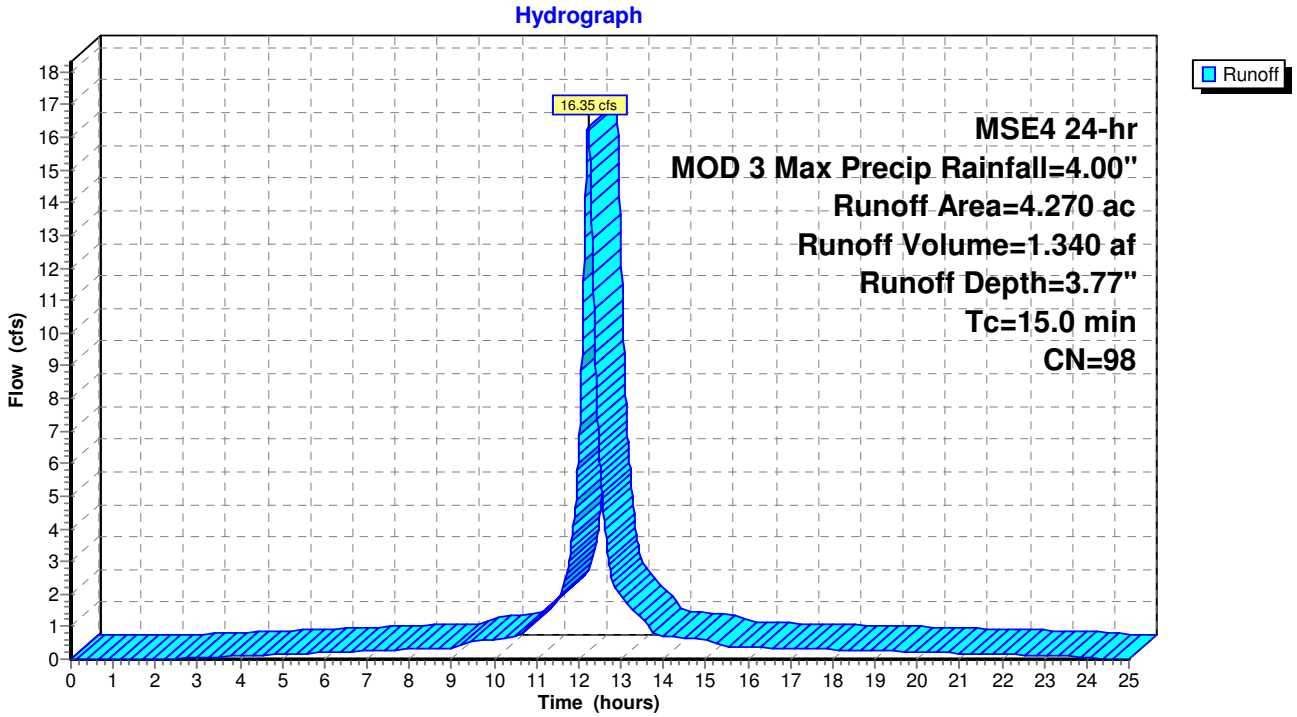
Runoff = 16.35 cfs @ 12.22 hrs, Volume= 1.340 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	4.270	98	Mod 2 final cover
	4.270		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Subcatchment 59S: Mod 2



Summary for Subcatchment 60S: Mod 3 Constructed

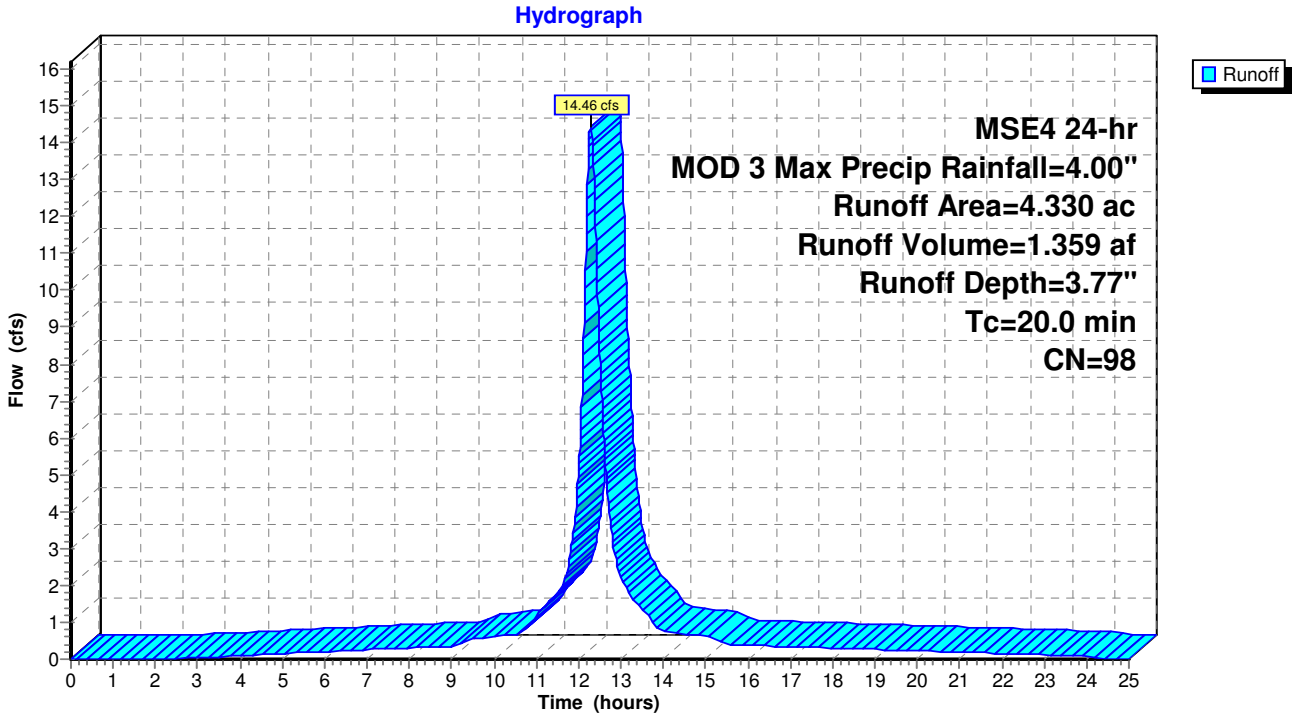
Runoff = 14.46 cfs @ 12.29 hrs, Volume= 1.359 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	4.330	98	Mod 3 no cover
	4.330		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 60S: Mod 3 Constructed



Summary for Subcatchment 61S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

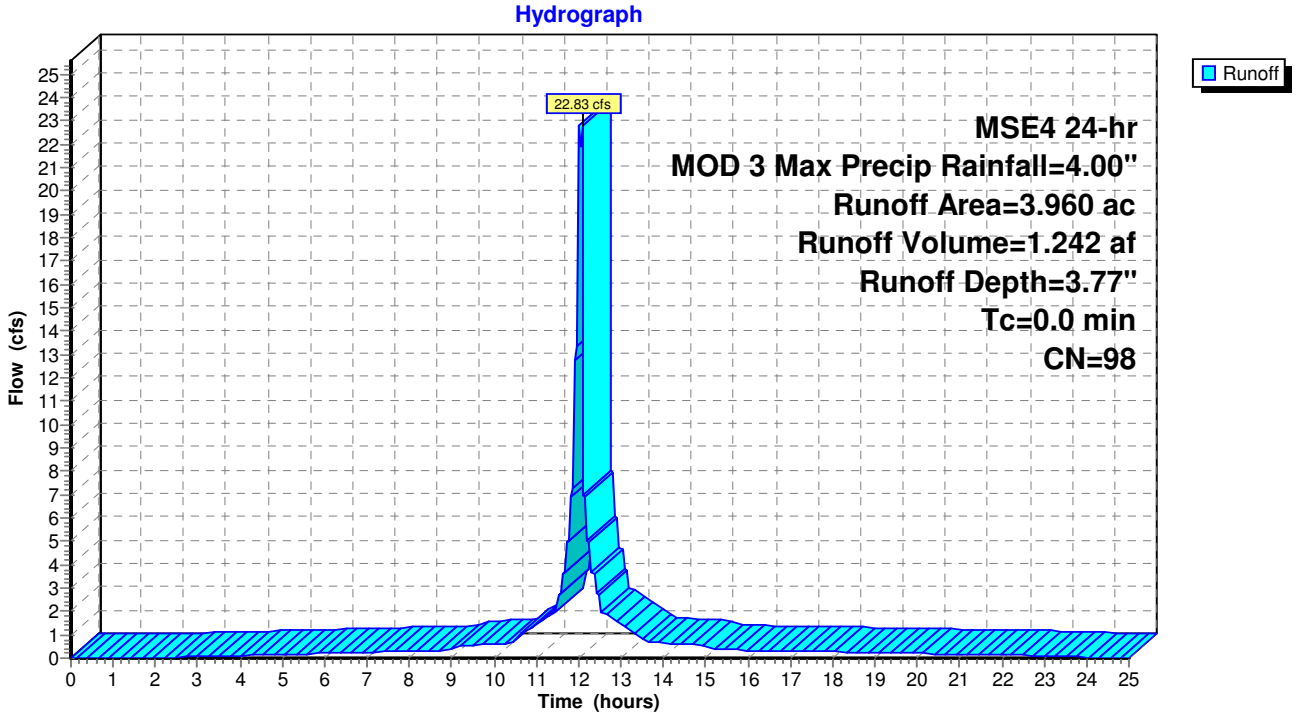
Runoff = 22.83 cfs @ 12.09 hrs, Volume= 1.242 af, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 3 Max Precip Rainfall=4.00"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 61S: Pond Area



Summary for Pond 62P: Ex Leachate Pond (As-built)

Inflow Area = 17.870 ac,100.00% Impervious, Inflow Depth = 3.77" for MOD 3 Max Precip event
Inflow = 55.25 cfs @ 12.24 hrs, Volume= 5.607 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

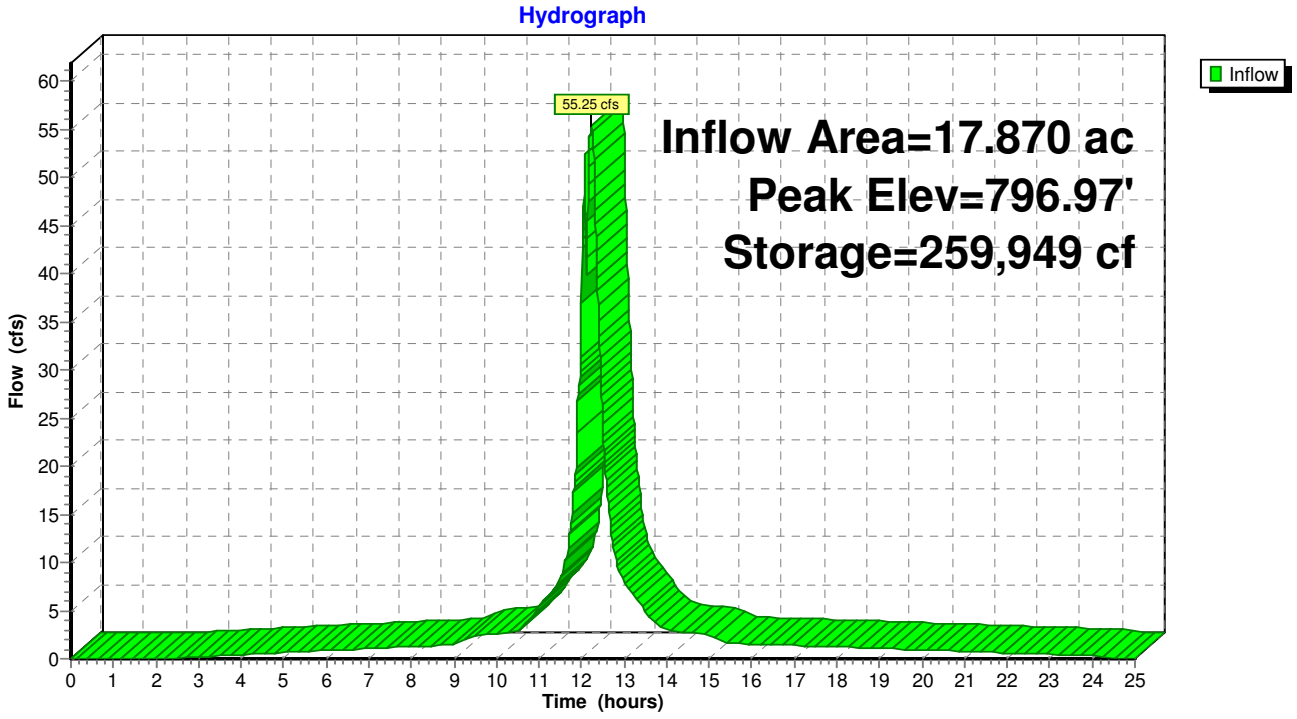
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,505 sf Storage= 259,949 cf (244,234 cf above start)

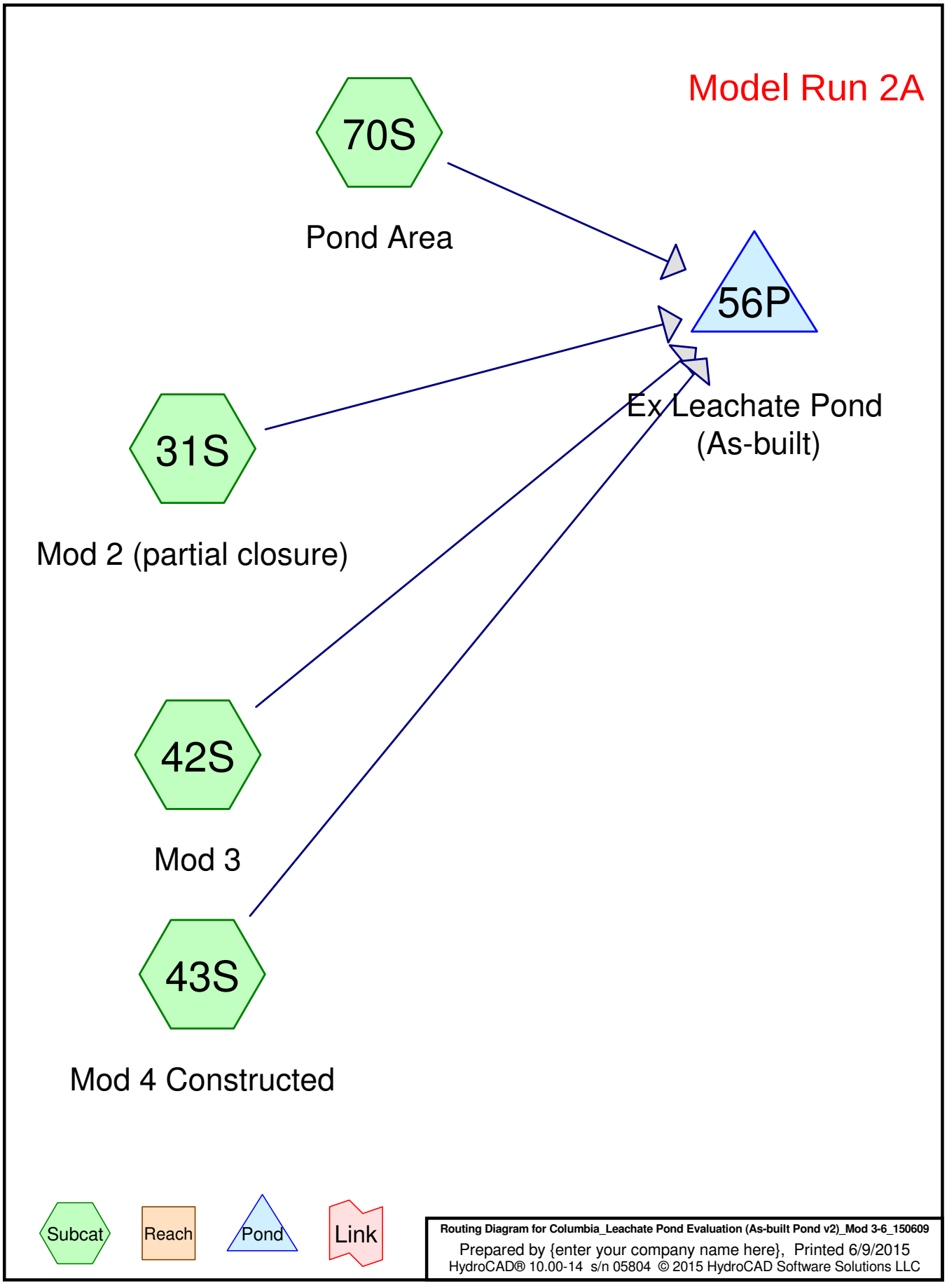
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 62P: Ex Leachate Pond (As-built)




Model Run 2A
70S
Pond Area
56P
Ex Leachate Pond
(As-built)
31S
Mod 2 (partial closure)
42S
Mod 3
43S
Mod 4 Constructed
Subcat
Reach
Pond
Link
Routing Diagram for Columbia_Leachate Pond Evaluation (As-built Pond v2)_Mod 3-6_150609
Prepared by {enter your company name here}, Printed 6/9/2015
HydroCAD® 10.00-14 s/n 05804 © 2015 HydroCAD Software Solutions LLC

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 31S: Mod 2 (partial closure) Runoff Area=1.760 ac 100.00% Impervious Runoff Depth=4.66"
Tc=15.0 min CN=98 Runoff=8.28 cfs 0.684 af

Subcatchment 42S: Mod 3 Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=17.76 cfs 1.683 af

Subcatchment 43S: Mod 4 Constructed Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=4.66"
Tc=25.0 min CN=98 Runoff=16.12 cfs 1.706 af

Subcatchment 70S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 56P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=260,152 cf Inflow=50.38 cfs 5.612 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.612 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 31S: Mod 2 (partial closure)

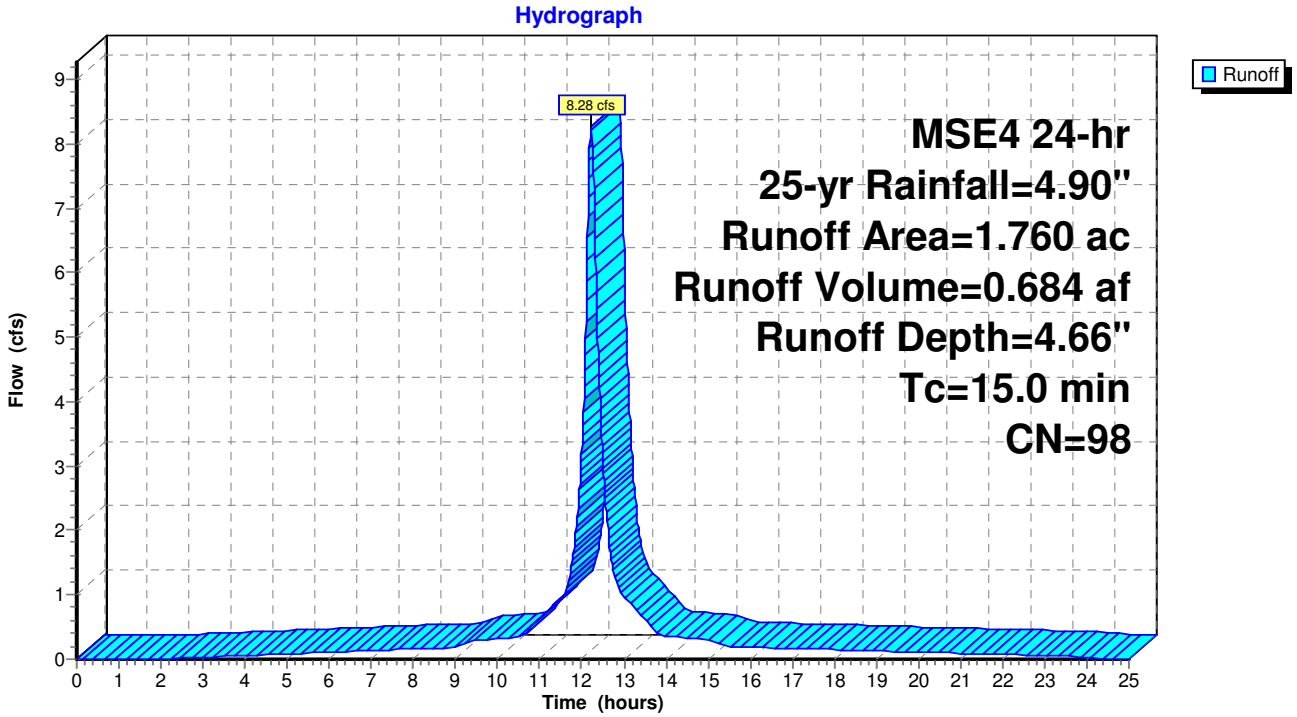
Runoff = 8.28 cfs @ 12.22 hrs, Volume= 0.684 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.760	98	Mod 2 final cover
	1.760		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Subcatchment 31S: Mod 2 (partial closure)



Summary for Subcatchment 42S: Mod 3

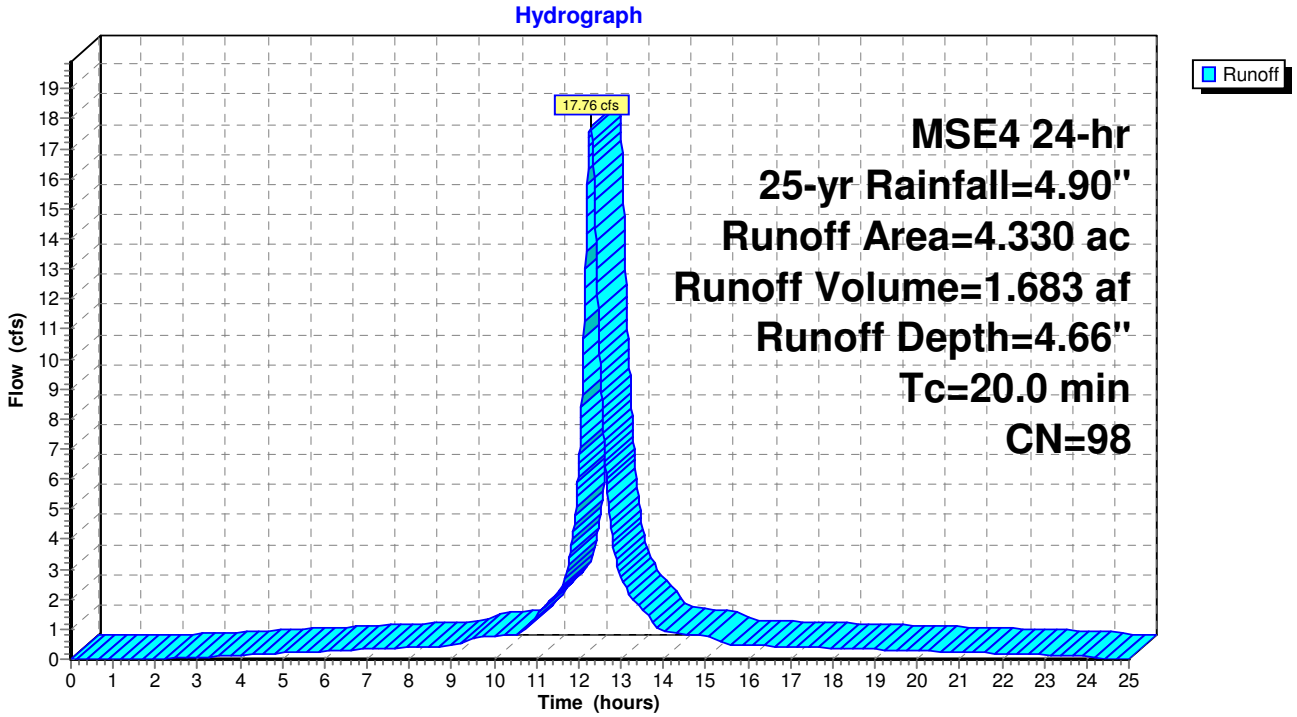
Runoff = 17.76 cfs @ 12.29 hrs, Volume= 1.683 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.330	98	Mod 3
	4.330		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 42S: Mod 3



Summary for Subcatchment 43S: Mod 4 Constructed

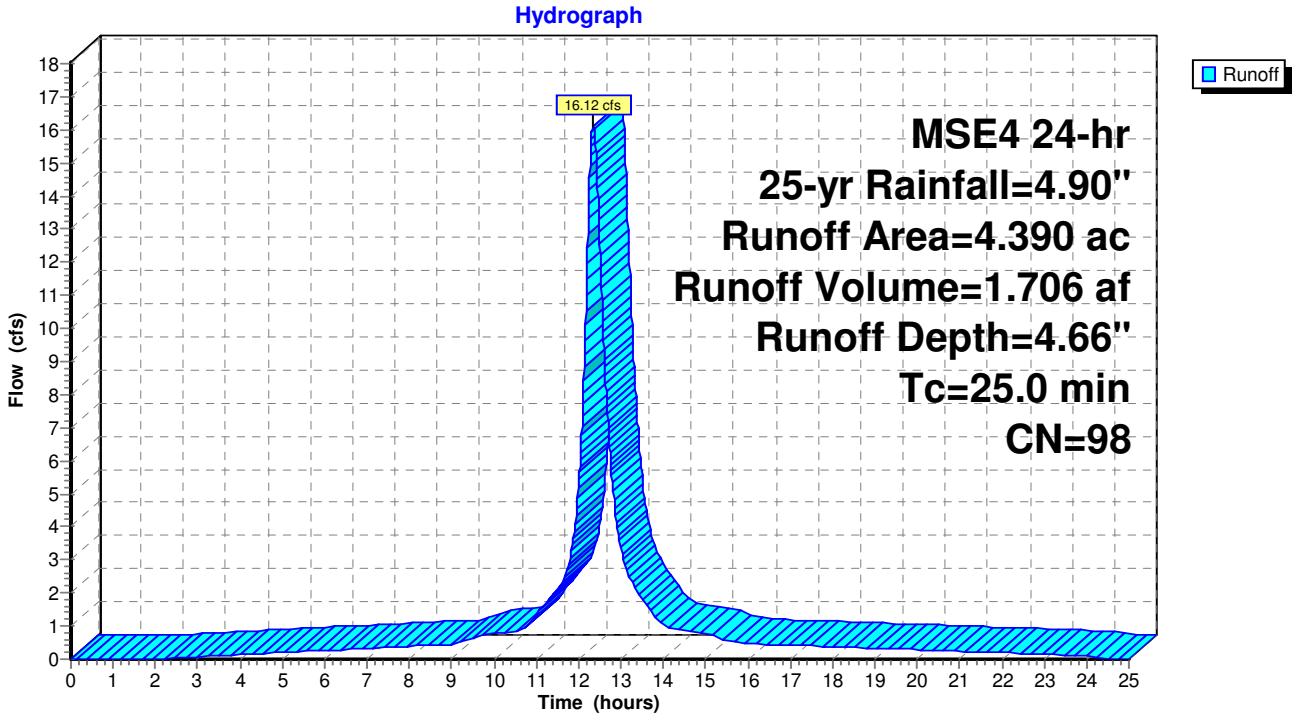
Runoff = 16.12 cfs @ 12.34 hrs, Volume= 1.706 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.390	98	Mod 4 no cover
	4.390		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Subcatchment 43S: Mod 4 Constructed



Summary for Subcatchment 70S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

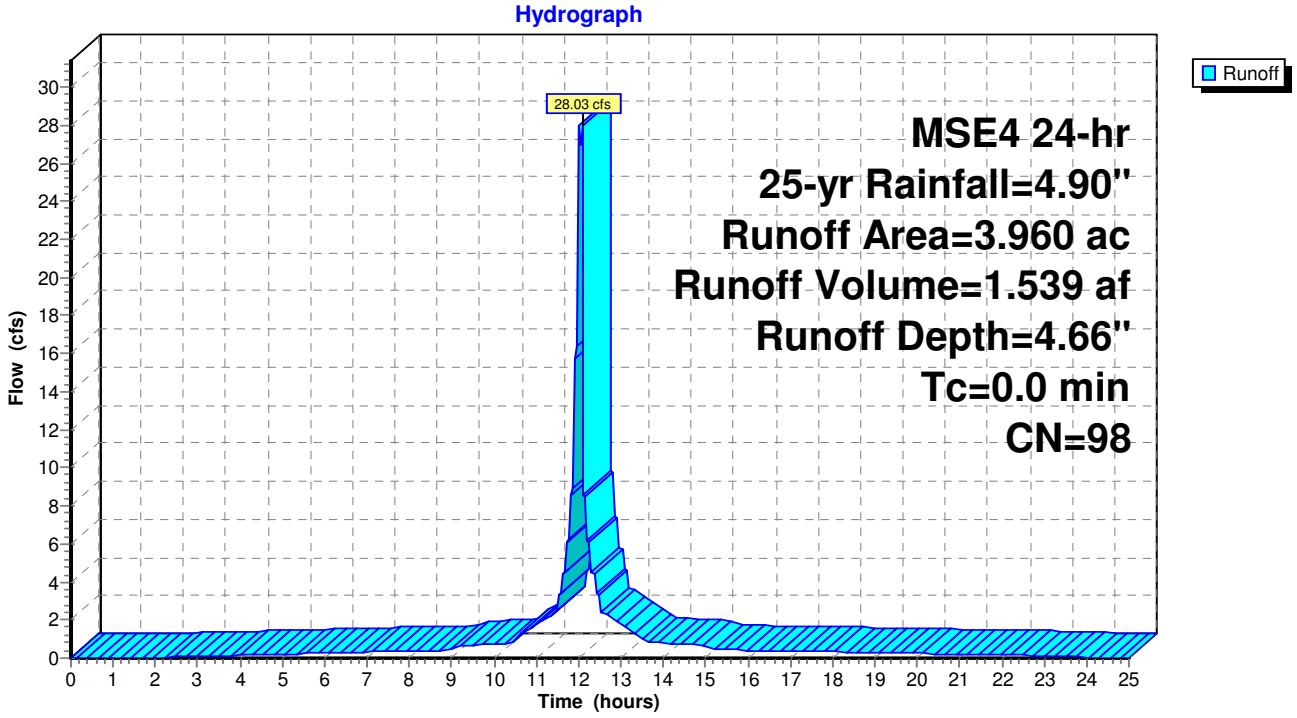
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 70S: Pond Area



Summary for Pond 56P: Ex Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr event
Inflow = 50.38 cfs @ 12.09 hrs, Volume= 5.612 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

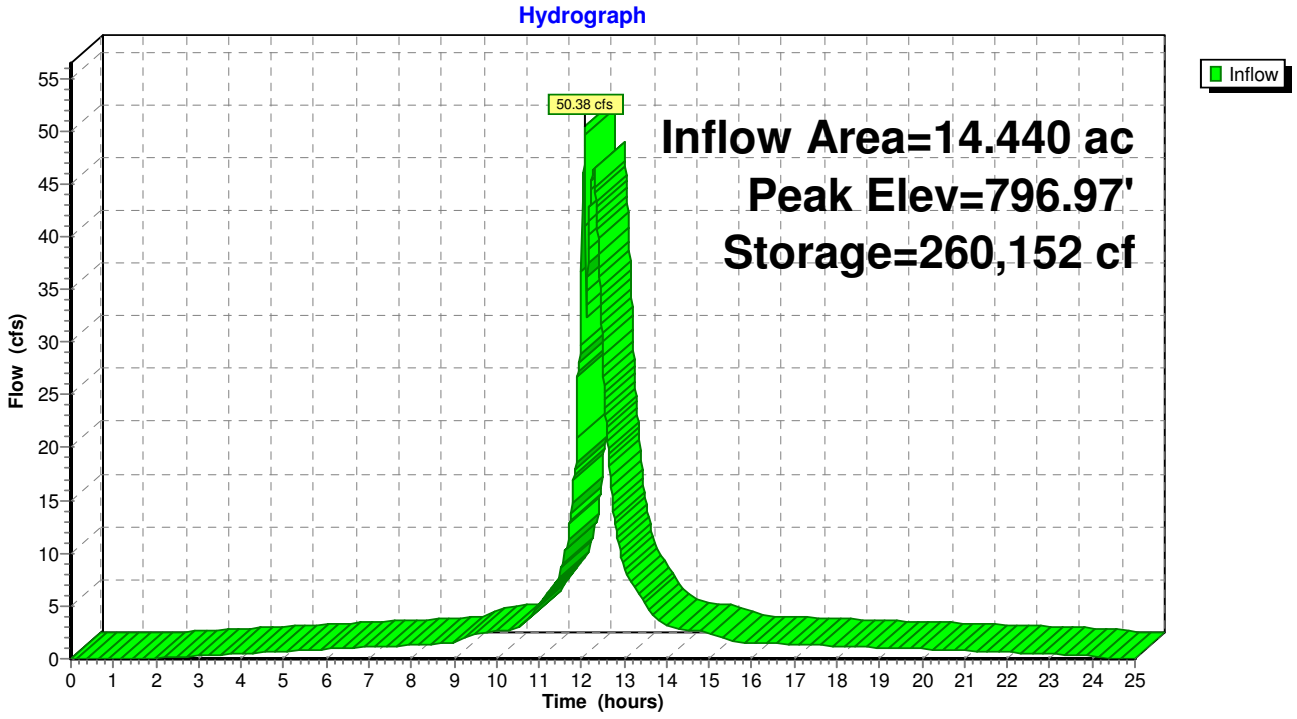
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,516 sf Storage= 260,152 cf (244,438 cf above start)

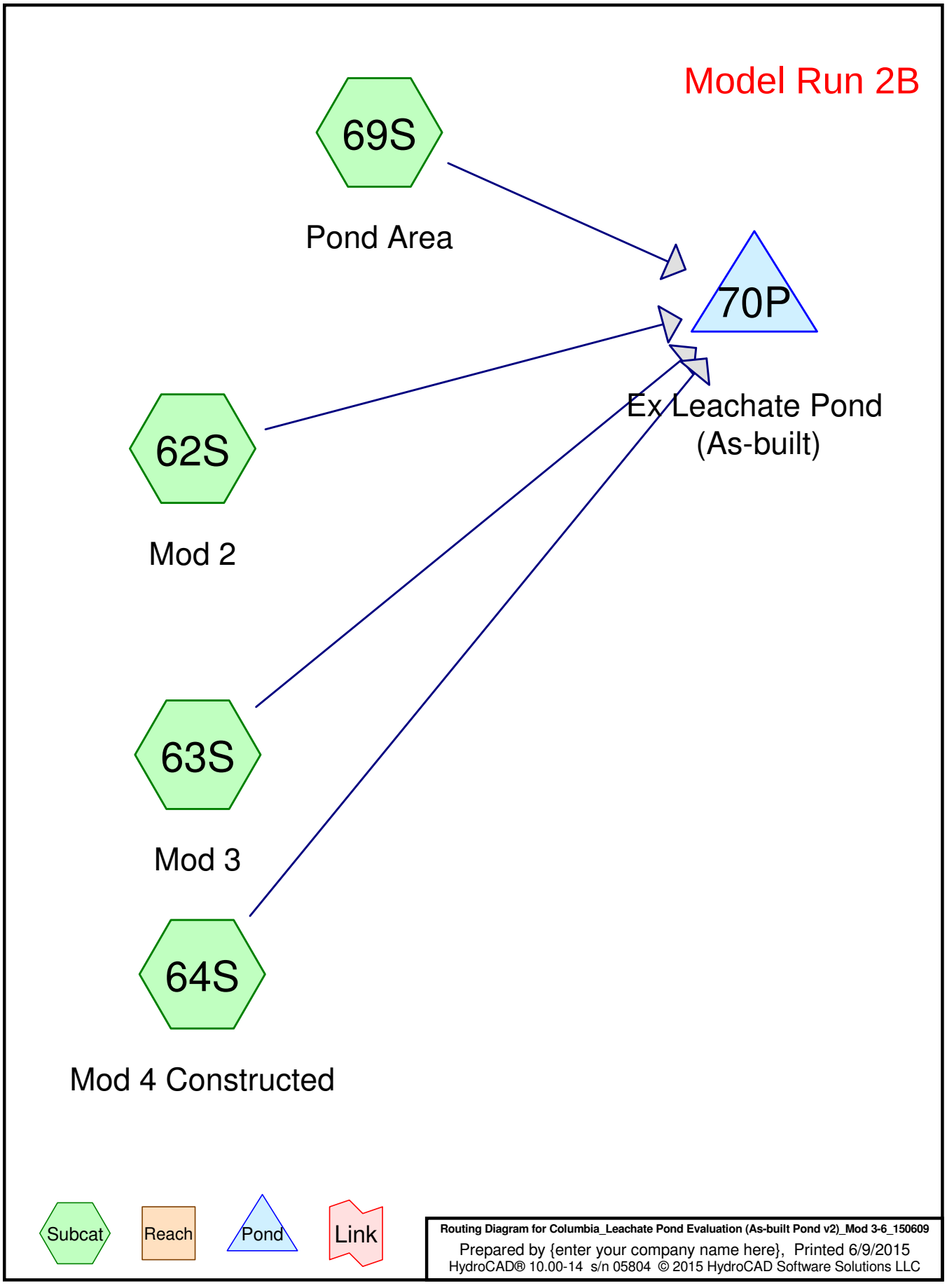
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 56P: Ex Leachate Pond (As-built)





Routing Diagram for Columbia_Leachate Pond Evaluation (As-built Pond v2)_Mod 3-6_150609
Prepared by {enter your company name here}, Printed 6/9/2015
HydroCAD® 10.00-14 s/n 05804 © 2015 HydroCAD Software Solutions LLC

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 62S: Mod 2 Runoff Area=4.270 ac 100.00% Impervious Runoff Depth=3.97"
Tc=15.0 min CN=98 Runoff=17.22 cfs 1.414 af

Subcatchment 63S: Mod 3 Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=3.97"
Tc=20.0 min CN=98 Runoff=15.23 cfs 1.434 af

Subcatchment 64S: Mod 4 Constructed Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=3.97"
Tc=25.0 min CN=98 Runoff=13.82 cfs 1.454 af

Subcatchment 69S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.97"
Tc=0.0 min CN=98 Runoff=24.05 cfs 1.312 af

Pond 70P: Ex Leachate Pond (As-built) Peak Elev=796.97' Storage=260,266 cf Inflow=49.37 cfs 5.614 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 16.950 ac Runoff Volume = 5.614 af Average Runoff Depth = 3.97"
0.00% Pervious = 0.000 ac 100.00% Impervious = 16.950 ac

Summary for Subcatchment 62S: Mod 2

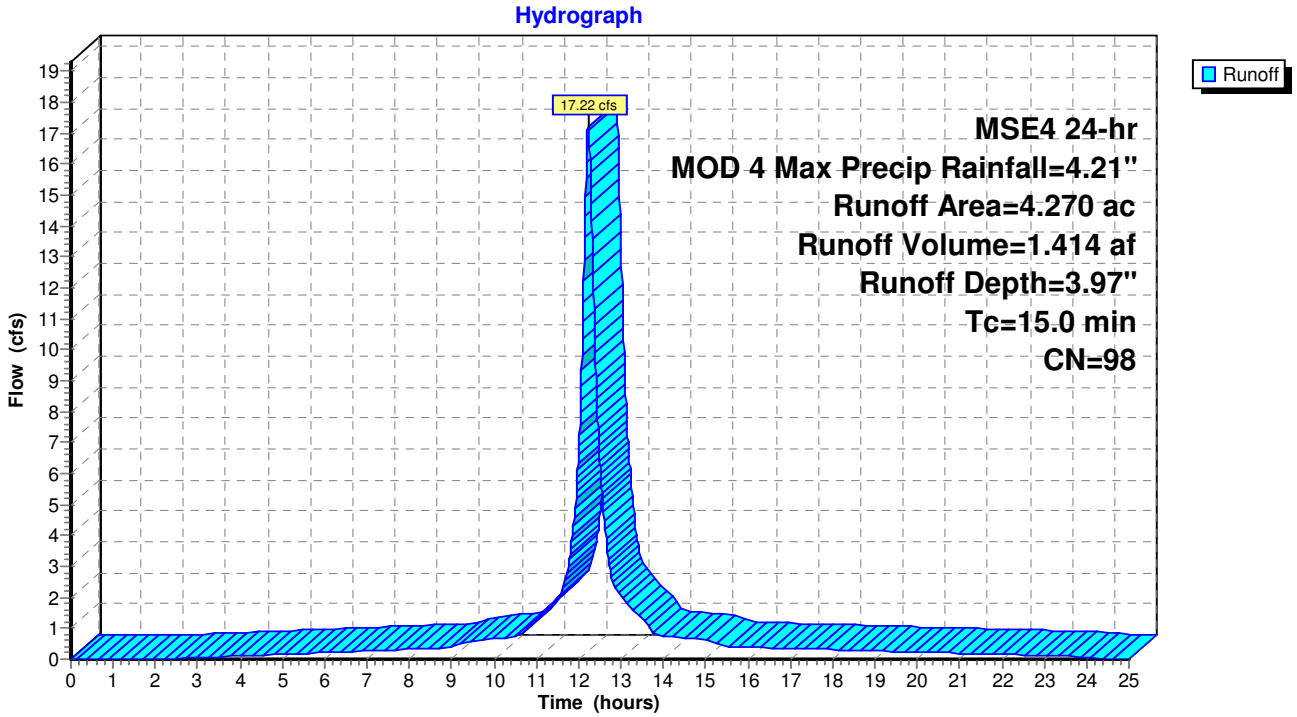
Runoff = 17.22 cfs @ 12.22 hrs, Volume= 1.414 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	4.270	98	Mod 2 final cover
	4.270		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Estimated**

Subcatchment 62S: Mod 2



Summary for Subcatchment 63S: Mod 3

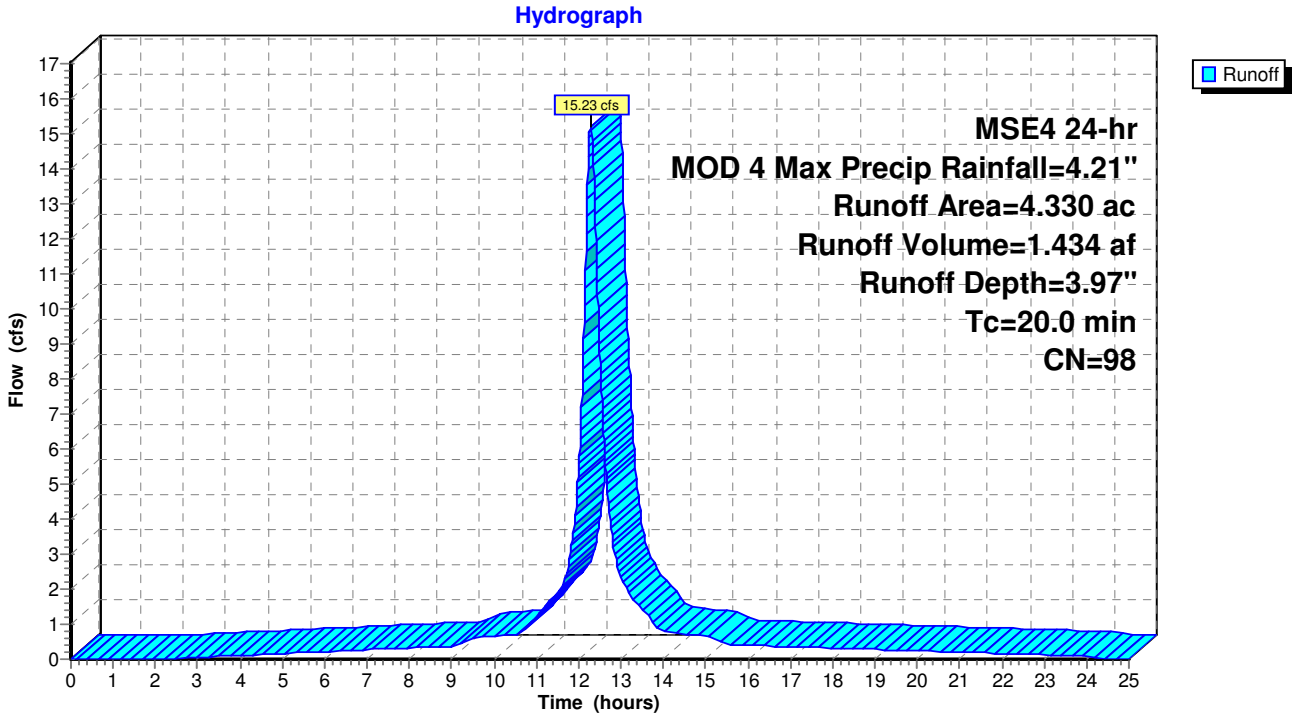
Runoff = 15.23 cfs @ 12.29 hrs, Volume= 1.434 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	4.330	98	Mod 3
	4.330		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 63S: Mod 3



Summary for Subcatchment 64S: Mod 4 Constructed

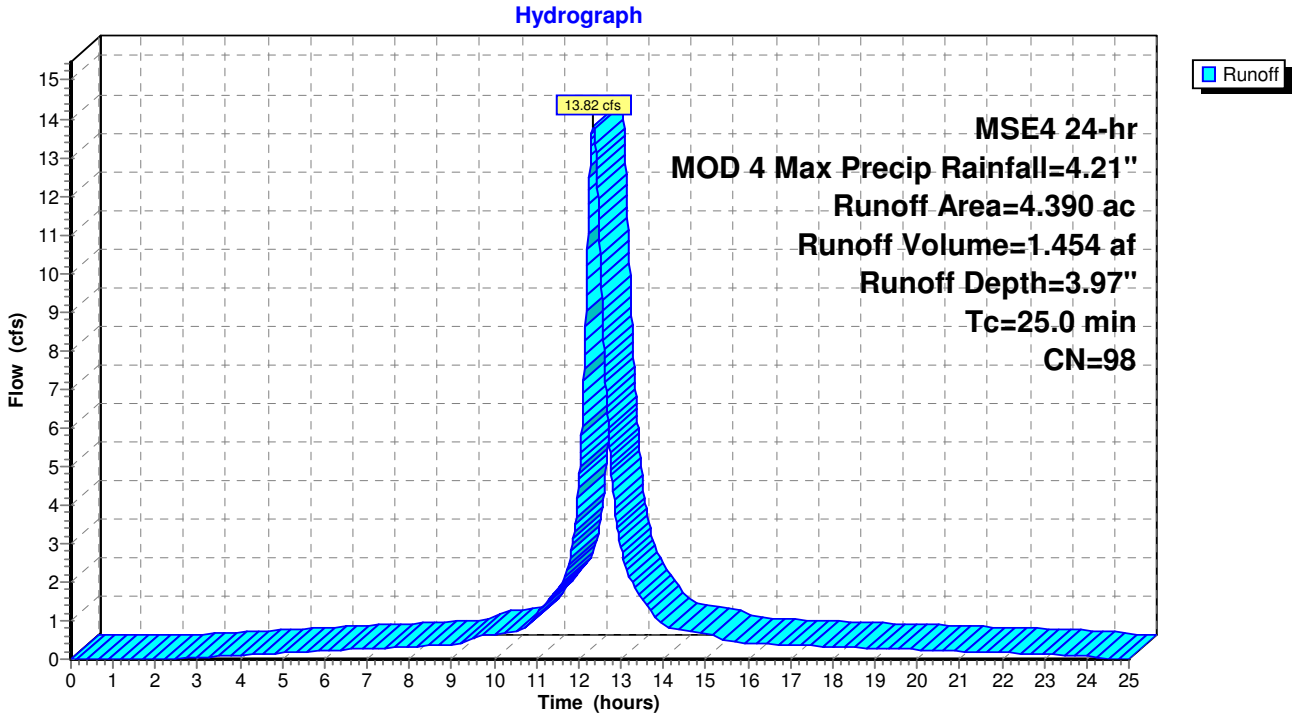
Runoff = 13.82 cfs @ 12.34 hrs, Volume= 1.454 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	4.390	98	Mod 4 no cover
	4.390		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Subcatchment 64S: Mod 4 Constructed



Summary for Subcatchment 69S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

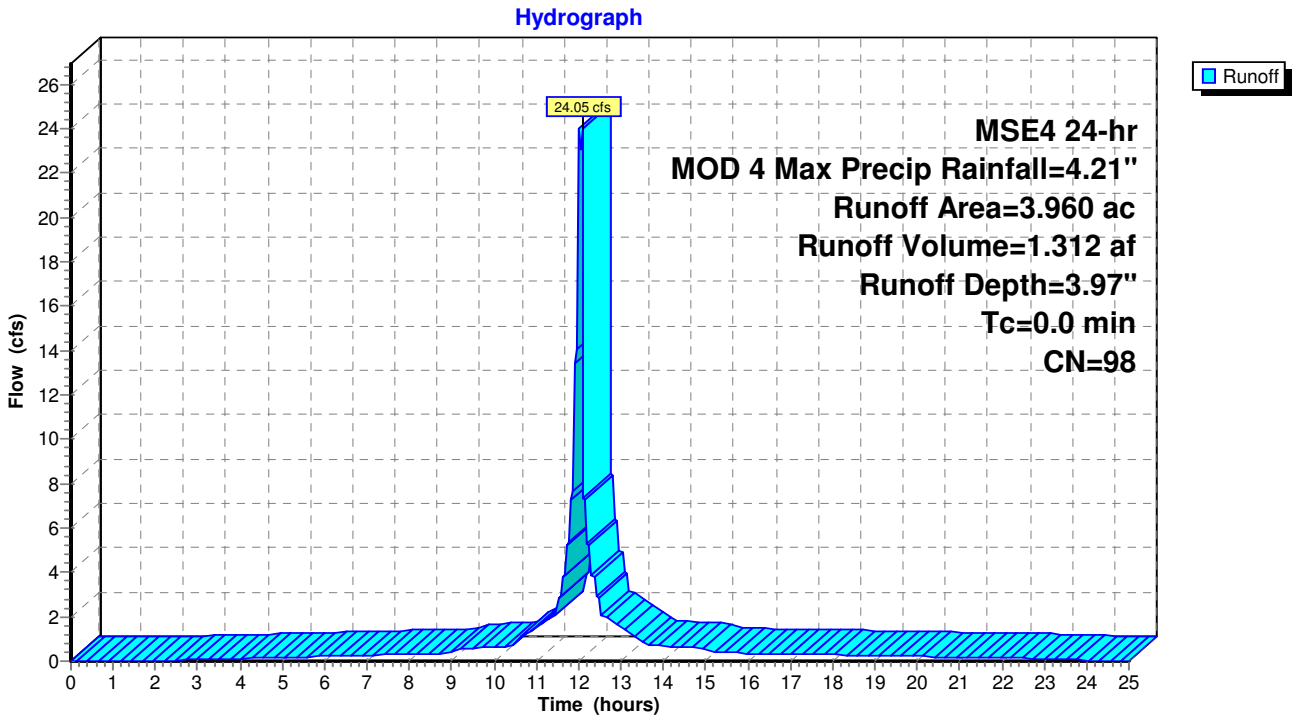
Runoff = 24.05 cfs @ 12.09 hrs, Volume= 1.312 af, Depth= 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 4 Max Precip Rainfall=4.21"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 69S: Pond Area



Summary for Pond 70P: Ex Leachate Pond (As-built)

Inflow Area = 16.950 ac,100.00% Impervious, Inflow Depth = 3.97" for MOD 4 Max Precip event
Inflow = 49.37 cfs @ 12.27 hrs, Volume= 5.614 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

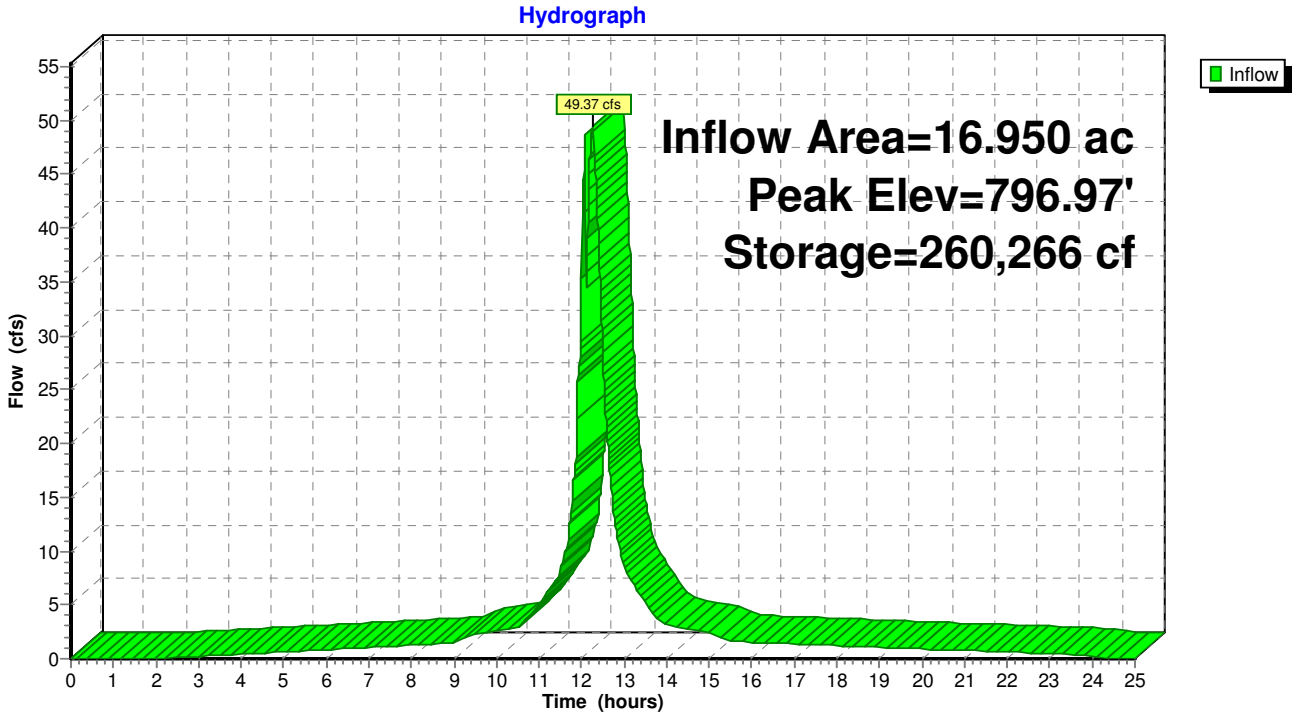
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,522 sf Storage= 260,266 cf (244,552 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

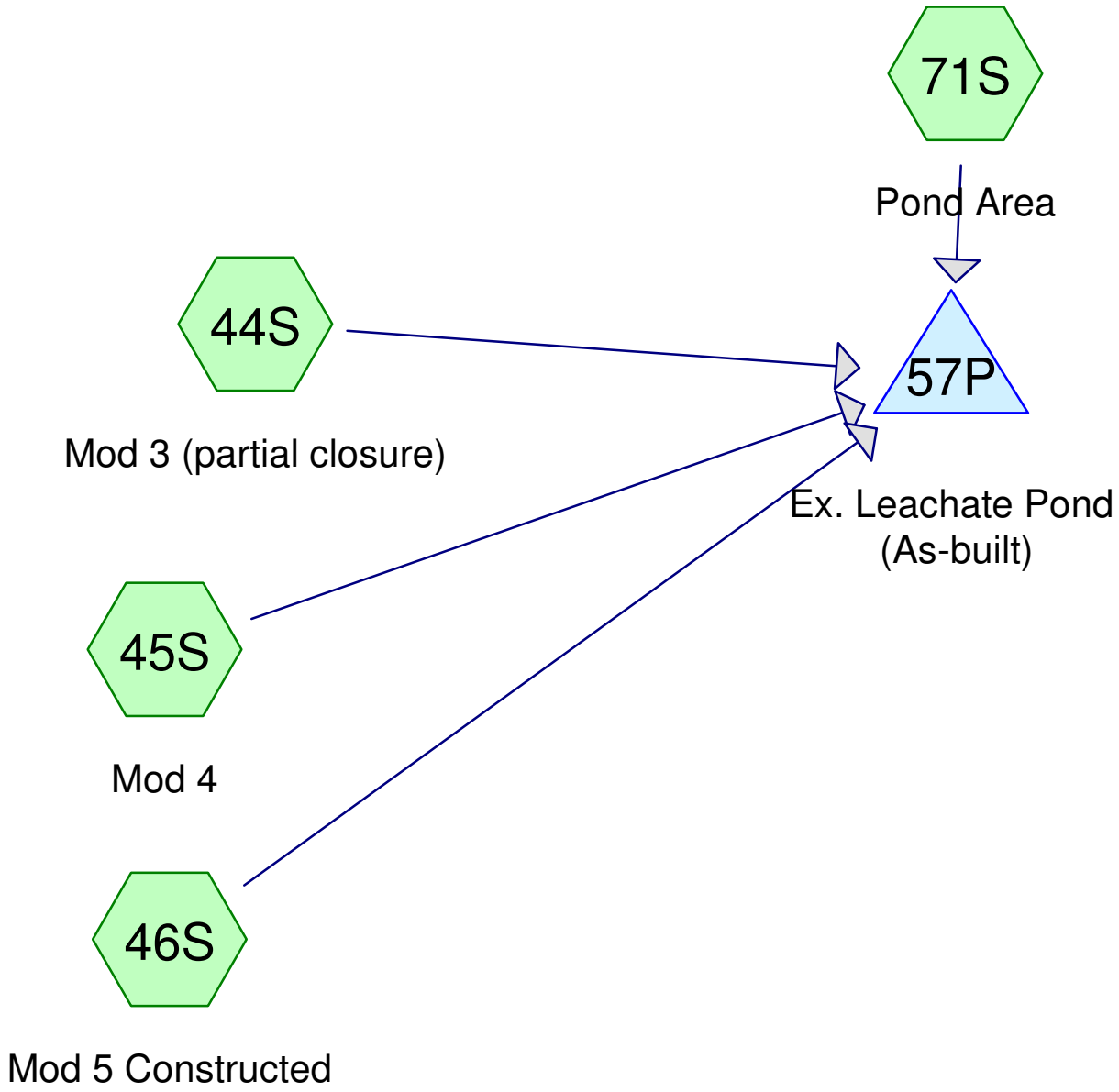
Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 70P: Ex Leachate Pond (As-built)



Model Run 3A



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 44S: Mod 3 (partial closure) Runoff Area=1.630 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=6.69 cfs 0.633 af

Subcatchment 45S: Mod 4 Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=4.66"
Tc=25.0 min CN=98 Runoff=16.12 cfs 1.706 af

Subcatchment 46S: Mod 5 Constructed Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>4.66"
Tc=30.0 min CN=98 Runoff=14.86 cfs 1.733 af

Subcatchment 71S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 57P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=260,150 cf Inflow=45.90 cfs 5.611 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.611 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 44S: Mod 3 (partial closure)

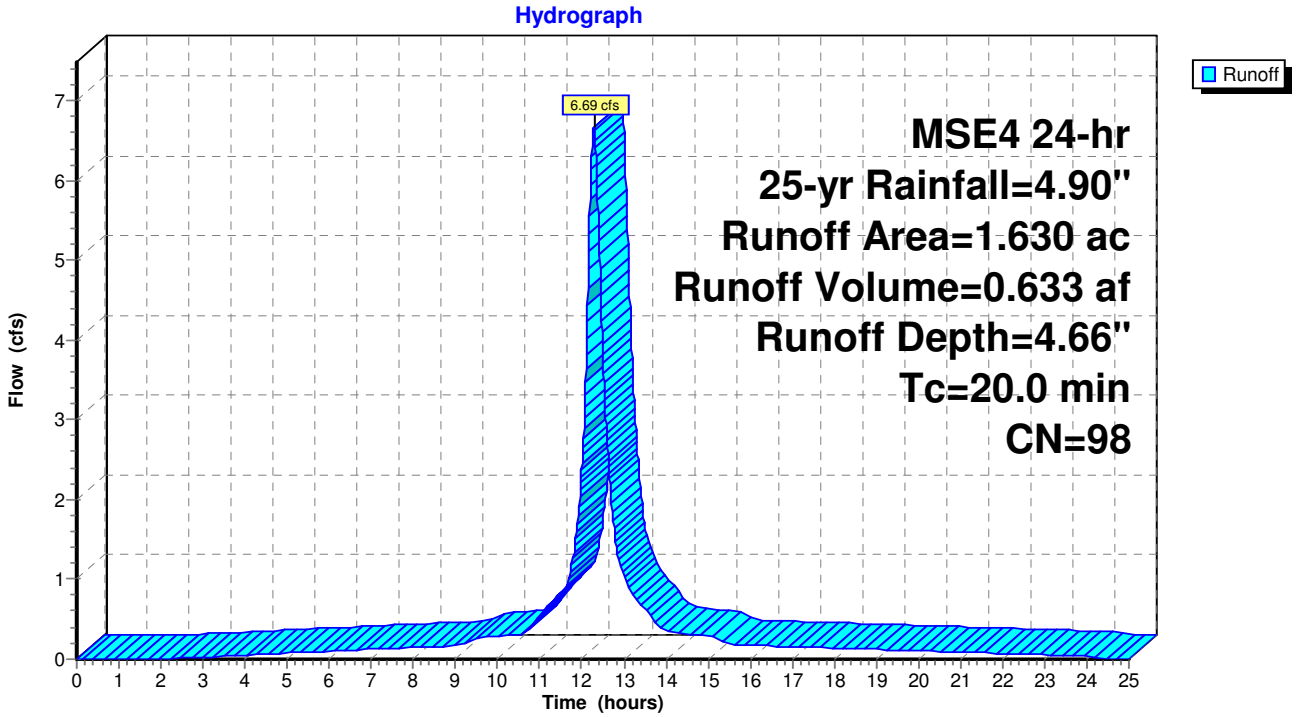
Runoff = 6.69 cfs @ 12.29 hrs, Volume= 0.633 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.630	98	Mod 3
	1.630		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 44S: Mod 3 (partial closure)



Summary for Subcatchment 45S: Mod 4

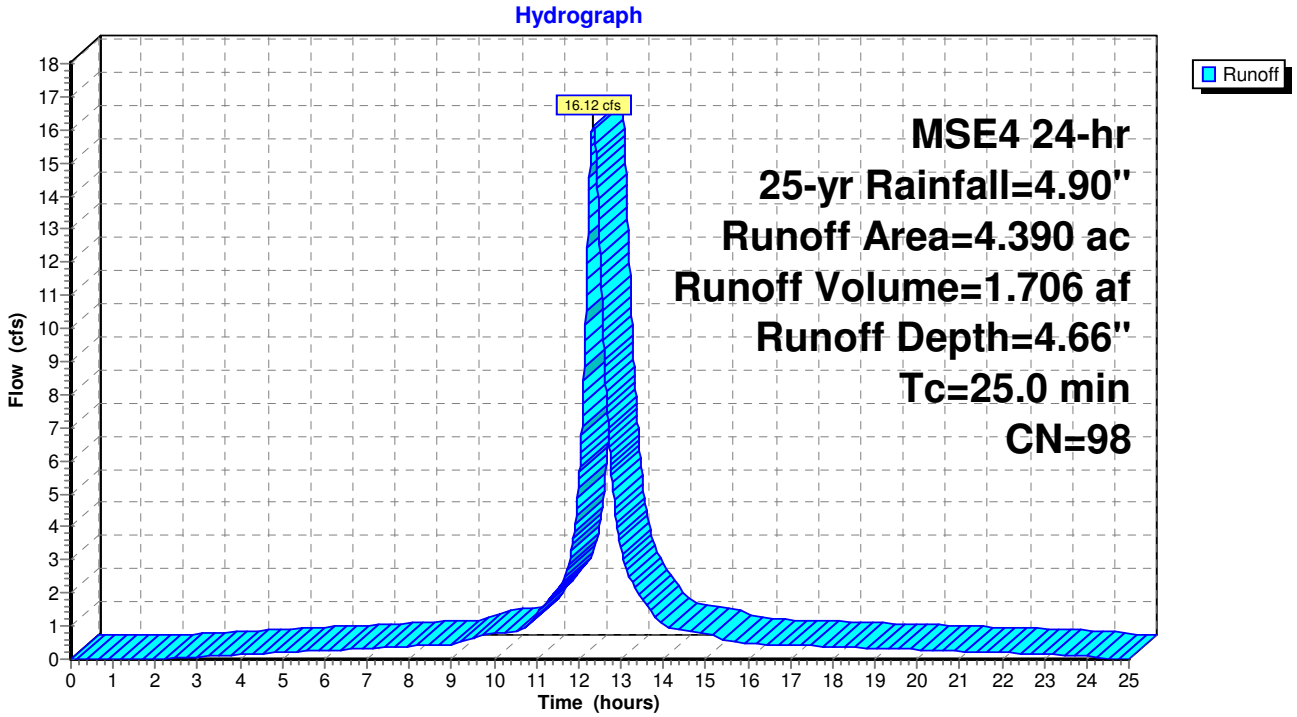
Runoff = 16.12 cfs @ 12.34 hrs, Volume= 1.706 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.390	98	Mod 4
	4.390		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Subcatchment 45S: Mod 4



Summary for Subcatchment 46S: Mod 5 Constructed

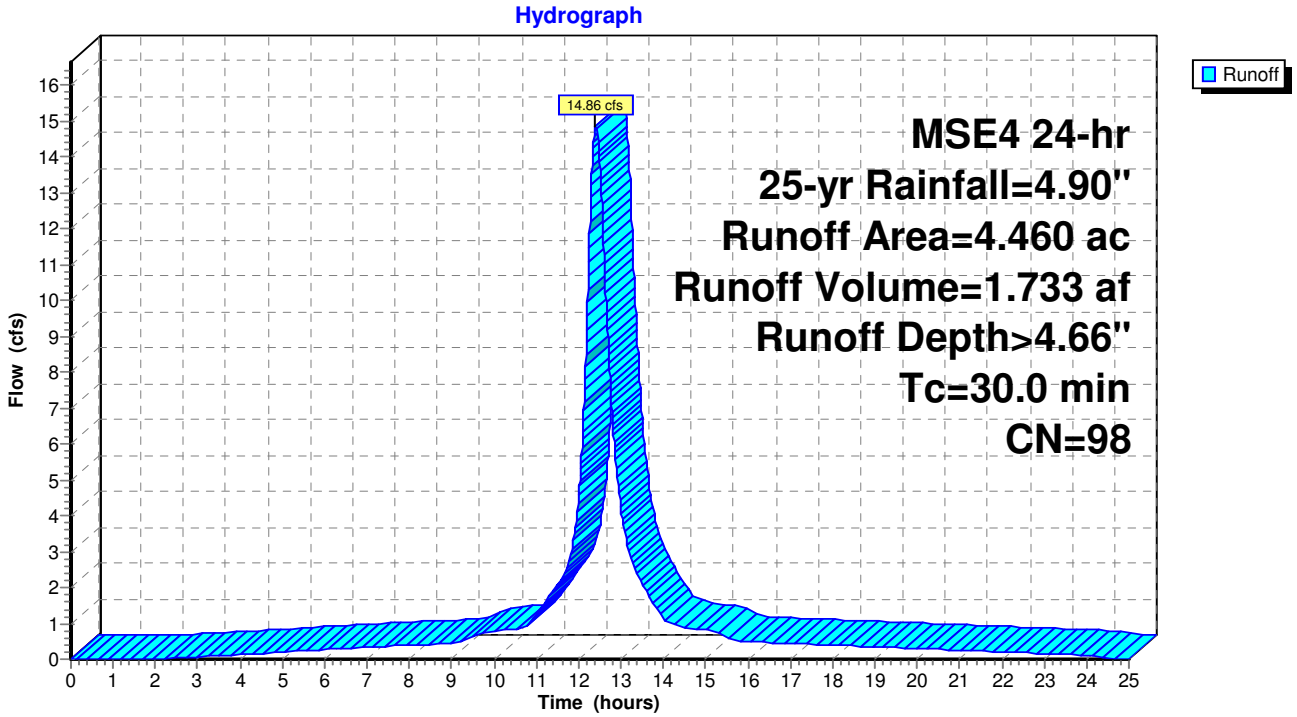
Runoff = 14.86 cfs @ 12.40 hrs, Volume= 1.733 af, Depth> 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.460	98	Mod 5 no cover
	4.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Estimated**

Subcatchment 46S: Mod 5 Constructed



Summary for Subcatchment 71S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

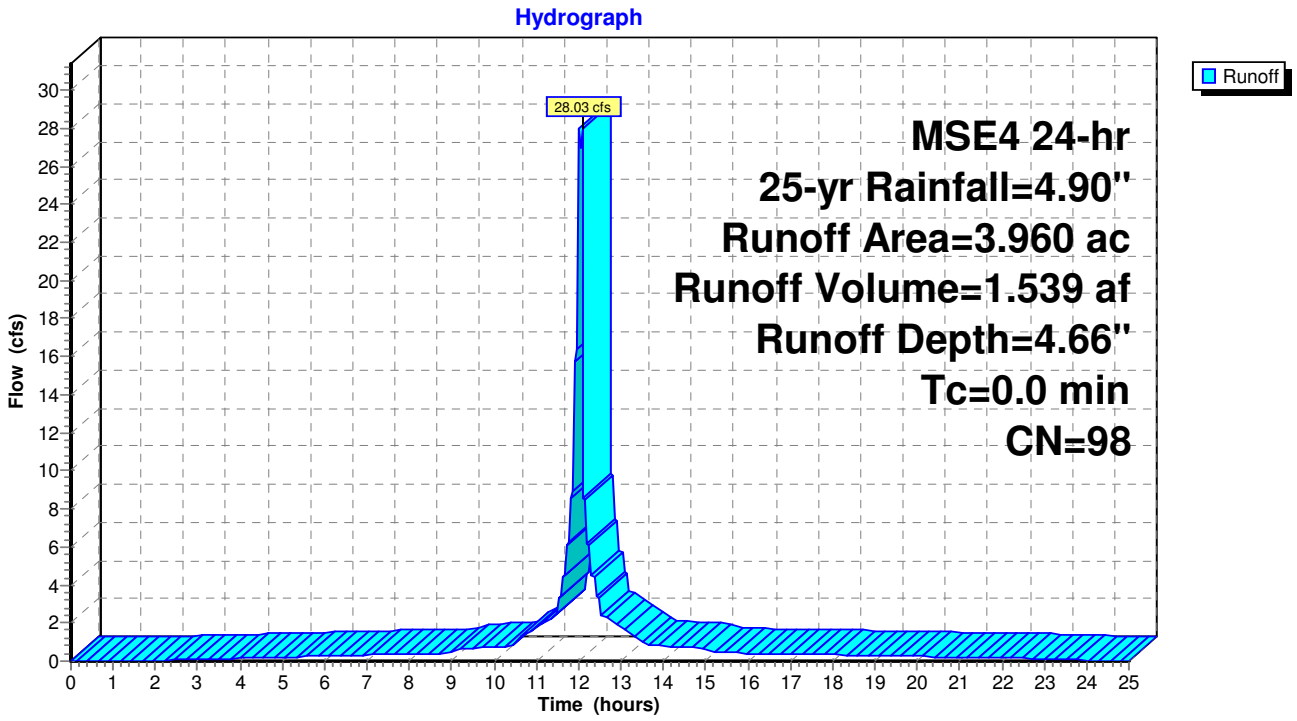
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 71S: Pond Area



Summary for Pond 57P: Ex. Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr event
Inflow = 45.90 cfs @ 12.09 hrs, Volume= 5.611 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

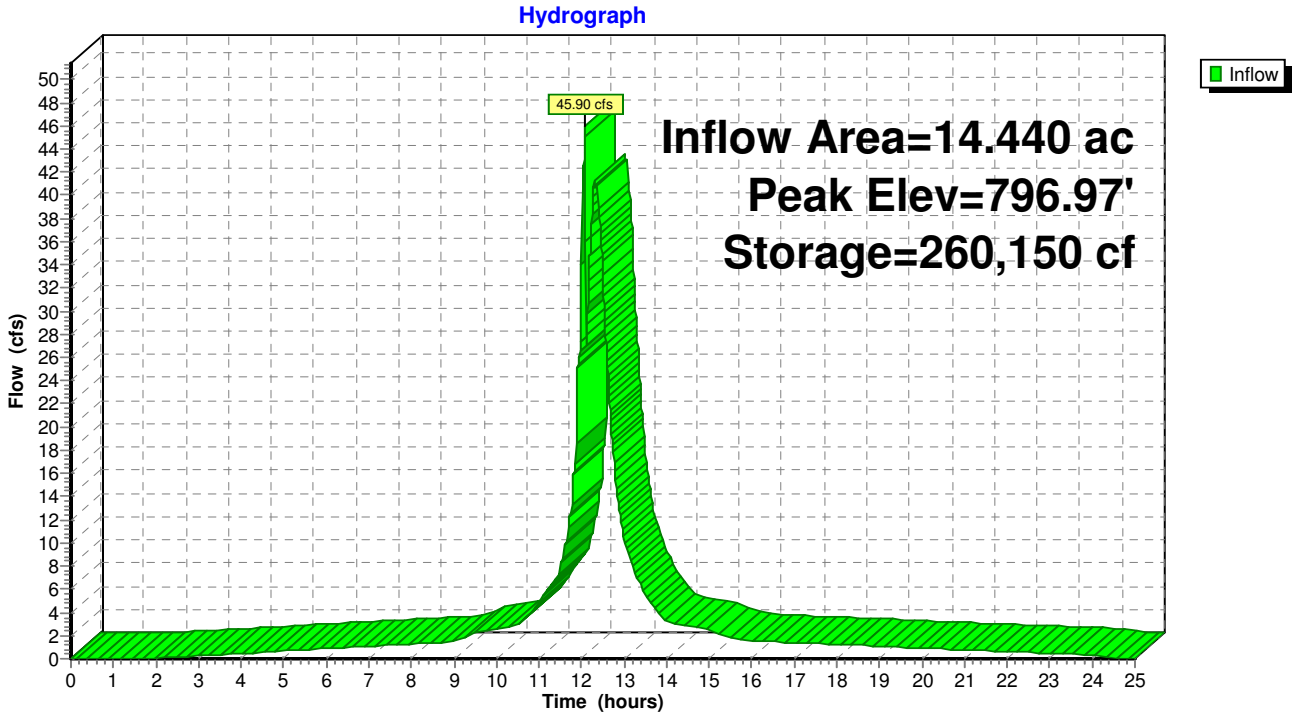
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,516 sf Storage= 260,150 cf (244,436 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

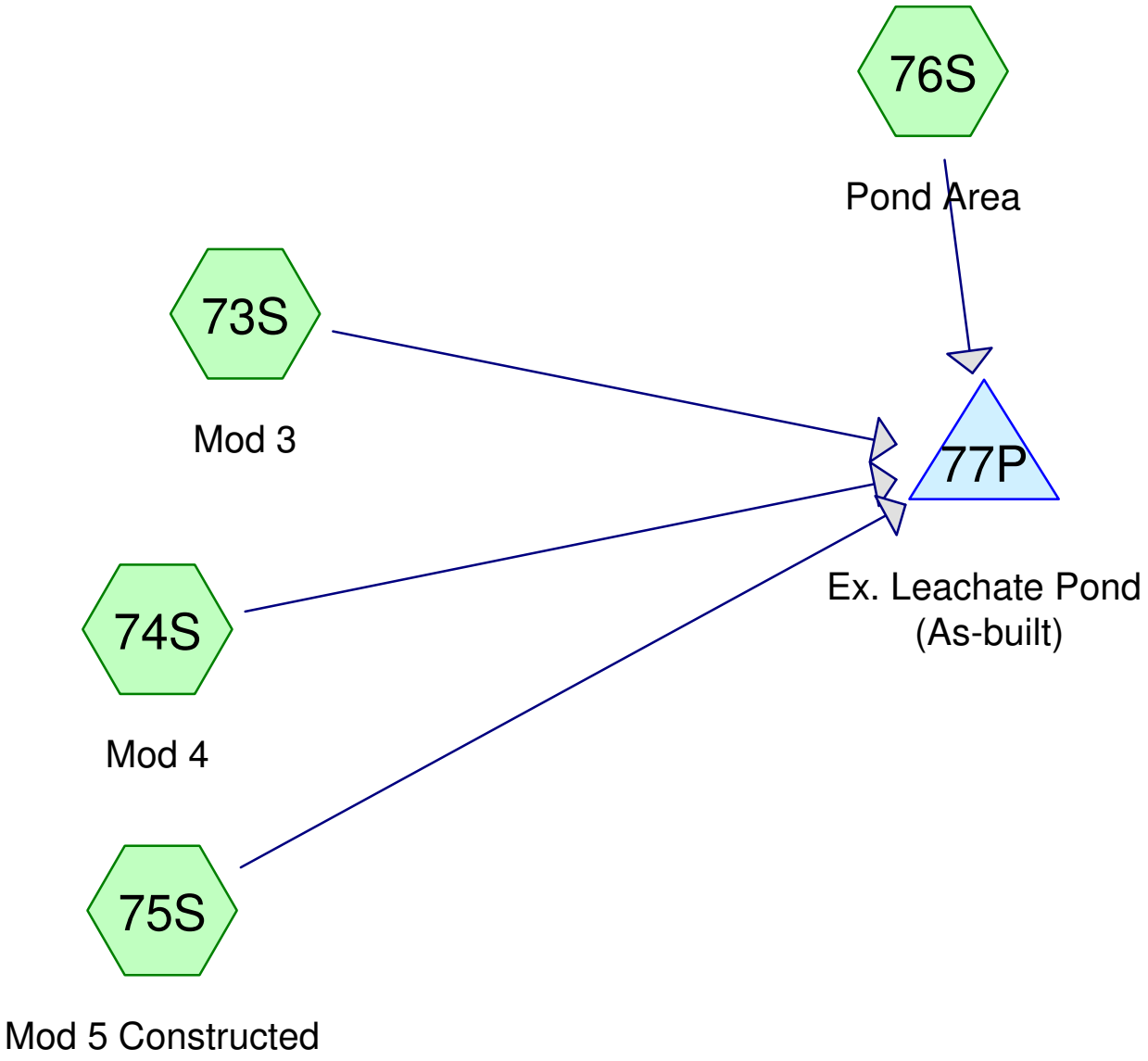
Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 57P: Ex. Leachate Pond (As-built)



Model Run 3B



Subcat Reach Pond Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 73S: Mod 3 Runoff Area=4.330 ac 100.00% Impervious Runoff Depth=3.92"
Tc=20.0 min CN=98 Runoff=15.04 cfs 1.416 af

Subcatchment 74S: Mod 4 Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=3.92"
Tc=25.0 min CN=98 Runoff=13.65 cfs 1.436 af

Subcatchment 75S: Mod 5 Constructed Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>3.92"
Tc=30.0 min CN=98 Runoff=12.59 cfs 1.459 af

Subcatchment 76S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.92"
Tc=0.0 min CN=98 Runoff=23.76 cfs 1.295 af

Pond 77P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=259,902 cf Inflow=44.31 cfs 5.606 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 17.140 ac Runoff Volume = 5.606 af Average Runoff Depth = 3.92"
0.00% Pervious = 0.000 ac 100.00% Impervious = 17.140 ac

Summary for Subcatchment 73S: Mod 3

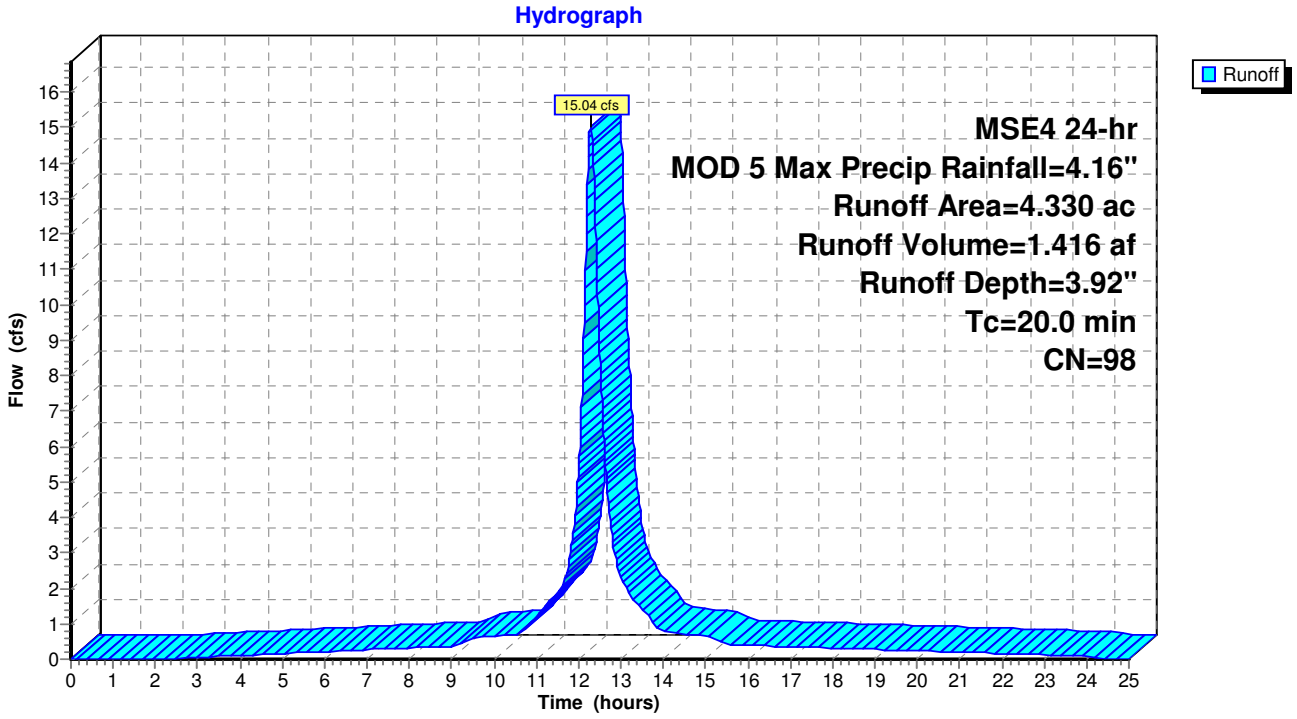
Runoff = 15.04 cfs @ 12.29 hrs, Volume= 1.416 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	4.330	98	Mod 3
	4.330		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 73S: Mod 3



Summary for Subcatchment 74S: Mod 4

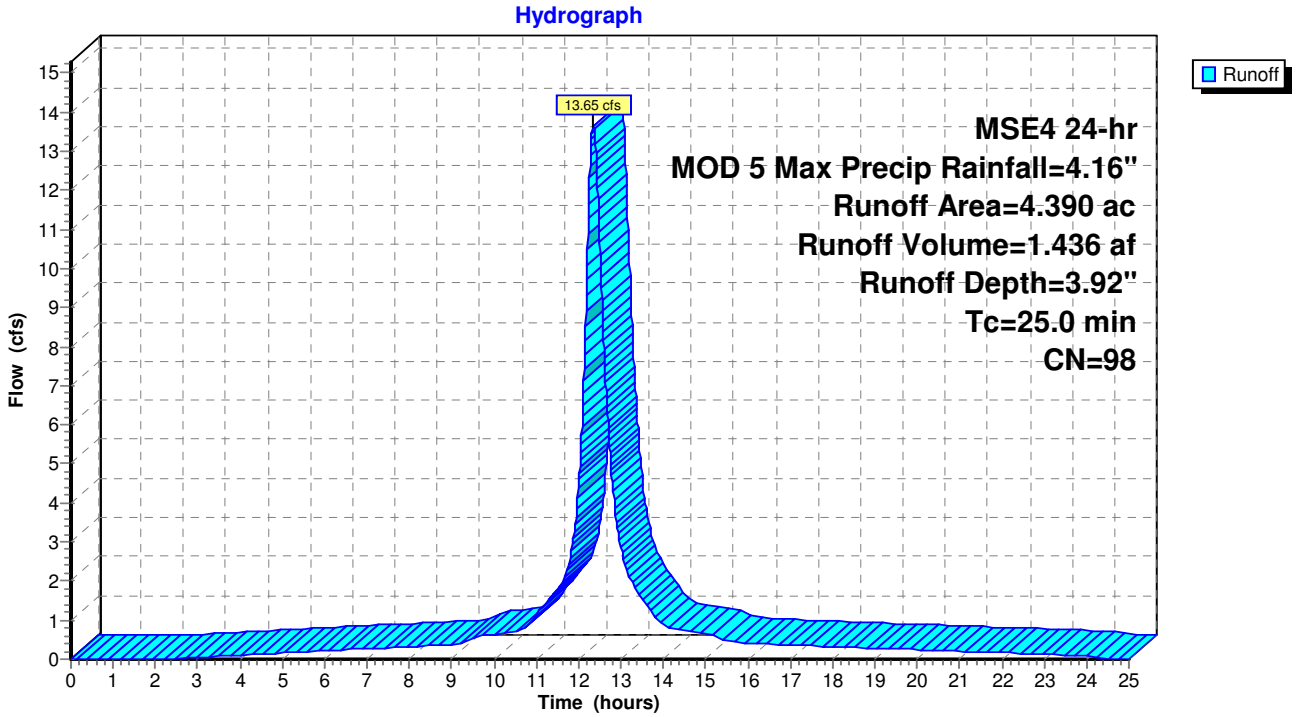
Runoff = 13.65 cfs @ 12.34 hrs, Volume= 1.436 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	4.390	98	Mod 4
	4.390		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Subcatchment 74S: Mod 4



Summary for Subcatchment 75S: Mod 5 Constructed

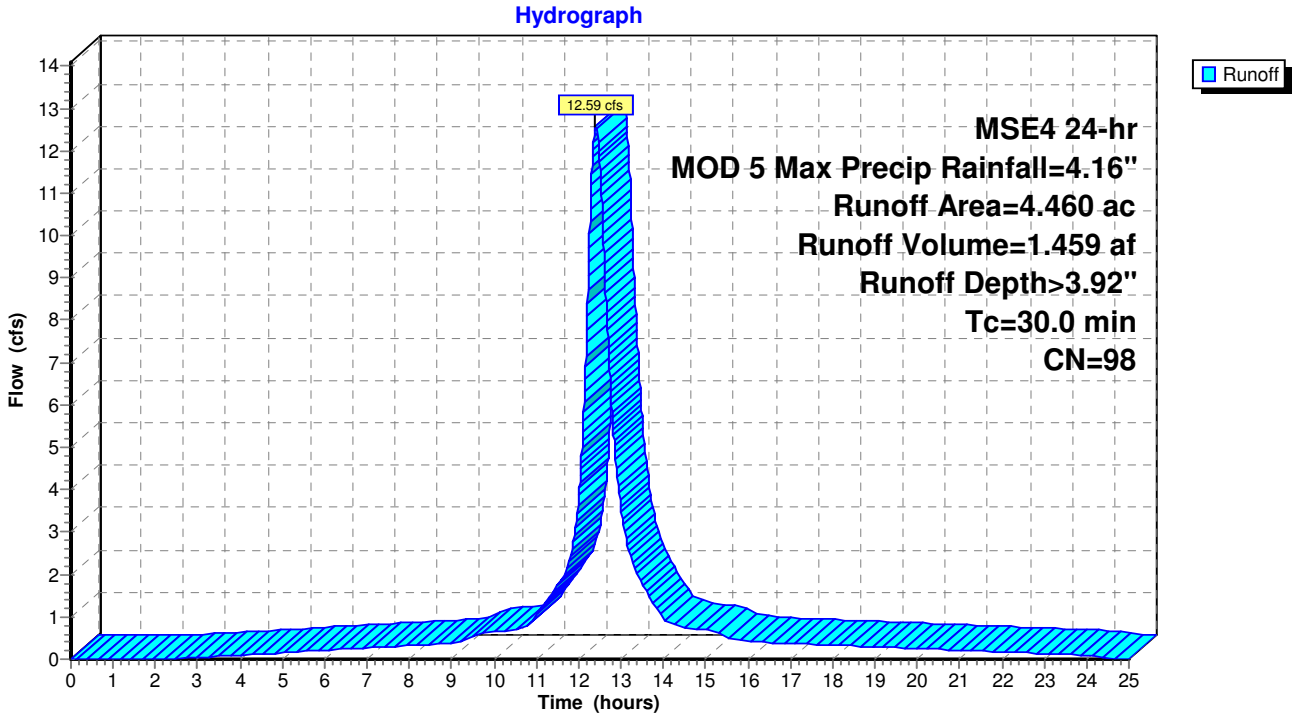
Runoff = 12.59 cfs @ 12.40 hrs, Volume= 1.459 af, Depth> 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	4.460	98	Mod 5 no cover
	4.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Estimated**

Subcatchment 75S: Mod 5 Constructed



Summary for Subcatchment 76S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

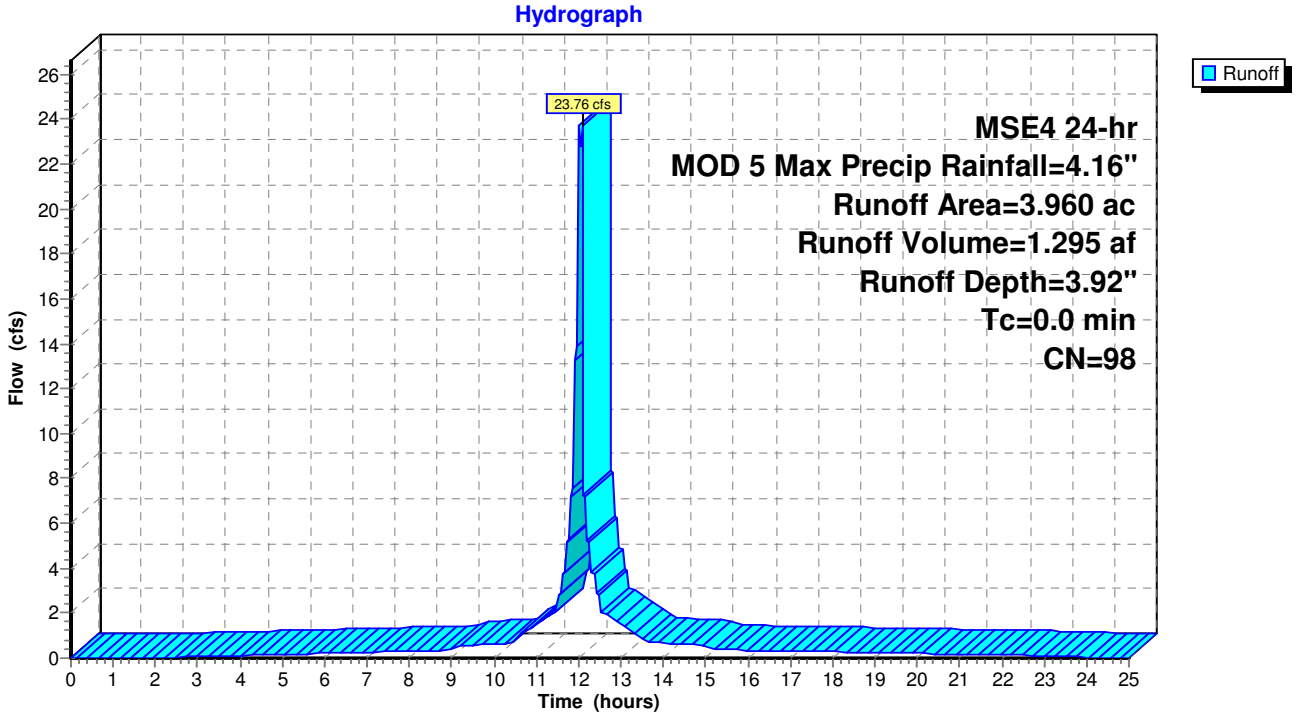
Runoff = 23.76 cfs @ 12.09 hrs, Volume= 1.295 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 5 Max Precip Rainfall=4.16"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 76S: Pond Area



Summary for Pond 77P: Ex. Leachate Pond (As-built)

Inflow Area = 17.140 ac,100.00% Impervious, Inflow Depth = 3.92" for MOD 5 Max Precip event
Inflow = 44.31 cfs @ 12.29 hrs, Volume= 5.606 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

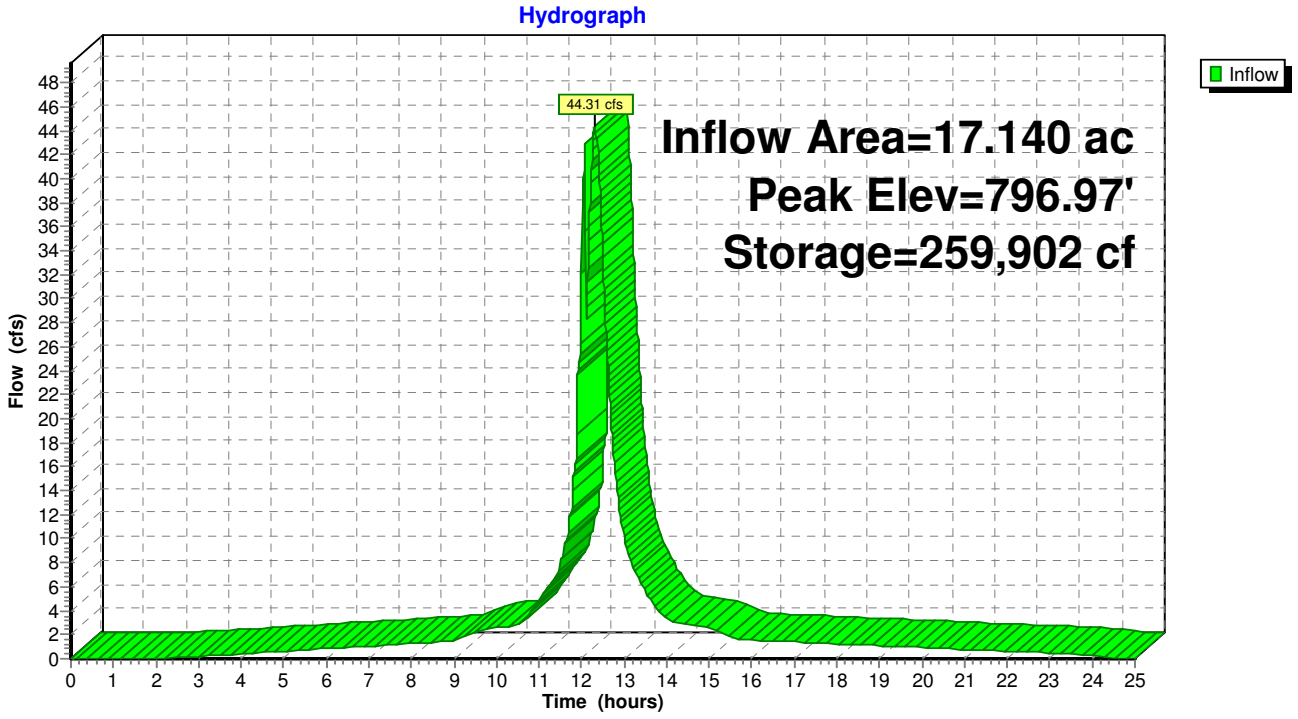
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,502 sf Storage= 259,902 cf (244,187 cf above start)

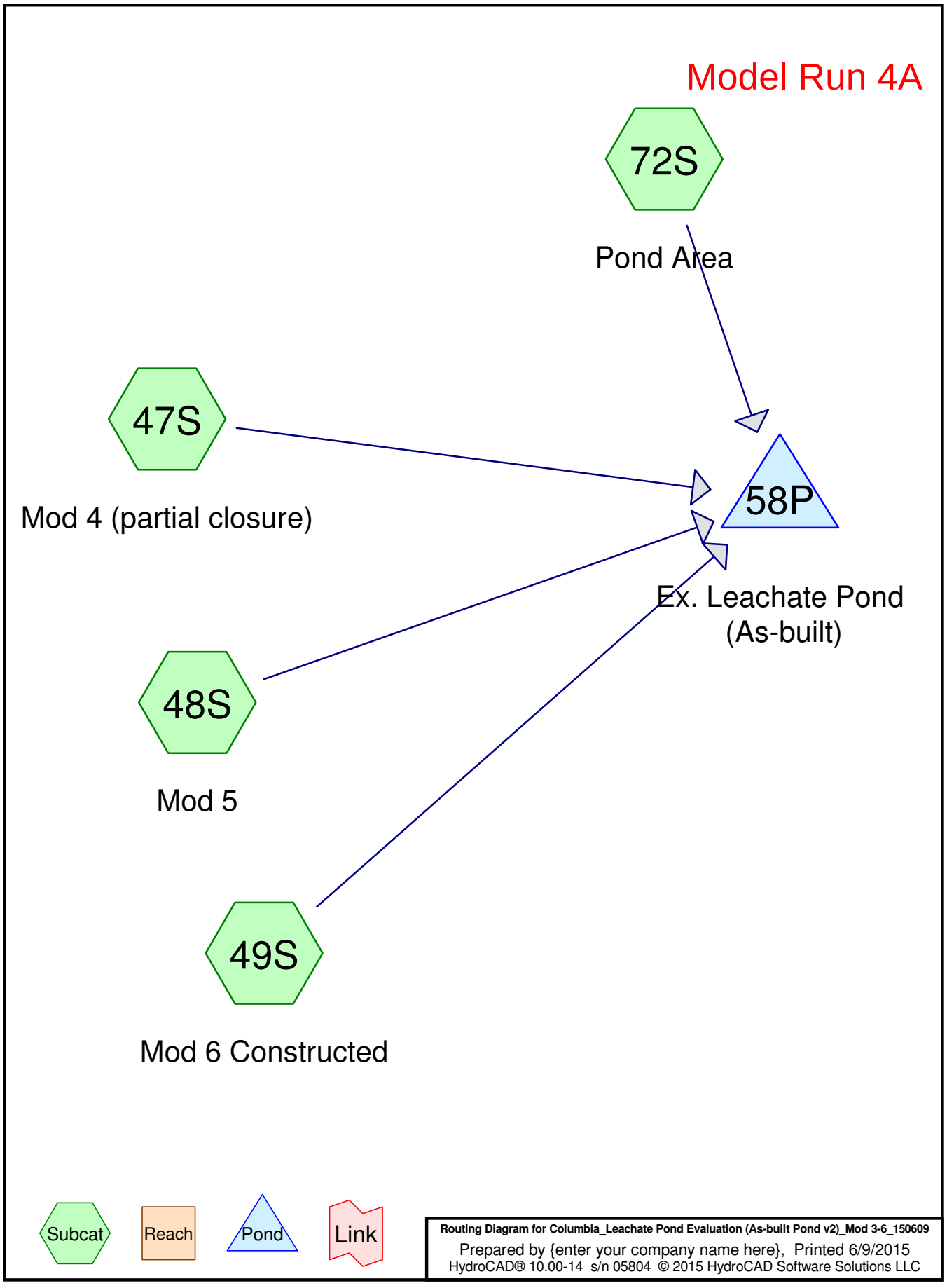
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 77P: Ex. Leachate Pond (As-built)




Model Run 4A
72S
Pond Area
47S
Mod 4 (partial closure)
58P
Ex. Leachate Pond
(As-built)
48S
Mod 5
49S
Mod 6 Constructed
Subcat
Reach
Pond
Link

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 47S: Mod 4 (partial closure) Runoff Area=1.640 ac 100.00% Impervious Runoff Depth=4.66"
Tc=25.0 min CN=98 Runoff=6.02 cfs 0.637 af

Subcatchment 48S: Mod 5 Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>4.66"
Tc=30.0 min CN=98 Runoff=14.86 cfs 1.733 af

Subcatchment 49S: Mod 6 Constructed Runoff Area=4.380 ac 100.00% Impervious Runoff Depth>4.66"
Tc=35.0 min CN=98 Runoff=13.45 cfs 1.702 af

Subcatchment 72S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.03 cfs 1.539 af

Pond 58P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=260,146 cf Inflow=42.93 cfs 5.611 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 14.440 ac Runoff Volume = 5.611 af Average Runoff Depth = 4.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 14.440 ac

Summary for Subcatchment 47S: Mod 4 (partial closure)

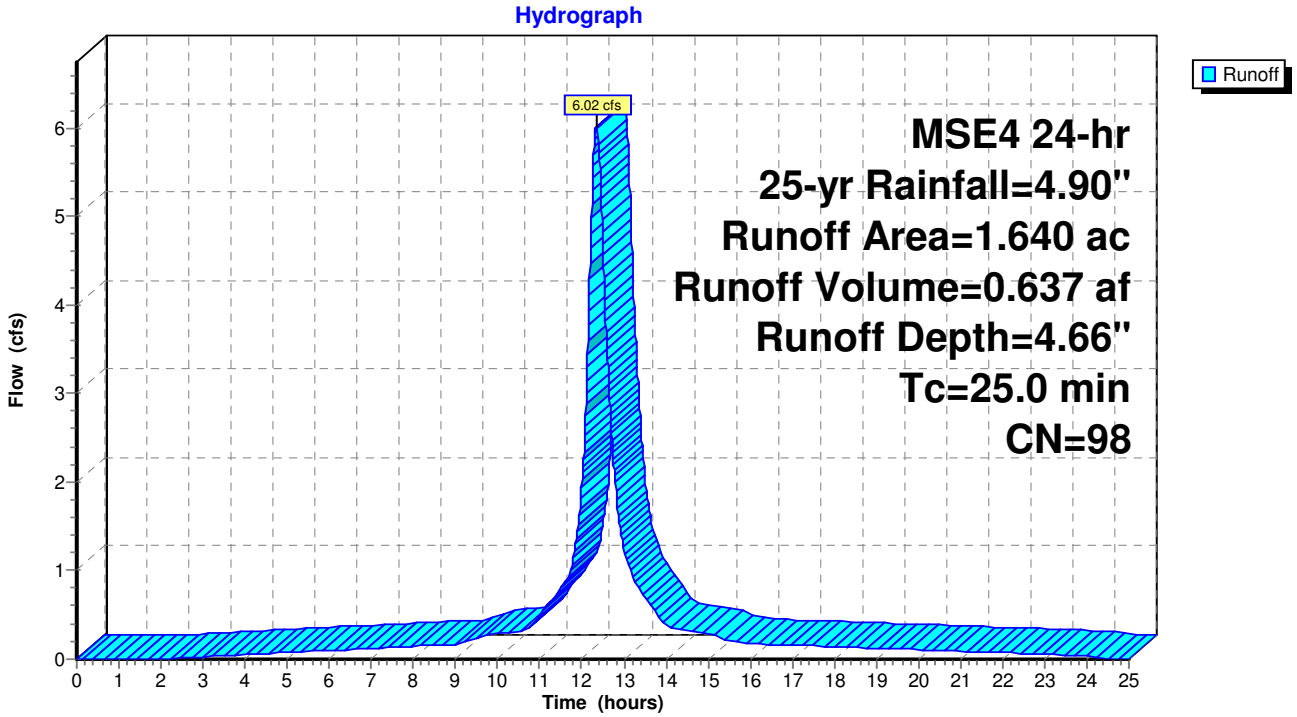
Runoff = 6.02 cfs @ 12.34 hrs, Volume= 0.637 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	1.640	98	Mod 4
	1.640		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Subcatchment 47S: Mod 4 (partial closure)



Summary for Subcatchment 48S: Mod 5

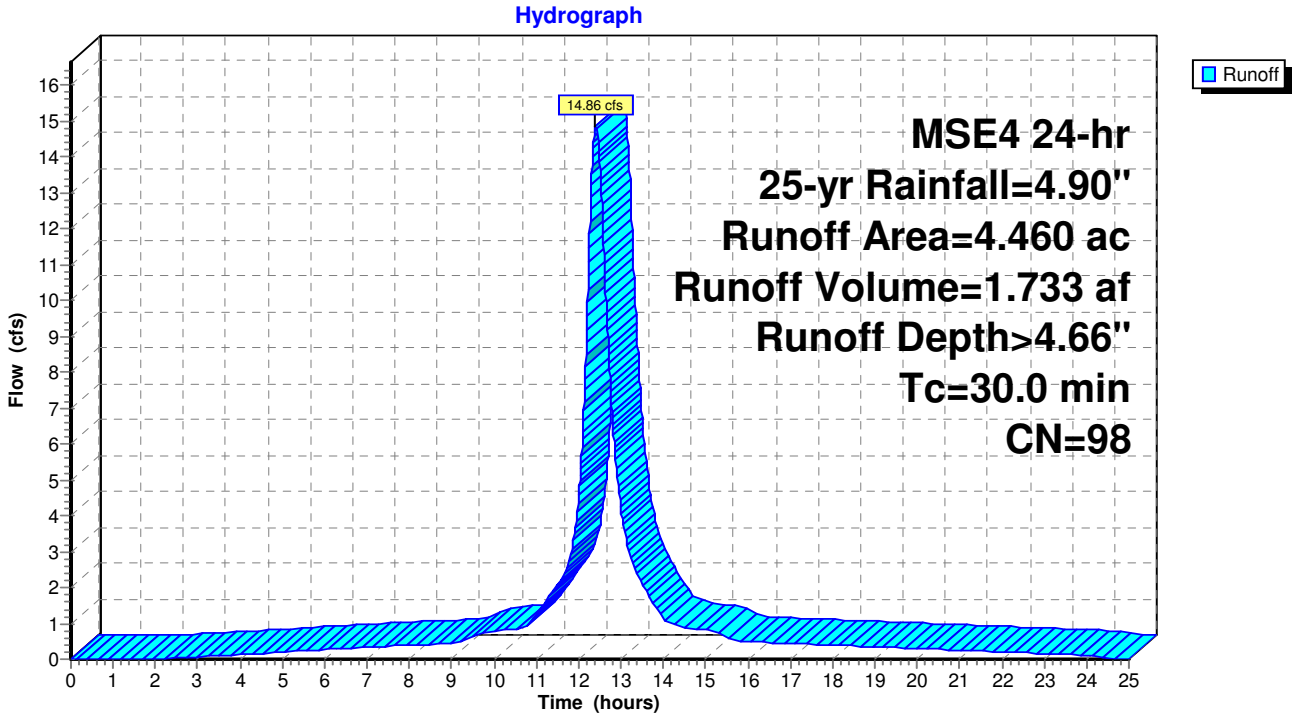
Runoff = 14.86 cfs @ 12.40 hrs, Volume= 1.733 af, Depth> 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.460	98	Mod 5
	4.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Estimated**

Subcatchment 48S: Mod 5



Summary for Subcatchment 49S: Mod 6 Constructed

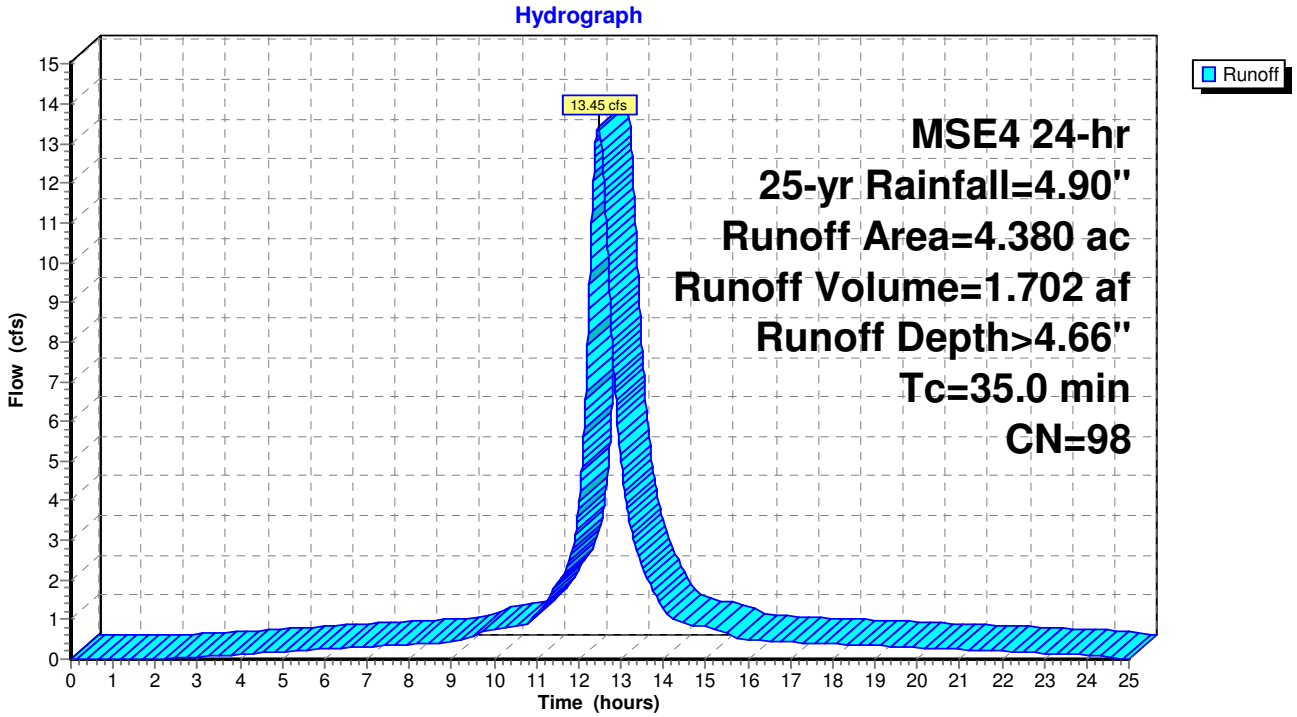
Runoff = 13.45 cfs @ 12.48 hrs, Volume= 1.702 af, Depth> 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	4.380	98	Mod 6 no cover
	4.380		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.0					**Direct Entry, Estimated**

Subcatchment 49S: Mod 6 Constructed



Summary for Subcatchment 72S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

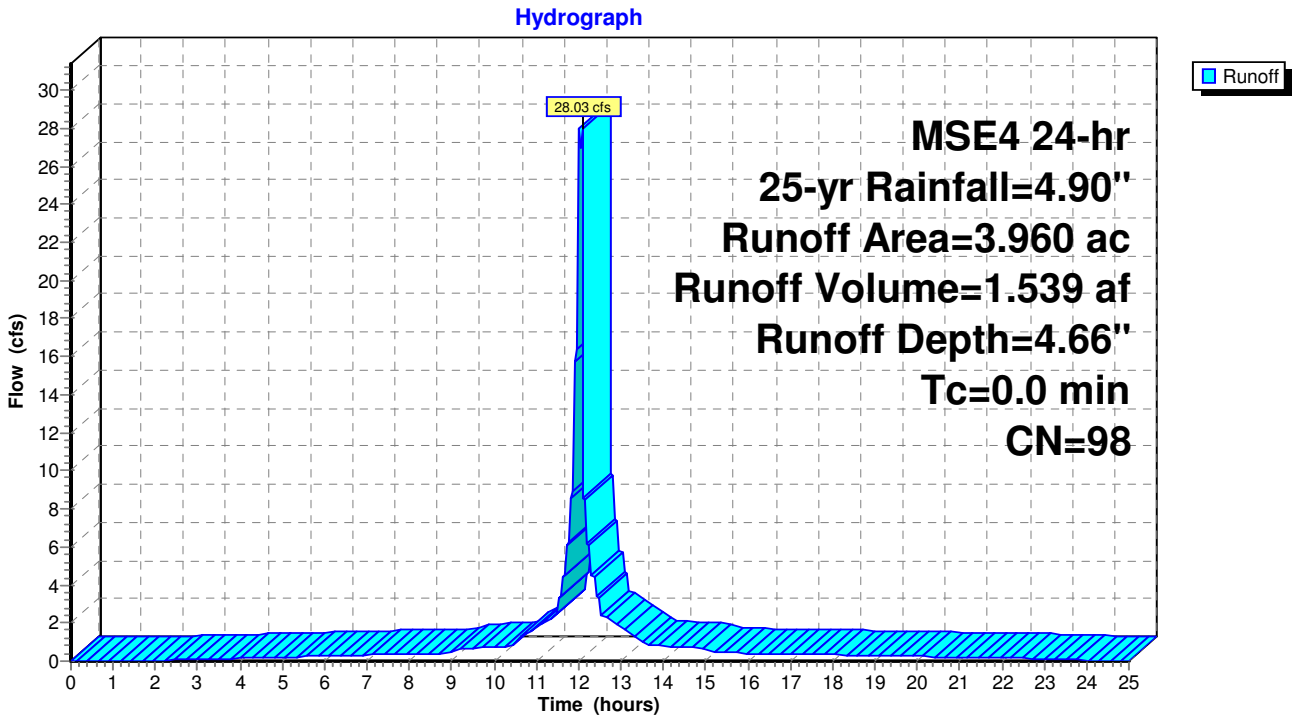
Runoff = 28.03 cfs @ 12.09 hrs, Volume= 1.539 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr 25-yr Rainfall=4.90"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 72S: Pond Area



Summary for Pond 58P: Ex. Leachate Pond (As-built)

Inflow Area = 14.440 ac,100.00% Impervious, Inflow Depth > 4.66" for 25-yr event
Inflow = 42.93 cfs @ 12.09 hrs, Volume= 5.611 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

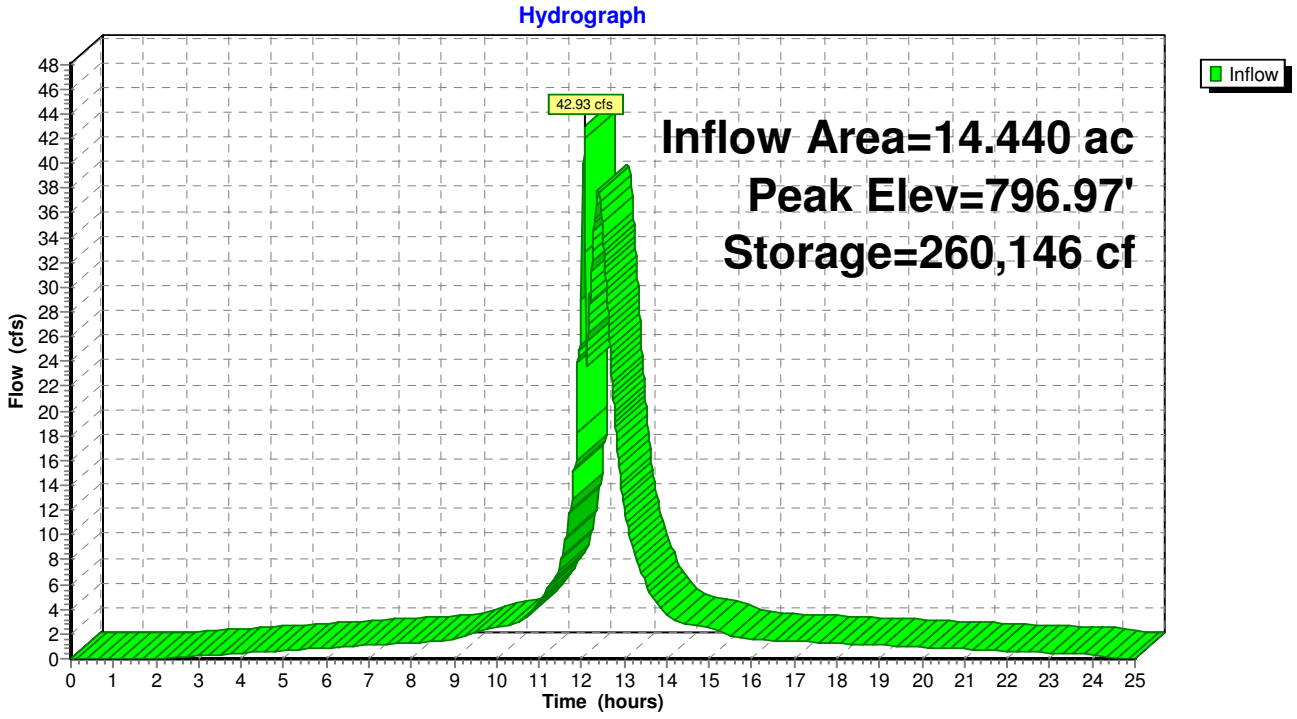
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,515 sf Storage= 260,146 cf (244,432 cf above start)

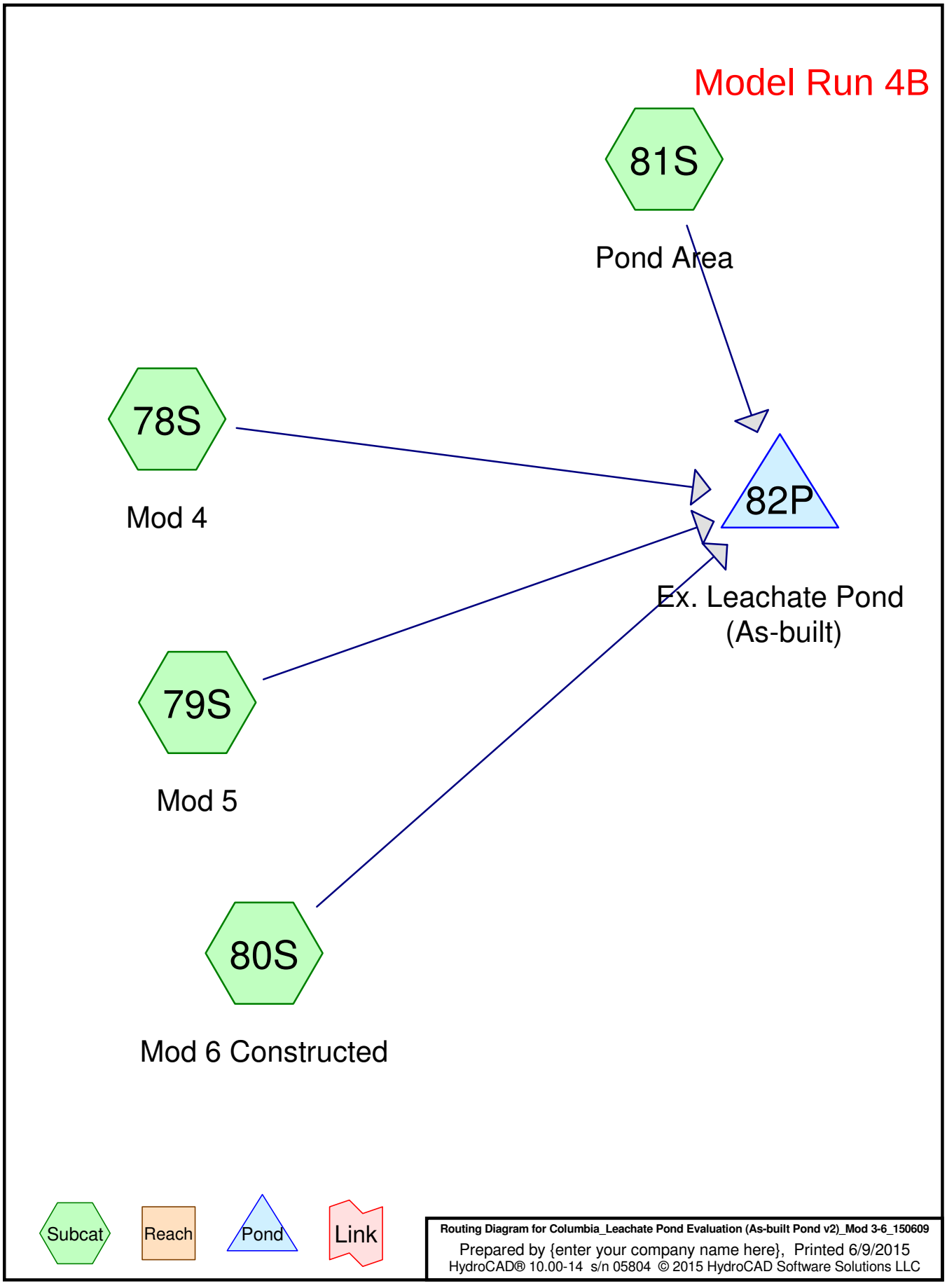
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 58P: Ex. Leachate Pond (As-built)





Routing Diagram for Columbia_Leachate Pond Evaluation (As-built Pond v2)_Mod 3-6_150609

Prepared by {enter your company name here}, Printed 6/9/2015

HydroCAD® 10.00-14 s/n 05804 © 2015 HydroCAD Software Solutions LLC

Time span=0.00-25.00 hrs, dt=0.01 hrs, 2501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 78S: Mod 4 Runoff Area=4.390 ac 100.00% Impervious Runoff Depth=3.91"
Tc=25.0 min CN=98 Runoff=13.62 cfs 1.432 af

Subcatchment 79S: Mod 5 Runoff Area=4.460 ac 100.00% Impervious Runoff Depth>3.91"
Tc=30.0 min CN=98 Runoff=12.56 cfs 1.455 af

Subcatchment 80S: Mod 6 Constructed Runoff Area=4.380 ac 100.00% Impervious Runoff Depth>3.91"
Tc=35.0 min CN=98 Runoff=11.36 cfs 1.429 af

Subcatchment 81S: Pond Area Runoff Area=3.960 ac 100.00% Impervious Runoff Depth=3.91"
Tc=0.0 min CN=98 Runoff=23.70 cfs 1.292 af

Pond 82P: Ex. Leachate Pond (As-built) Peak Elev=796.97' Storage=259,988 cf Inflow=40.45 cfs 5.608 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 17.190 ac Runoff Volume = 5.608 af Average Runoff Depth = 3.91"
0.00% Pervious = 0.000 ac 100.00% Impervious = 17.190 ac

Summary for Subcatchment 78S: Mod 4

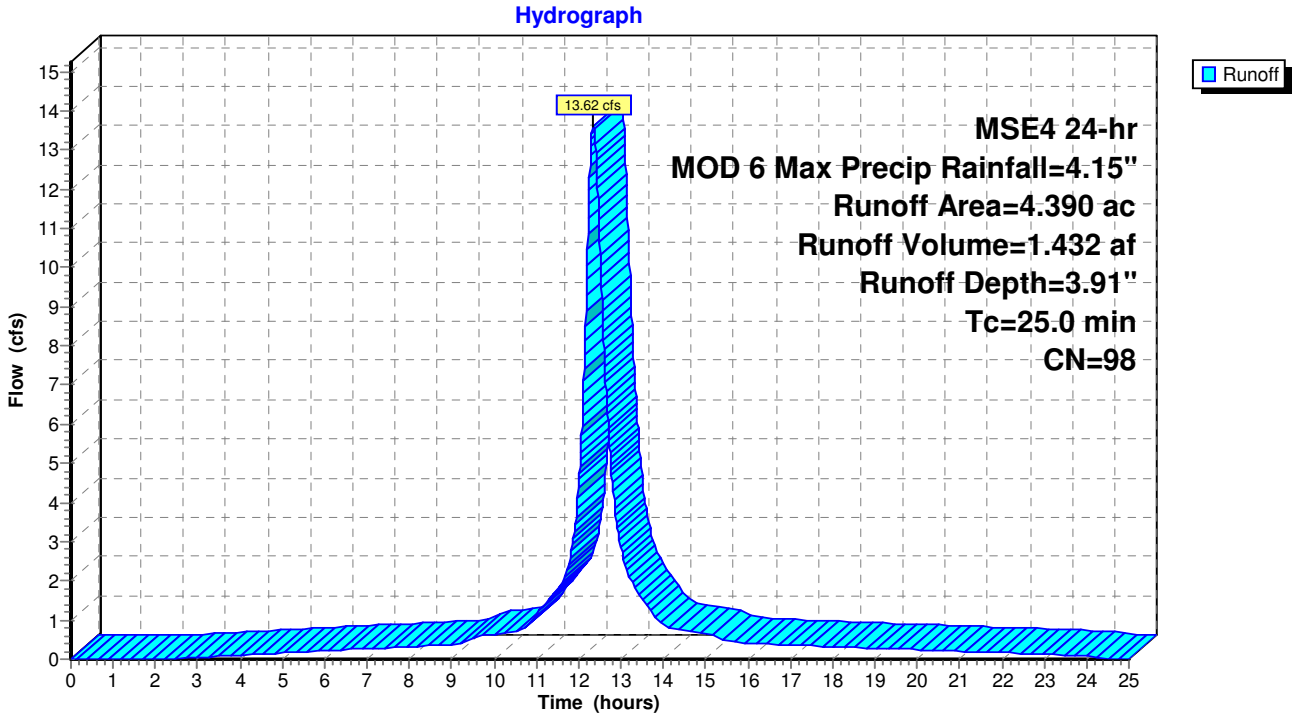
Runoff = 13.62 cfs @ 12.34 hrs, Volume= 1.432 af, Depth= 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	4.390	98	Mod 4
	4.390		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
25.0					**Direct Entry, Estimated**

Subcatchment 78S: Mod 4



Summary for Subcatchment 79S: Mod 5

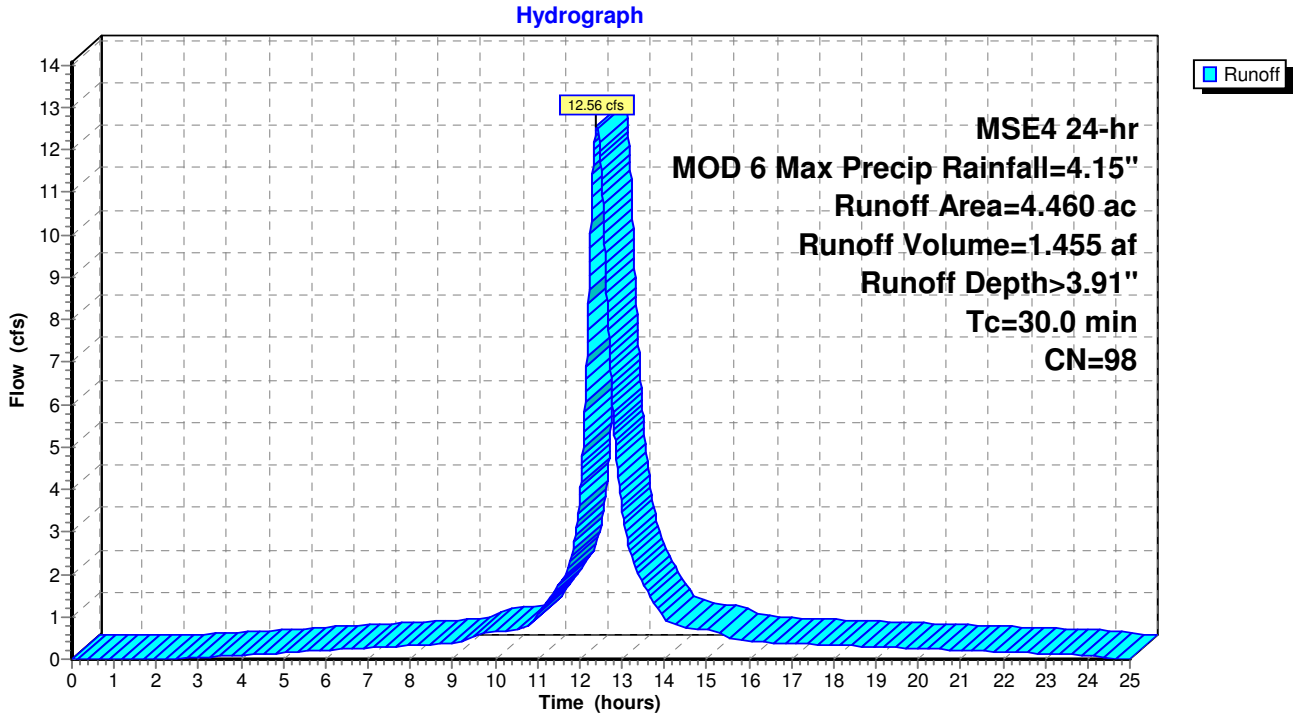
Runoff = 12.56 cfs @ 12.40 hrs, Volume= 1.455 af, Depth> 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	4.460	98	Mod 5
	4.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.0					**Direct Entry, Estimated**

Subcatchment 79S: Mod 5



Summary for Subcatchment 80S: Mod 6 Constructed

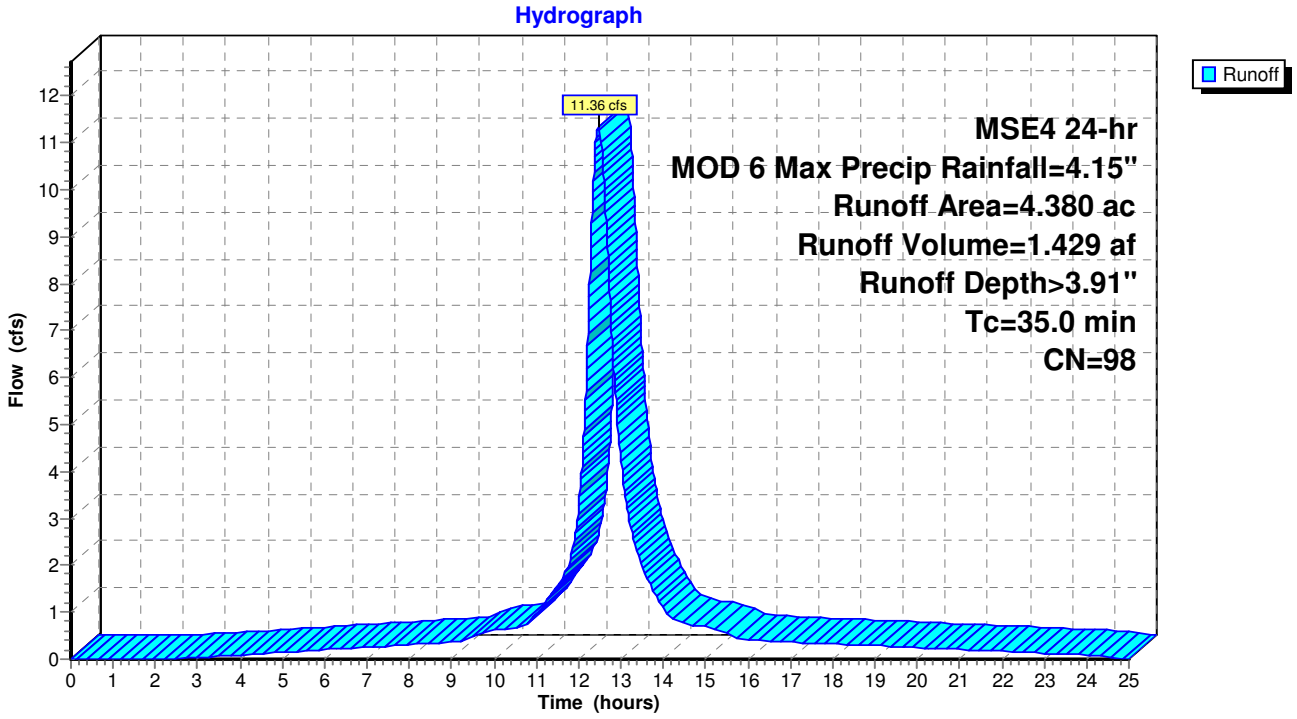
Runoff = 11.36 cfs @ 12.48 hrs, Volume= 1.429 af, Depth> 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	4.380	98	Mod 6 no cover
	4.380		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
35.0					**Direct Entry, Estimated**

Subcatchment 80S: Mod 6 Constructed



Summary for Subcatchment 81S: Pond Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

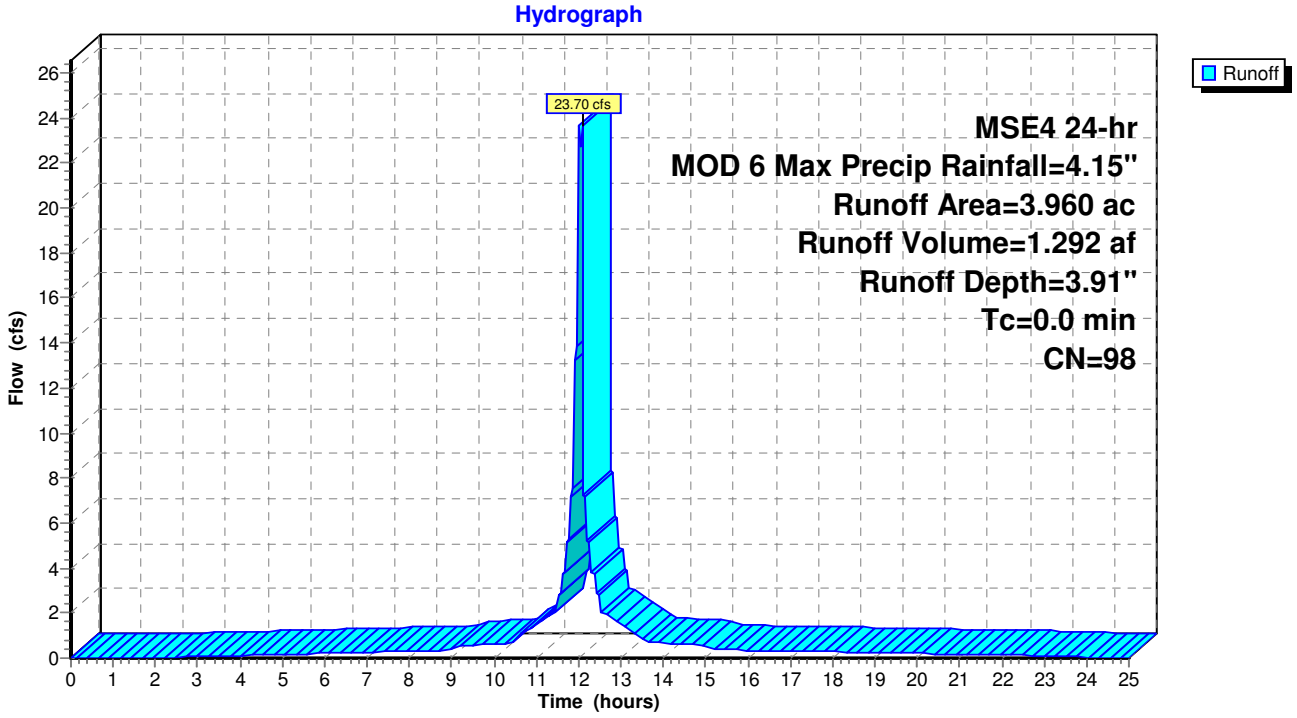
Runoff = 23.70 cfs @ 12.09 hrs, Volume= 1.292 af, Depth= 3.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
MSE4 24-hr MOD 6 Max Precip Rainfall=4.15"

	Area (ac)	CN	Description
*	3.960	98	
	3.960		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 81S: Pond Area



Summary for Pond 82P: Ex. Leachate Pond (As-built)

Inflow Area = 17.190 ac,100.00% Impervious, Inflow Depth > 3.91" for MOD 6 Max Precip event
Inflow = 40.45 cfs @ 12.39 hrs, Volume= 5.608 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

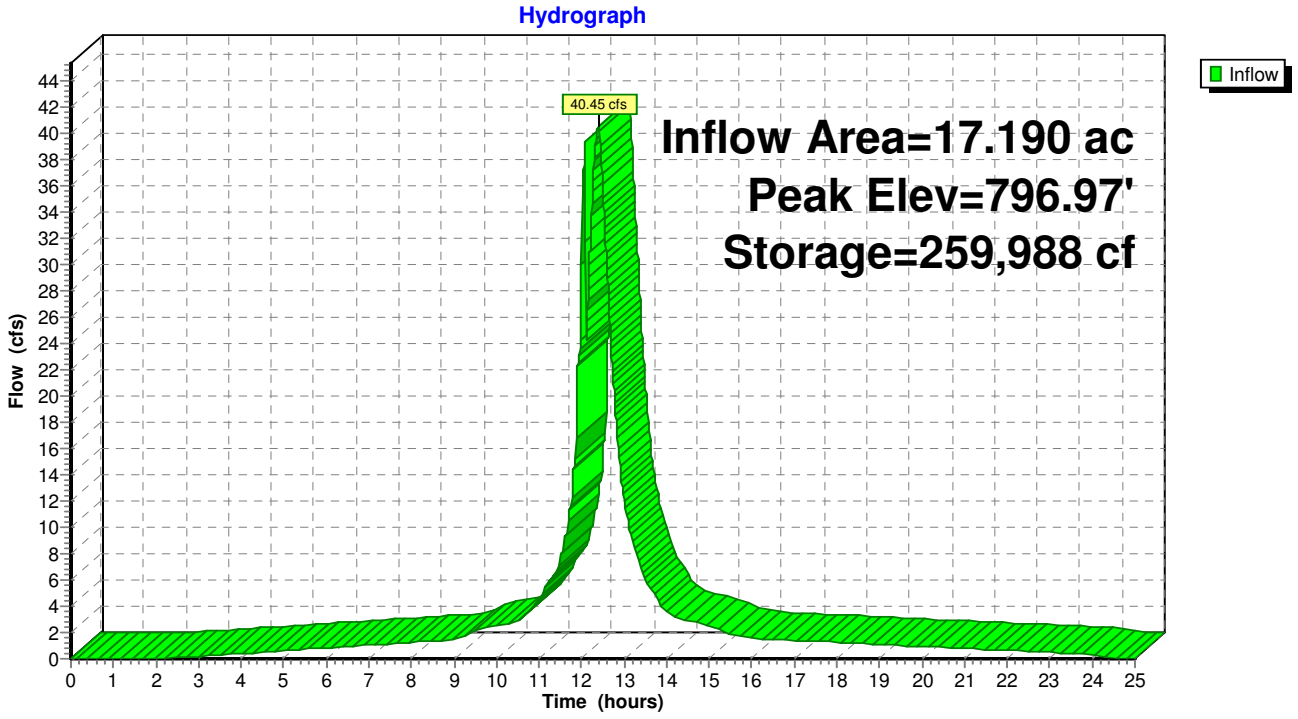
Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.01 hrs
Starting Elev= 792.50' Surf.Area= 34,630 sf Storage= 15,714 cf
Peak Elev= 796.97' @ 25.00 hrs Surf.Area= 65,507 sf Storage= 259,988 cf (244,273 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	329,280 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	28,228	0	0
794.00	53,834	82,062	82,062
796.00	62,164	115,998	198,060
798.00	69,056	131,220	329,280

Pond 82P: Ex. Leachate Pond (As-built)



Purpose:

The purpose of the leachate/surface water pond evaluation is to determine the following based on the as-built leachate/surface water pond top of liner elevation of 796.97 (see Background section below):

- The amount of intermediate/final cover area required with Module 4 constructed in order to maintain the peak water elevation resulting from the 25-year, 24-hour storm event at the maximum allowable 796.97.
- Based on the amount of intermediate/final cover area determined from the above, determine the maximum starting water elevations in the leachate/surface water pond to accommodate 1, 2, 5, and 10-year, 24-hour storm events without overtopping.

Background:

- During construction of Module 2, the top of the leachate/surface water pond liner was determined to be at elevation 796.97.
- Previous calculations submitted to the WDNR on February 24, 2016, evaluated the leachate/surface water pond capacity based on the as-built pond liner elevation.
- A similar evaluation was performed for Module 3 construction that produced a chart of maximum leachate/surface water pond starting elevations vs. rainfall storage capacity.
- Portions of Modules 1 and 2 currently have final or intermediate cover in place (see **Figure 1**).

Approach:

- Use the previously developed HydroCAD storm water model from Module 3 construction to model the below two scenarios.
    1. Scenario 1 –Assume a rain cover is in place over 50% of Module 4, resulting in the remaining 50% of Module 4 contributing to the leachate/surface water pond.
    2. Scenario 2 – Assume all of Module 4 is contributing to the leachate/surface water pond.

Assumptions:

- Ash surfaces and intermediate cover areas were assumed to be impermeable (CN=98).
- The top of pond liner elevation is 796.97 (see Background section).
- Set a standing water elevation in the pond at 6 inches off of the bottom (i.e., elevation 792.50).
- The maximum starting water elevations in the pond assumes no freeboard.

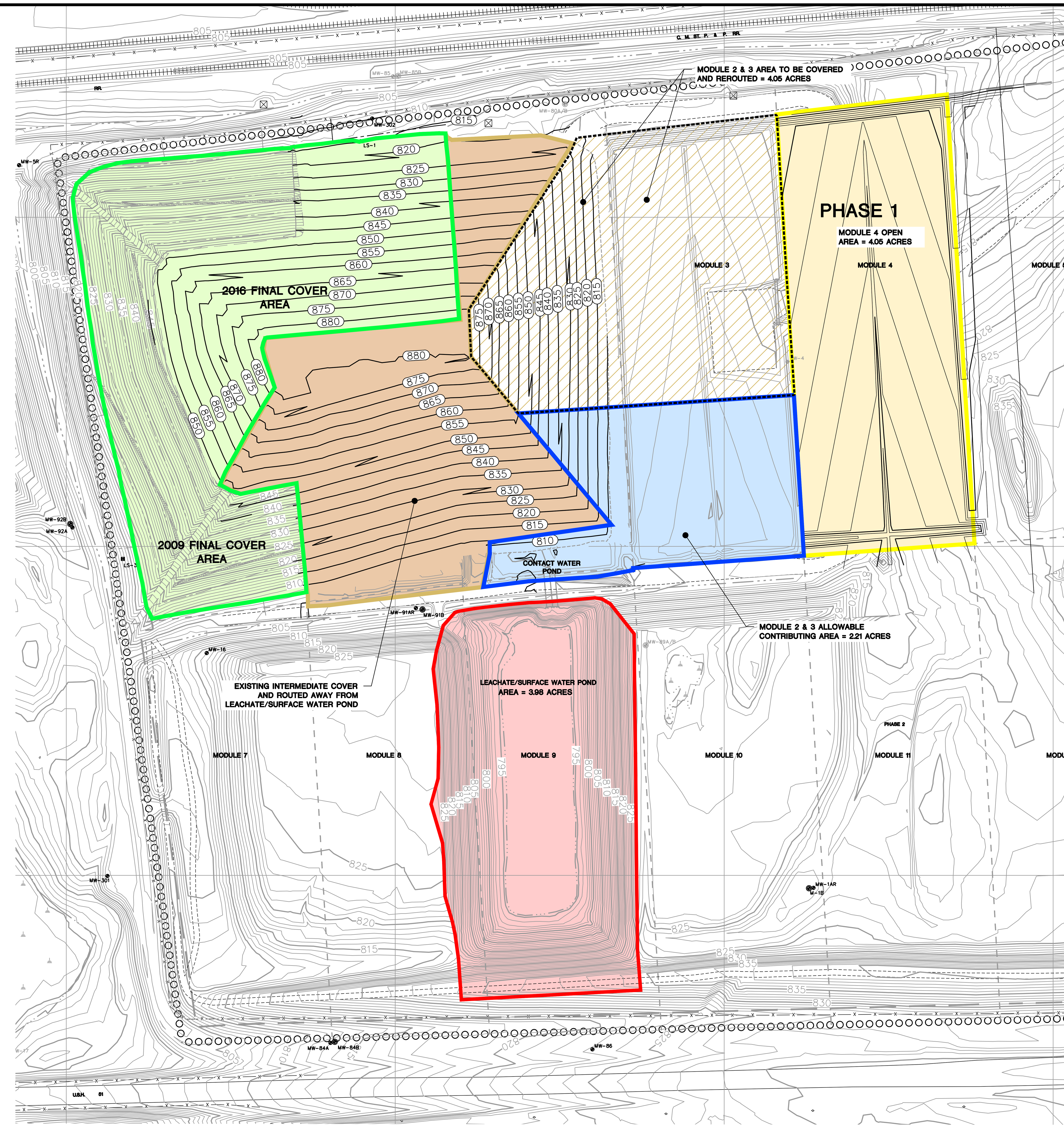
Results:

1. Scenario 1 - with 50% of Module 4 contributing to the leachate/storm water pond:
   - The maximum allowable contributing area of Modules 2 and 3 to the leachate/surface water pond is 4.235 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of Modules 2 and 3 (2.025 acres) would need to be closed/covered with final or intermediate cover and routed away from the pond.
   - **Figure 1** shows a conceptual 2.025 acres of additional cover, and **Figure 2** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

2. Scenario 2 - with 100% of Module 4 contributing to the leachate/storm water pond:
   - The maximum allowable contributing area of Modules 2 and 3 to the leachate/surface water pond is 2.210 acres for the leachate/surface water pond to accommodate the runoff from a 25-year, 24-hour storm without overtopping.
   - The remainder of Modules 2 and 3 (4.050 acres) would need to be closed/covered with final or intermediate cover and routed away from the pond.
   - **Figure 1** shows a conceptual 4.050 acres of additional cover, and **Figure 3** shows the various operating levels of the leachate/surface water pond to accommodate the various storm events with the additional cover in place.

The HydroCAD reports for each scenario and storm event modeled are attached. The full report is included for the 25-year, 25-hour storm event, and the leachate/surface water pond summary is included for all other storm events under each scenario.

SCENARIO 1 - 50% OF MODULE 4 OPEN



SCENARIO 2 - 100% OF MODULE 4 OPEN

LEGEND

- EXISTING FINAL COVER AREA
- EXISTING INTERMEDIATE COVER AND ROUTED AWAY FROM POND
- LEACHATE/SURFACE WATER POND CONTRIBUTING AREA
- MODULE 2&3 CONTRIBUTING AREA
- MODULE 4 CONTRIBUTING AREA
- AREA TO BE COVERED/REROUTED

100 0 100

SCALE: 1" = 100'

PROJECT NO.	25217156.00
DRAWN:	11/7/16
REVISED:	11/29/17
DRAWN BY:	ES/KP/BJM
CHECKED BY:	JO
APPROVED BY:	

CLIENT: Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

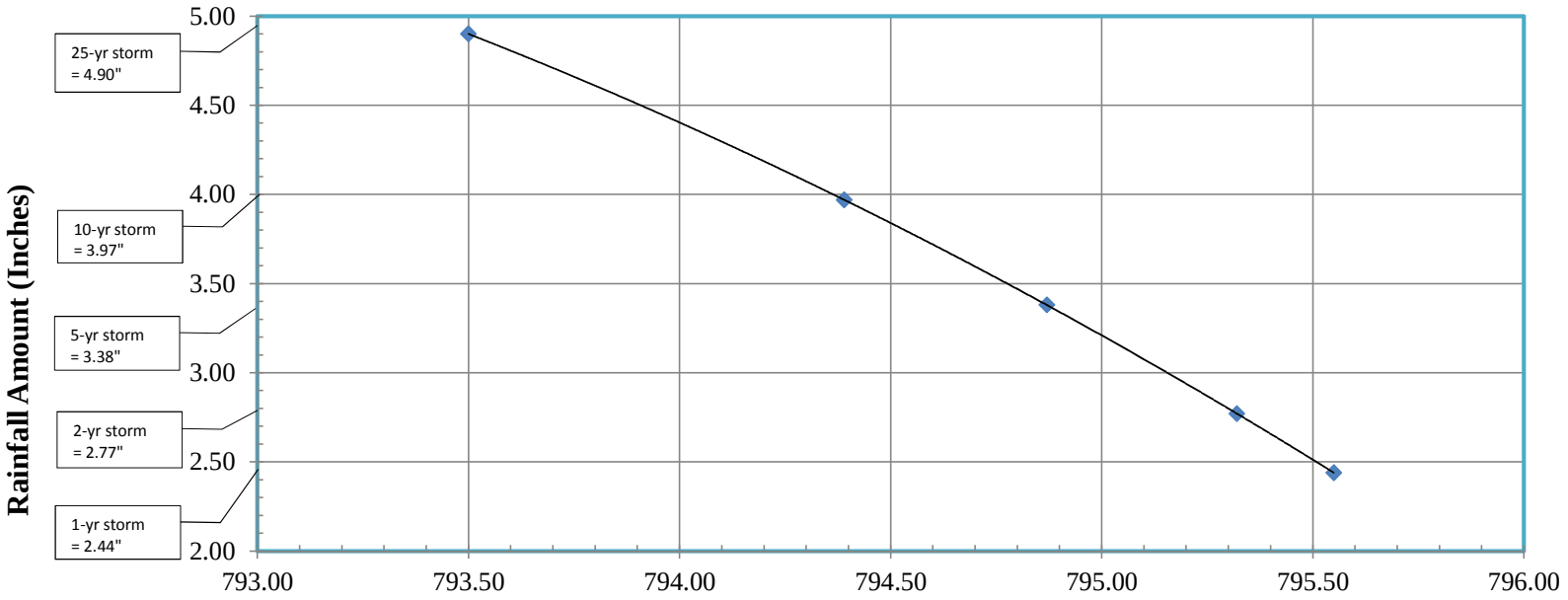
ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

SITE: WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

LEACHATE/SURFACE WATER POND EVALUATION

FIGURE 1

Figure 2
Columbia Energy Center
Scenario 1 - Module 4 50% Open
Leachate/Surface Water Pond Maximum Starting Water Elevation

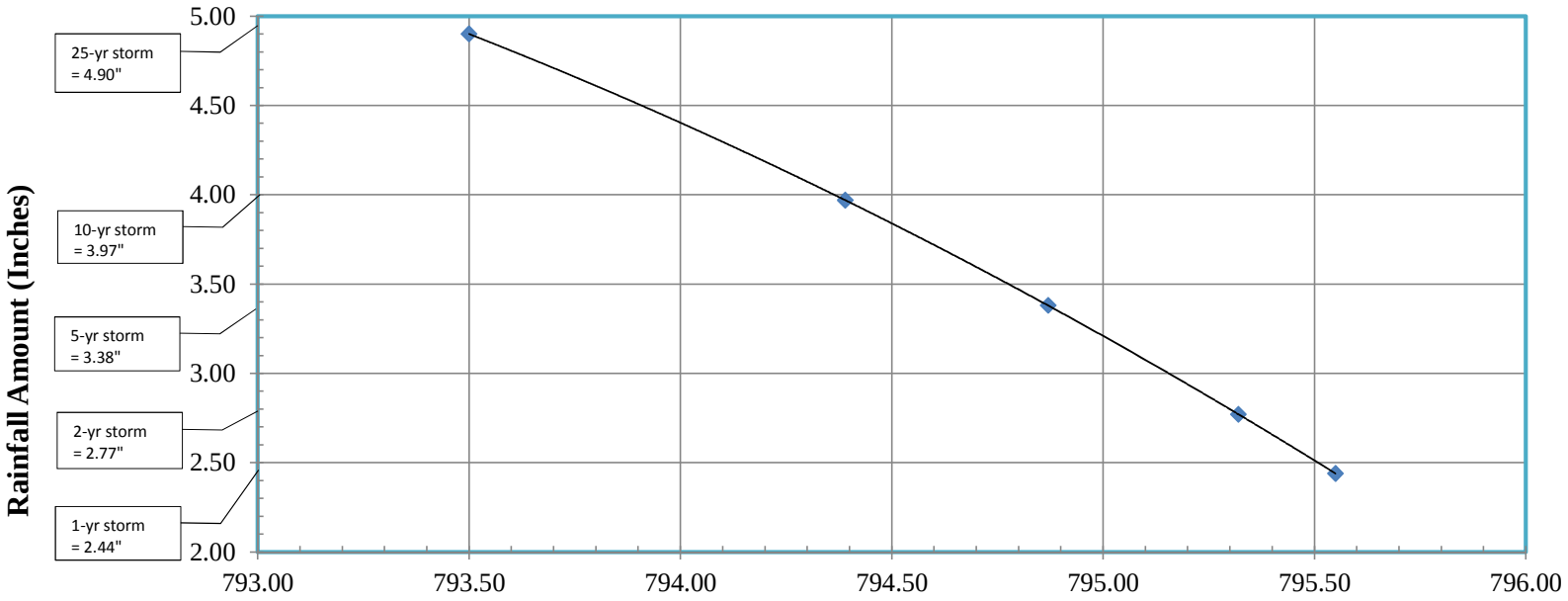


Notes/Assumptions:

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (refer to Leachate/Surface Water Pond Evaluation figure dated 11/29/17):
   - Mod 4 open area = 50% of module = 2.025 acres.
   - Mod 2 and Mod 3 open area = 4.235 acres (previously open/contributing area [6.26 acres] - required closure/rerouted area [2.025 acres]).
   - Leachate/Surface Water Pond Area, 3.98 acres.

I:\25217156.00\Data and Calculations\Leachate_Surface Water Pond Evaluation

Figure 3
Columbia Energy Center
Scenario 2 - Module 4 100% Open
Leachate/Surface Water Pond Maximum Starting Water Elevation

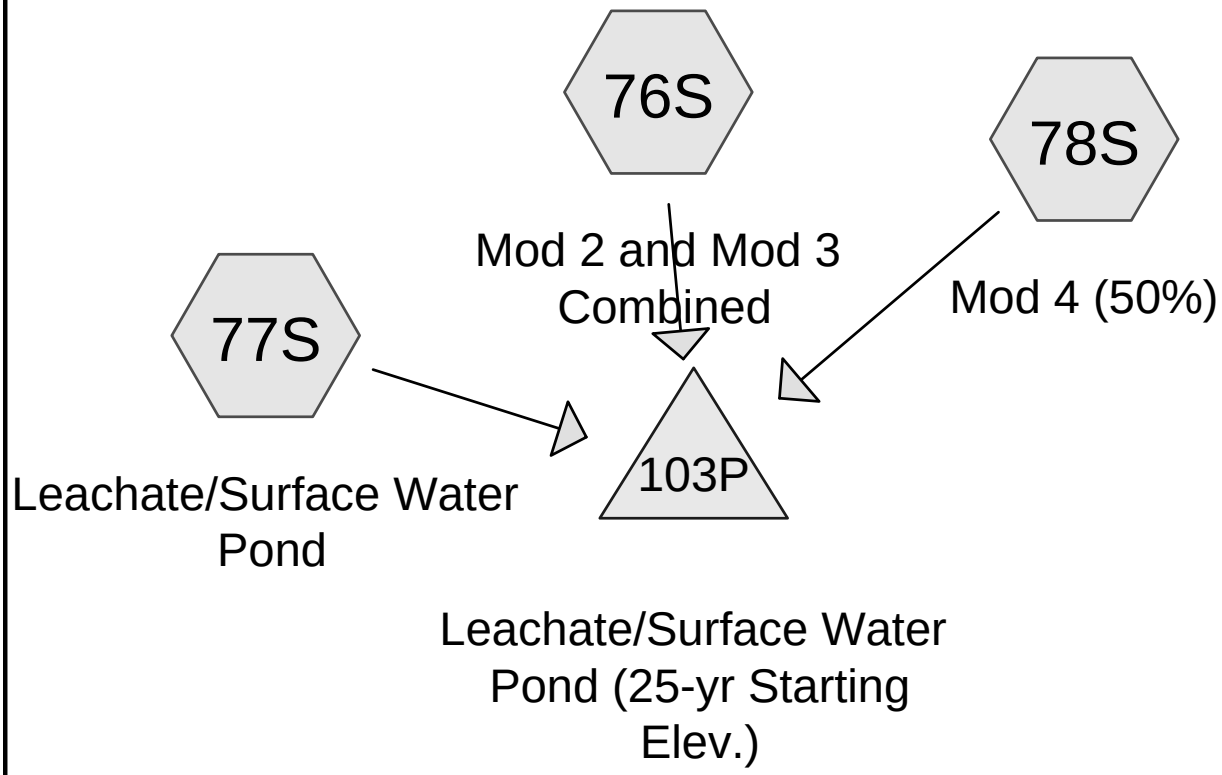


Notes/Assumptions:

1. Maximum starting water elevations based on 2011 Mod 2 as-built survey which determined the top of pond liner elevation = 796.97.
2. Maximum starting water elevation assumes no freeboard.
3. Previously developed HydroCAD model utilized with curve number for intermediate cover areas and ash surfaces assumed at CN = 98.
4. HydroCAD model assumes drainage areas contributing to pond include (refer to Leachate/Surface Water Pond Evaluation figure dated 11/29/17):
   - Mod 4 open area = 100% of module = 4.05 acres.
   - Mod 2 and Mod 3 open area = 2.21 acres (previously open/contributing area [6.26 acres] -required closure/rerouted area [4.05 acres]).
   - Leachate/Surface Water Pond Area, 3.98 acres.

I:\25217156.00\Data and Calculations\Leachate_Surface Water Pond Evaluation

Scenario 1 - Module 4 50% Open



Subcat Reach Pond Link

Routing Diagram for WPL Columbia_Mod 4 Leachate Pond Evaluation

Prepared by {enter your company name here}, Printed 11/28/2017

HydroCAD® 10.00-20 s/n 05804 © 2017 HydroCAD Software Solutions LLC

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 76S: Mod 2 and Mod 3 Runoff Area=4.235 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=17.25 cfs 1.646 af

Subcatchment 77S: Leachate/Surface Runoff Area=3.980 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.24 cfs 1.547 af

Subcatchment 78S: Mod 4 (50%) Runoff Area=2.025 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=8.25 cfs 0.787 af

Pond 103P: Leachate/Surface Water Peak Elev=796.97' Storage=197,459 cf Inflow=39.30 cfs 3.979 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 76S: Mod 2 and Mod 3 Combined

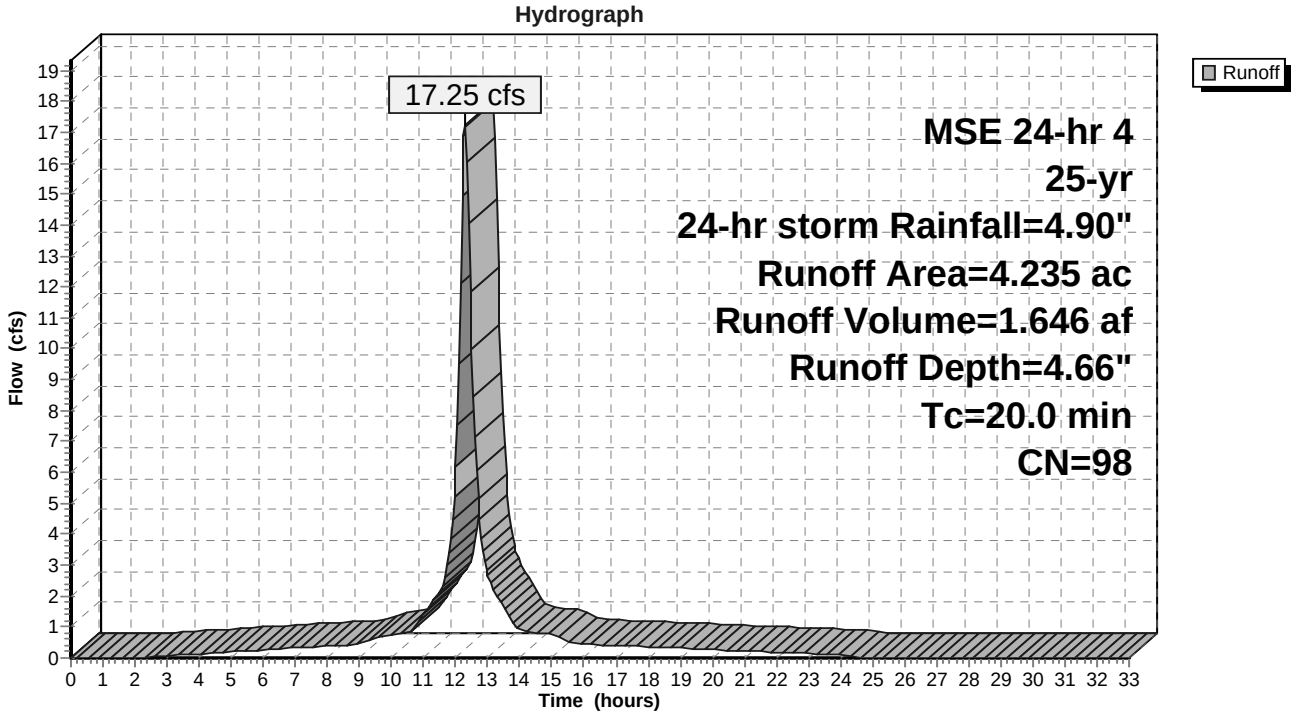
Runoff = 17.25 cfs @ 12.28 hrs, Volume= 1.646 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.90"

	Area (ac)	CN	Description
*	4.235	98	Mod 2 and Mod 3 Allowable Open Area
	4.235		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 76S: Mod 2 and Mod 3 Combined



Summary for Subcatchment 77S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

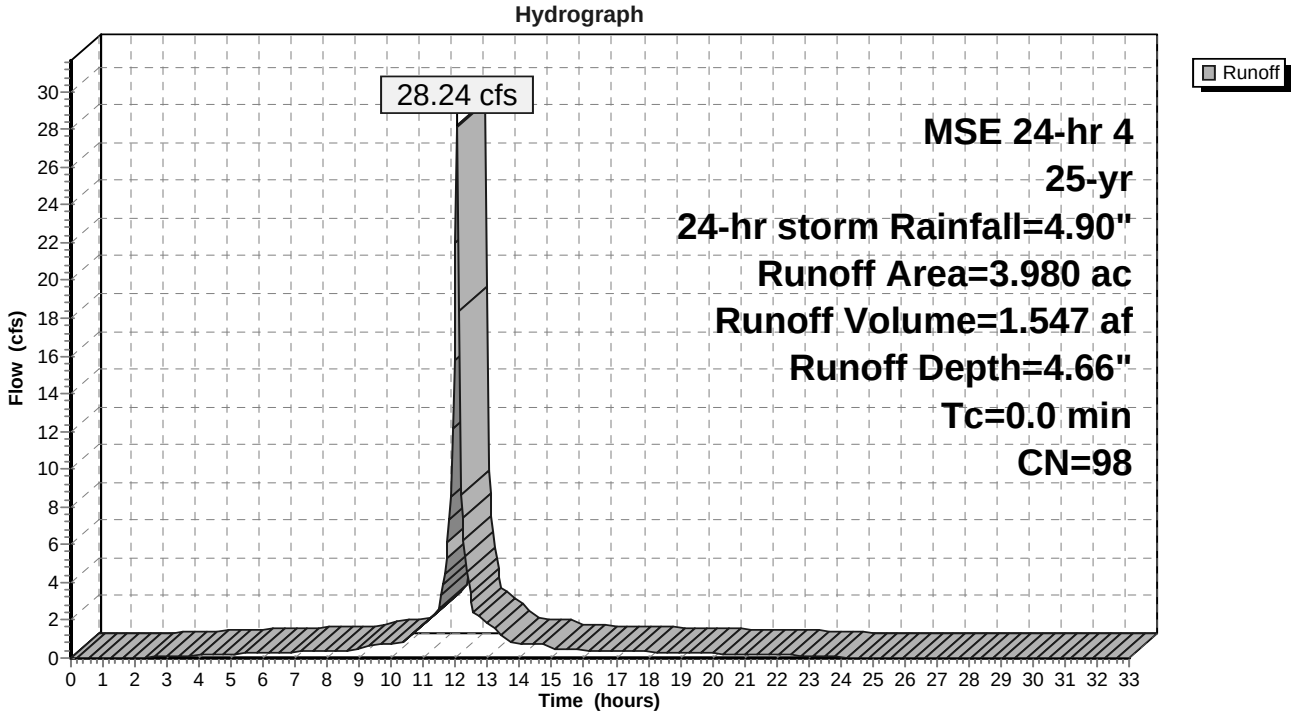
Runoff = 28.24 cfs @ 12.04 hrs, Volume= 1.547 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.90"

	Area (ac)	CN	Description
*	3.980	98	Leachate Surface Water Pond
	3.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 77S: Leachate/Surface Water Pond



Summary for Subcatchment 78S: Mod 4 (50%)

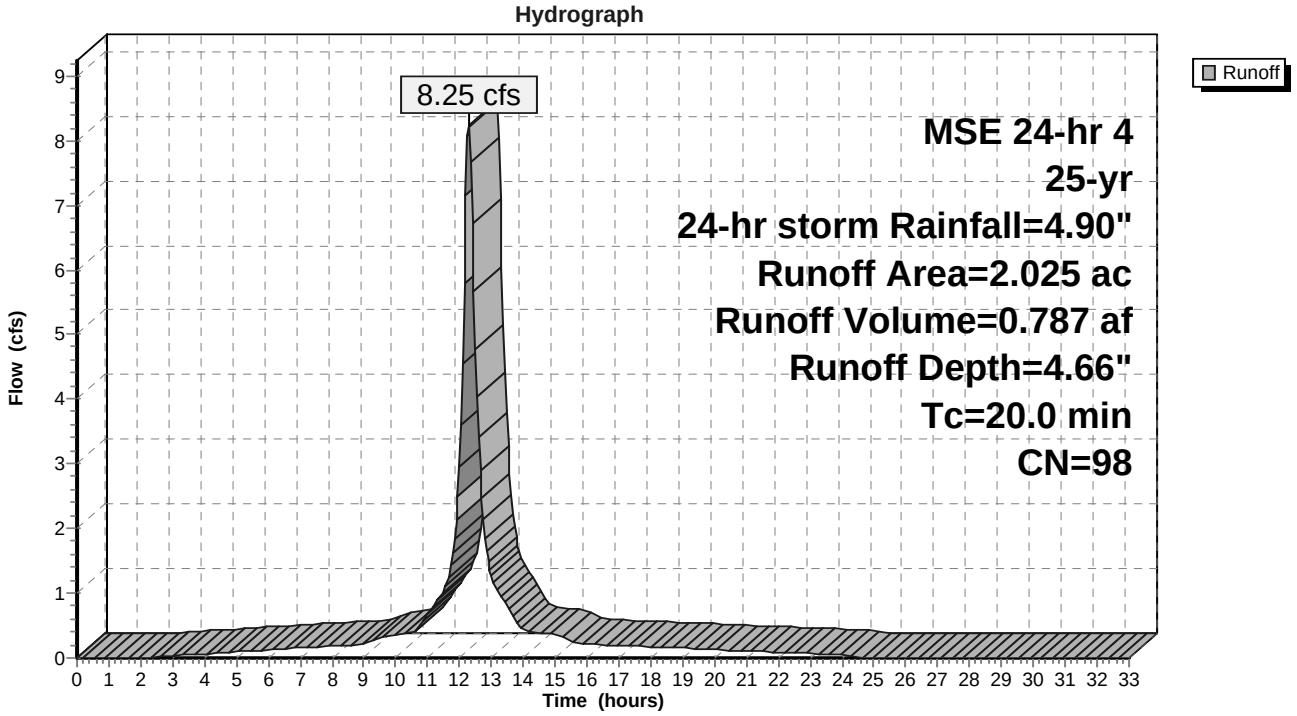
Runoff = 8.25 cfs @ 12.28 hrs, Volume= 0.787 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.90"

	Area (ac)	CN	Description
*	2.025	98	Ash
	2.025		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 78S: Mod 4 (50%)



Summary for Pond 103P: Leachate/Surface Water Pond (25-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr, 24-hr storm event
Inflow = 39.30 cfs @ 12.05 hrs, Volume= 3.979 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

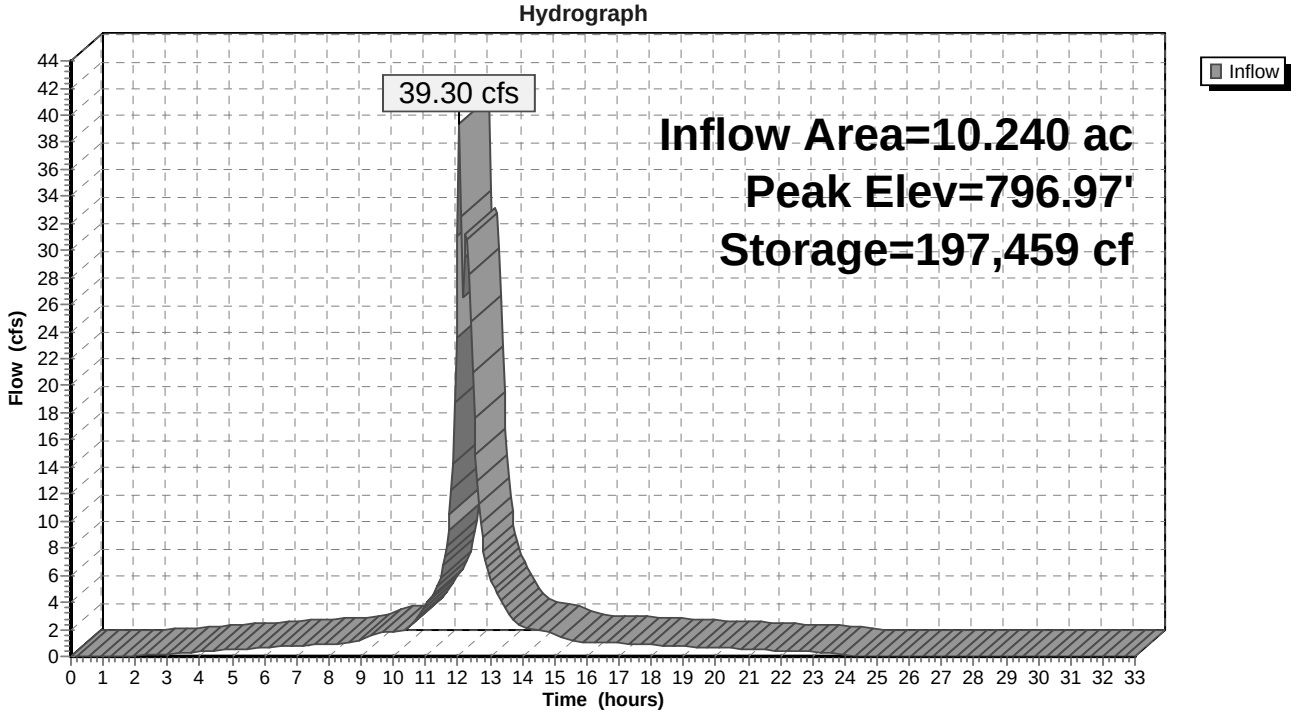
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 793.50' Surf.Area= 31,107 sf Storage= 24,119 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,573 sf Storage= 197,459 cf (173,340 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (173,529 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 103P: Leachate/Surface Water Pond (25-yr Starting Elev.)



Summary for Pond 108P: Leachate/Surface Water Pond (10-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 31.73 cfs @ 12.05 hrs, Volume= 3.187 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

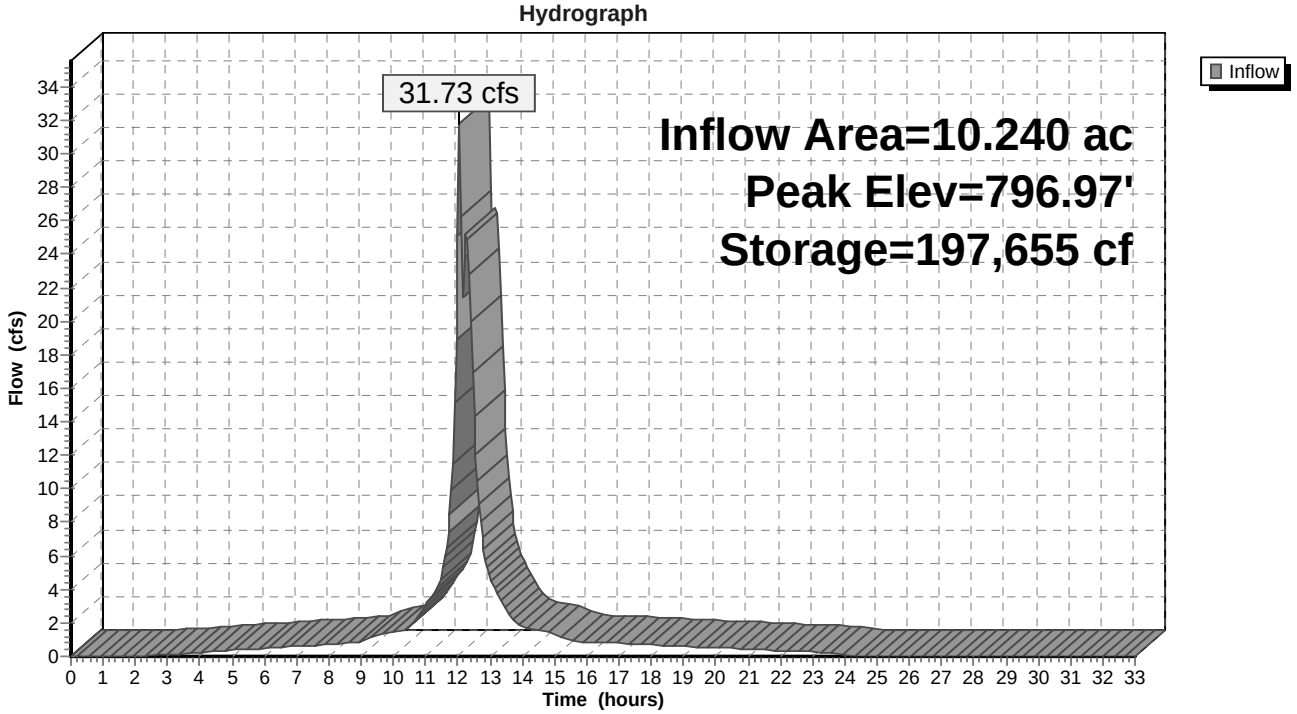
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.39' Surf.Area= 44,199 sf Storage= 58,815 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,588 sf Storage= 197,655 cf (138,840 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (138,832 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 108P: Leachate/Surface Water Pond (10-yr Starting Elev.)



Summary for Pond 113P: Leachate/Surface Water Pond (5-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 26.92 cfs @ 12.05 hrs, Volume= 2.685 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

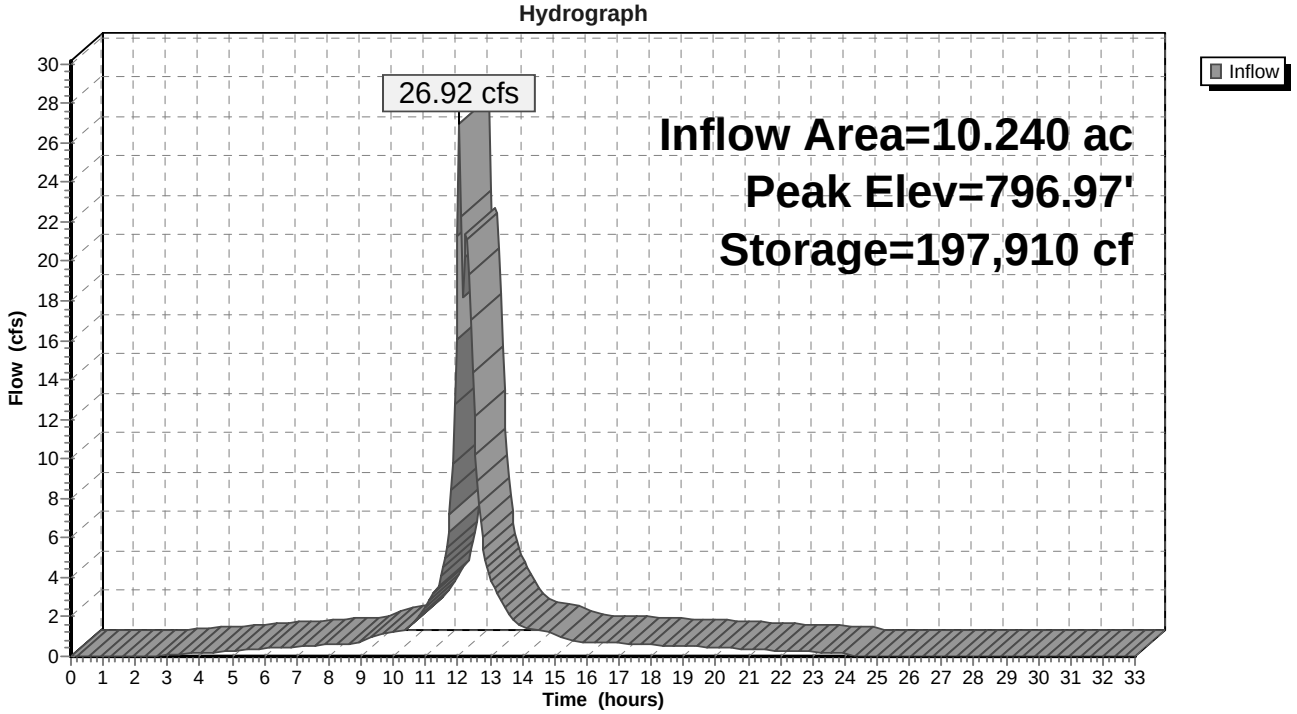
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.87' Surf.Area= 47,981 sf Storage= 80,939 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,608 sf Storage= 197,910 cf (116,972 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (116,709 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 113P: Leachate/Surface Water Pond (5-yr Starting Elev.)



Summary for Pond 118P: Leachate/Surface Water Pond (2-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.93 cfs @ 12.05 hrs, Volume= 2.167 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

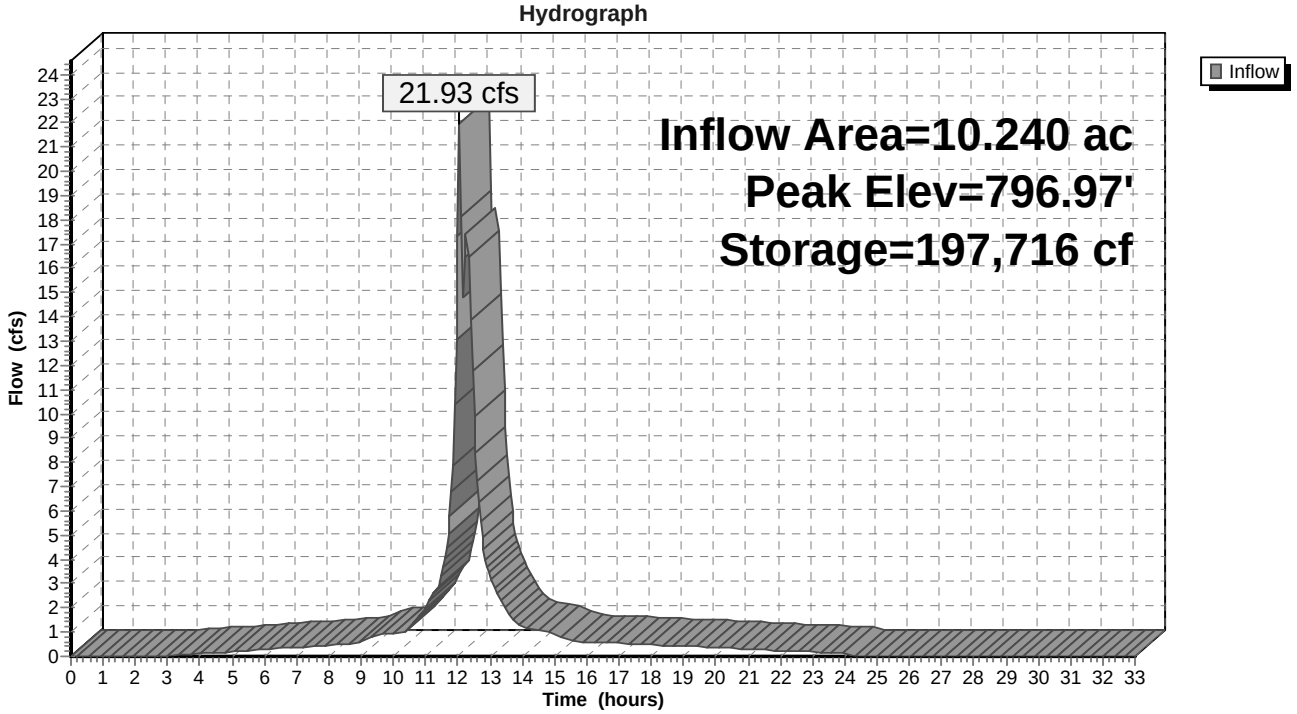
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.32' Surf.Area= 51,527 sf Storage= 103,328 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,593 sf Storage= 197,716 cf (94,388 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (94,319 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 118P: Leachate/Surface Water Pond (2-yr Starting Elev.)



Summary for Pond 123P: Leachate/Surface Water Pond (1-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 19.22 cfs @ 12.05 hrs, Volume= 1.887 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

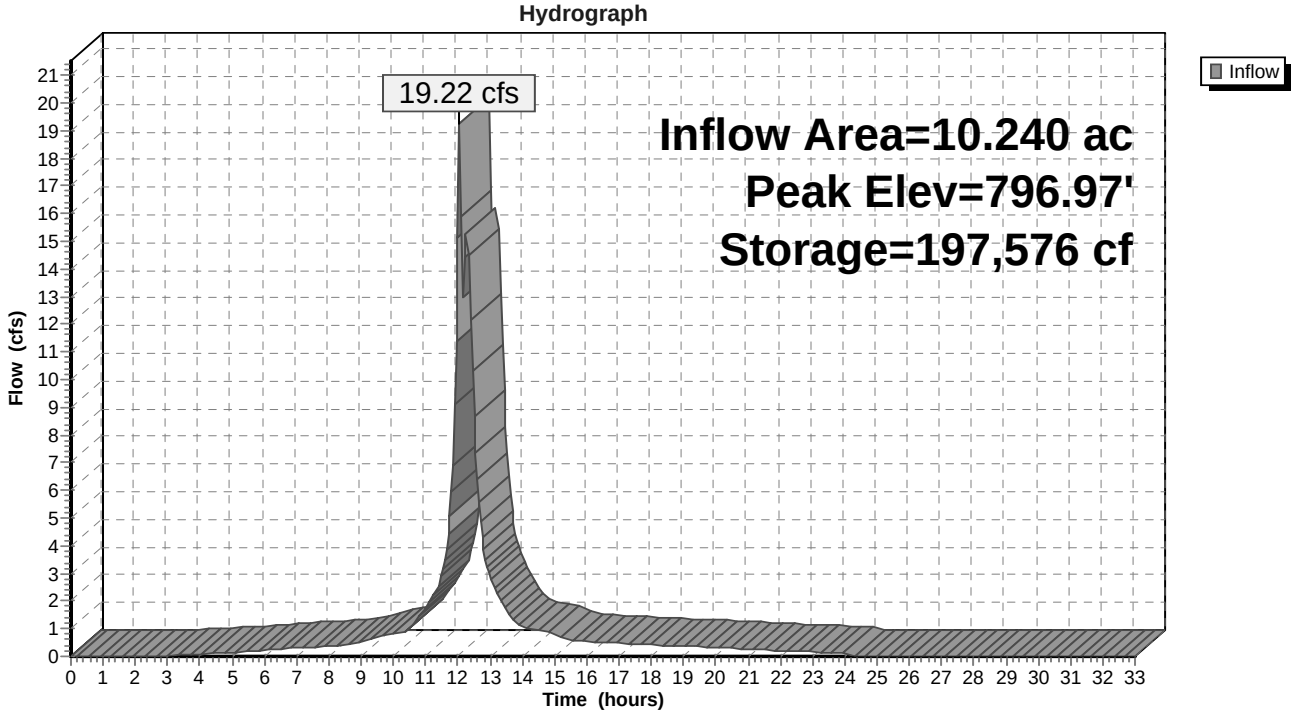
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.55' Surf.Area= 53,339 sf Storage= 115,388 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,582 sf Storage= 197,576 cf (82,188 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (82,260 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

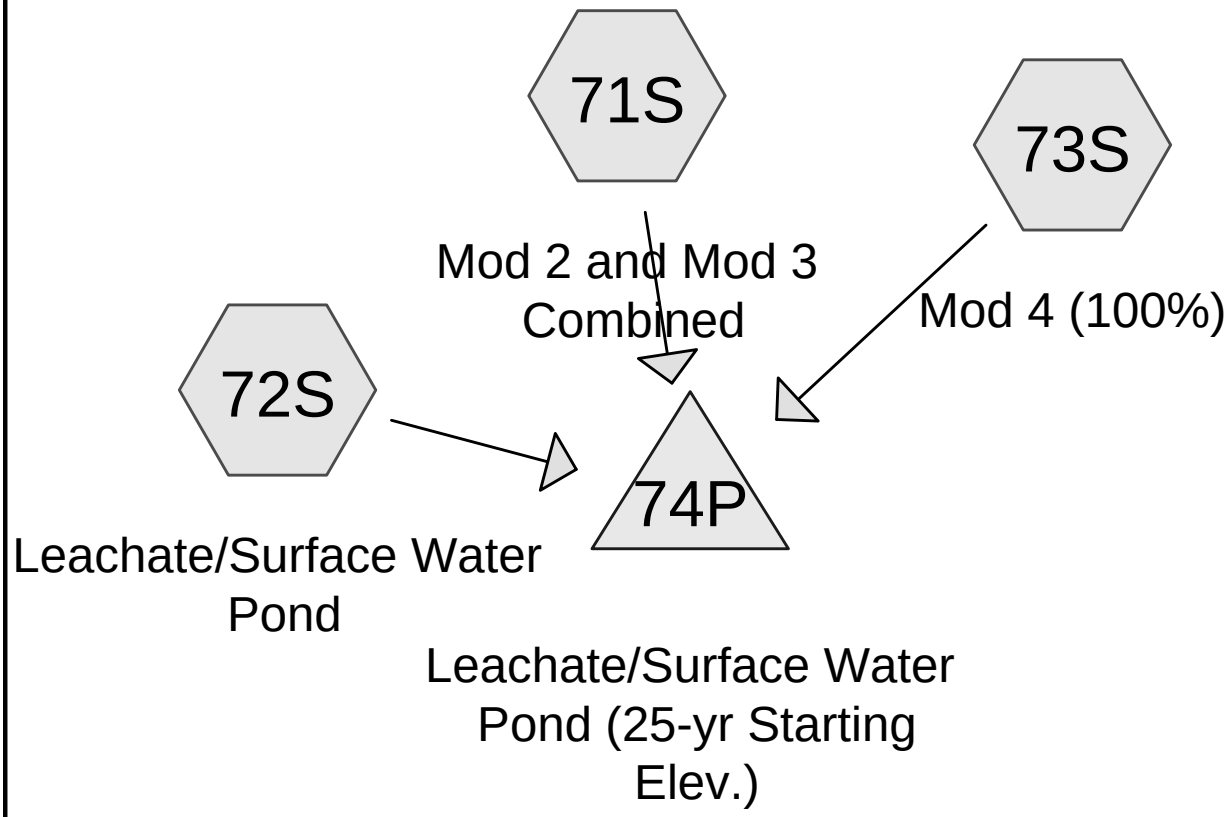
Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 123P: Leachate/Surface Water Pond (1-yr Starting Elev.)



Scenario 2 - Module 4 100% Open



Subcat Reach Pond Link

Routing Diagram for WPL Columbia_Mod 4 Leachate Pond Evaluation

Prepared by {enter your company name here}, Printed 11/28/2017

HydroCAD® 10.00-20 s/n 05804 © 2017 HydroCAD Software Solutions LLC

Time span=0.00-33.00 hrs, dt=0.05 hrs, 661 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 71S: Mod 2 and Mod 3 Runoff Area=2.210 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=9.00 cfs 0.859 af

Subcatchment 72S: Leachate/Surface Runoff Area=3.980 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=28.24 cfs 1.547 af

Subcatchment 73S: Mod 4 (100%) Runoff Area=4.050 ac 100.00% Impervious Runoff Depth=4.66"
Tc=20.0 min CN=98 Runoff=16.50 cfs 1.574 af

Pond 74P: Leachate/Surface Water Pond Peak Elev=796.97' Storage=197,459 cf Inflow=39.30 cfs 3.979 af
Outflow=0.00 cfs 0.000 af

Summary for Subcatchment 71S: Mod 2 and Mod 3 Combined

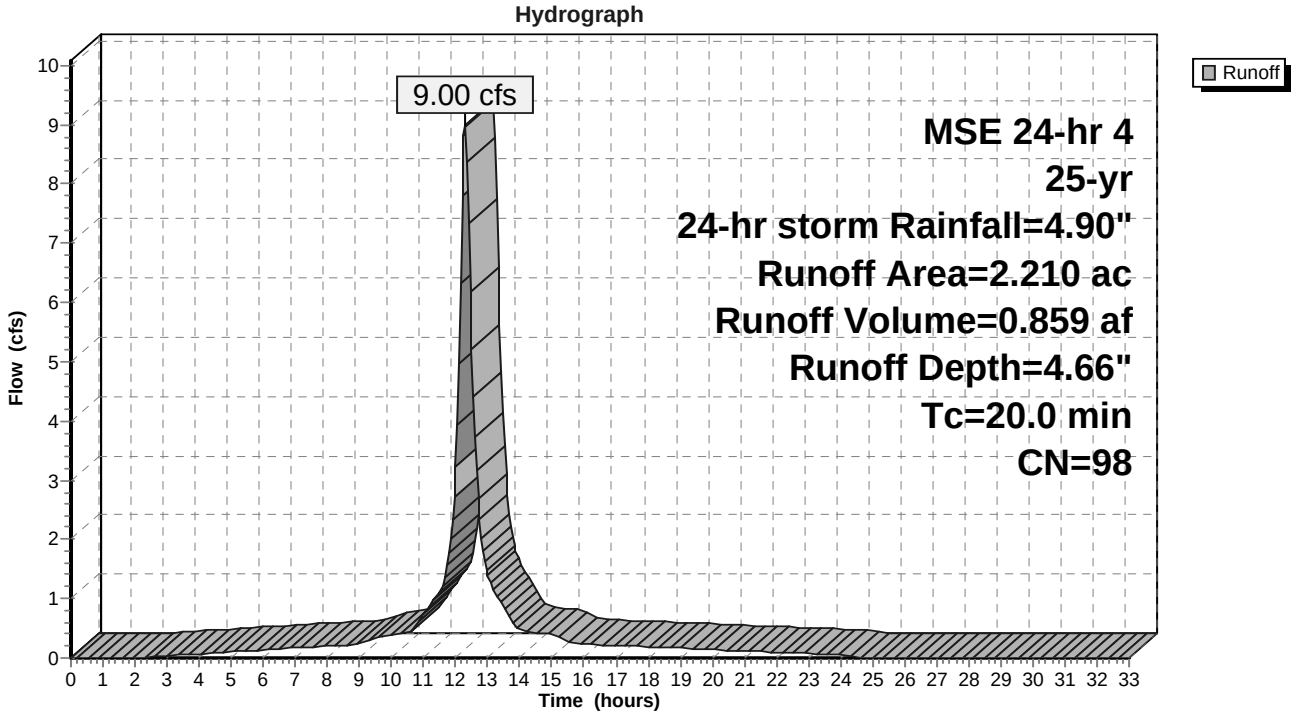
Runoff = 9.00 cfs @ 12.28 hrs, Volume= 0.859 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.90"

	Area (ac)	CN	Description
*	2.210	98	Mod 2 and Mod 3 Allowable Open Area
	2.210		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 71S: Mod 2 and Mod 3 Combined



Summary for Subcatchment 72S: Leachate/Surface Water Pond

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

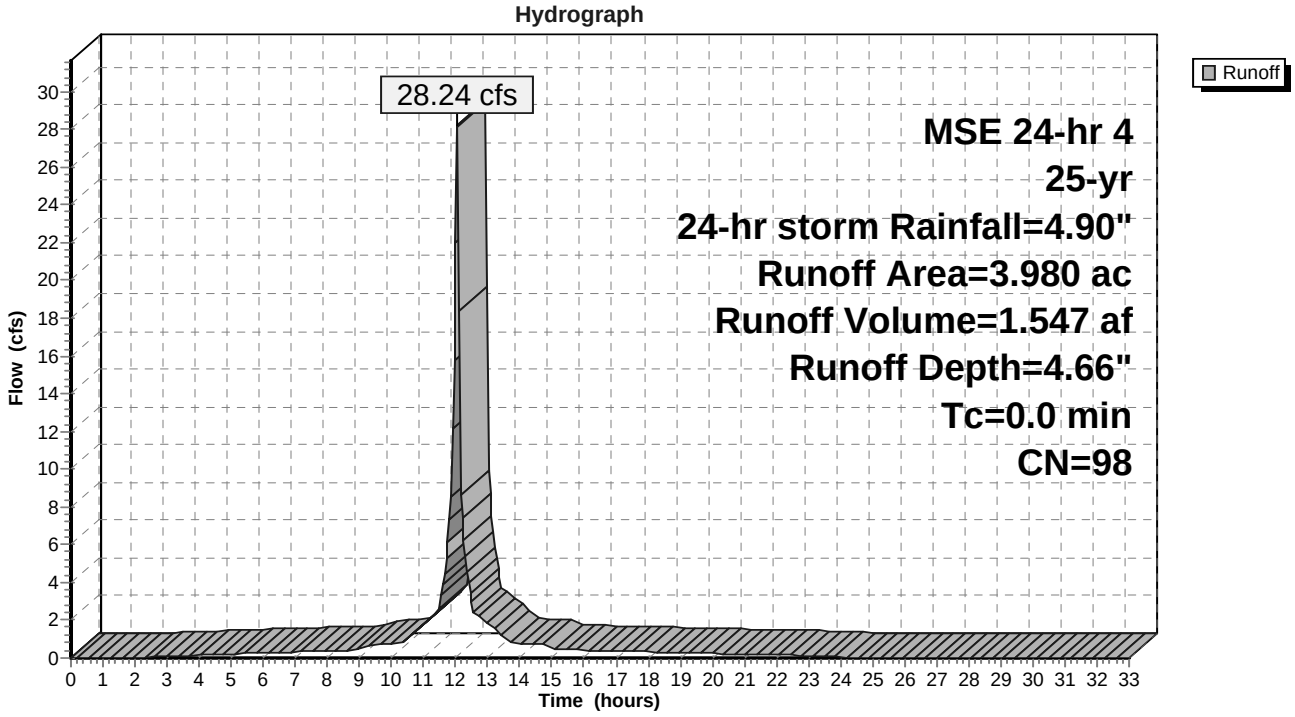
Runoff = 28.24 cfs @ 12.04 hrs, Volume= 1.547 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.90"

	Area (ac)	CN	Description
*	3.980	98	Leachate Surface Water Pond
	3.980		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Subcatchment 72S: Leachate/Surface Water Pond



Summary for Subcatchment 73S: Mod 4 (100%)

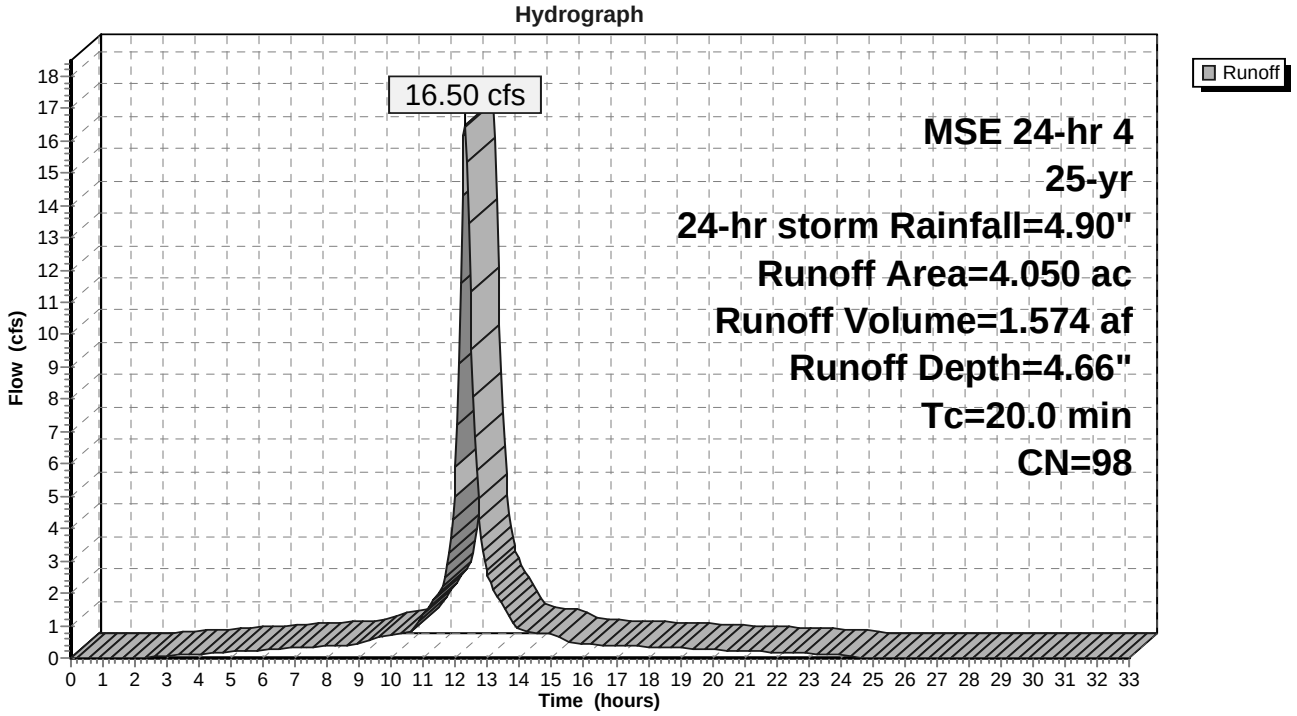
Runoff = 16.50 cfs @ 12.28 hrs, Volume= 1.574 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.90"

	Area (ac)	CN	Description
*	4.050	98	Mod 4 (entire area)
	4.050		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry, Estimated**

Subcatchment 73S: Mod 4 (100%)



Summary for Pond 74P: Leachate/Surface Water Pond (25-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 4.66" for 25-yr, 24-hr storm event
Inflow = 39.30 cfs @ 12.05 hrs, Volume= 3.979 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

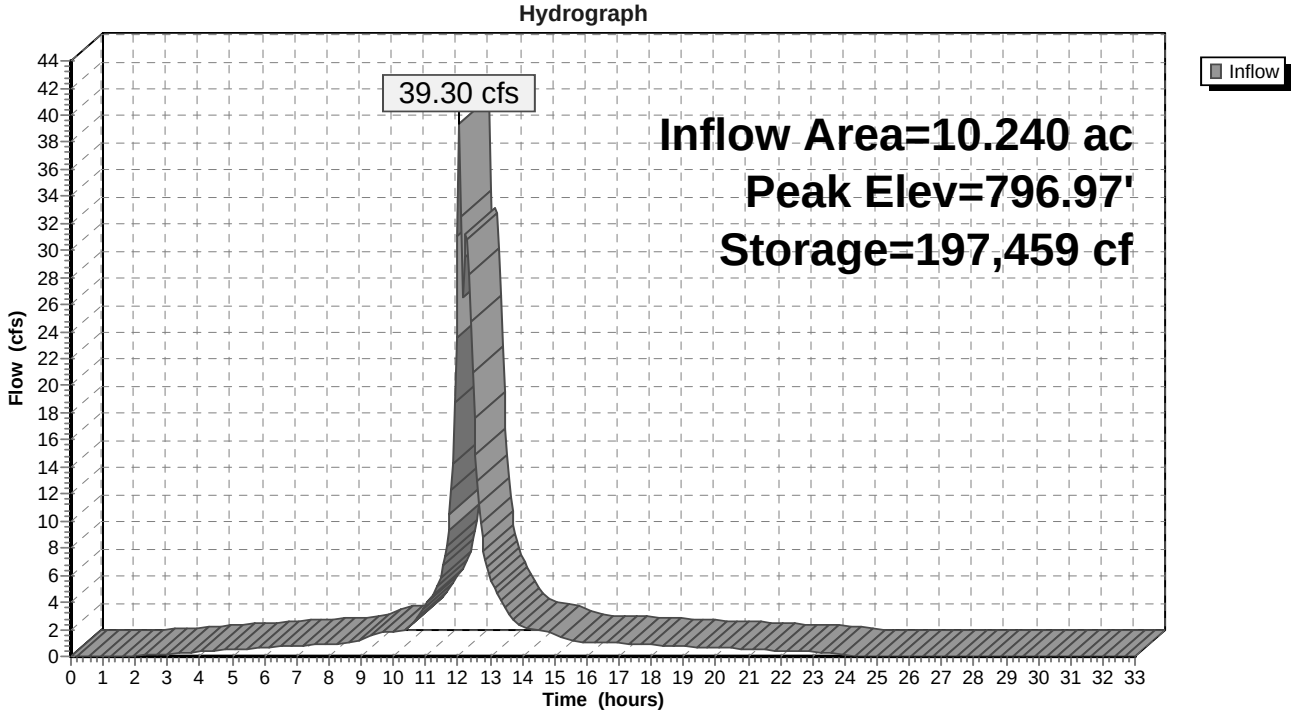
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 793.50' Surf.Area= 31,107 sf Storage= 24,119 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,573 sf Storage= 197,459 cf (173,340 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (173,529 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 74P: Leachate/Surface Water Pond (25-yr Starting Elev.)



Summary for Pond 81P: Leachate/Surface Water Pond (10-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.74" for 10-yr, 24-hr storm event
Inflow = 31.73 cfs @ 12.05 hrs, Volume= 3.187 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

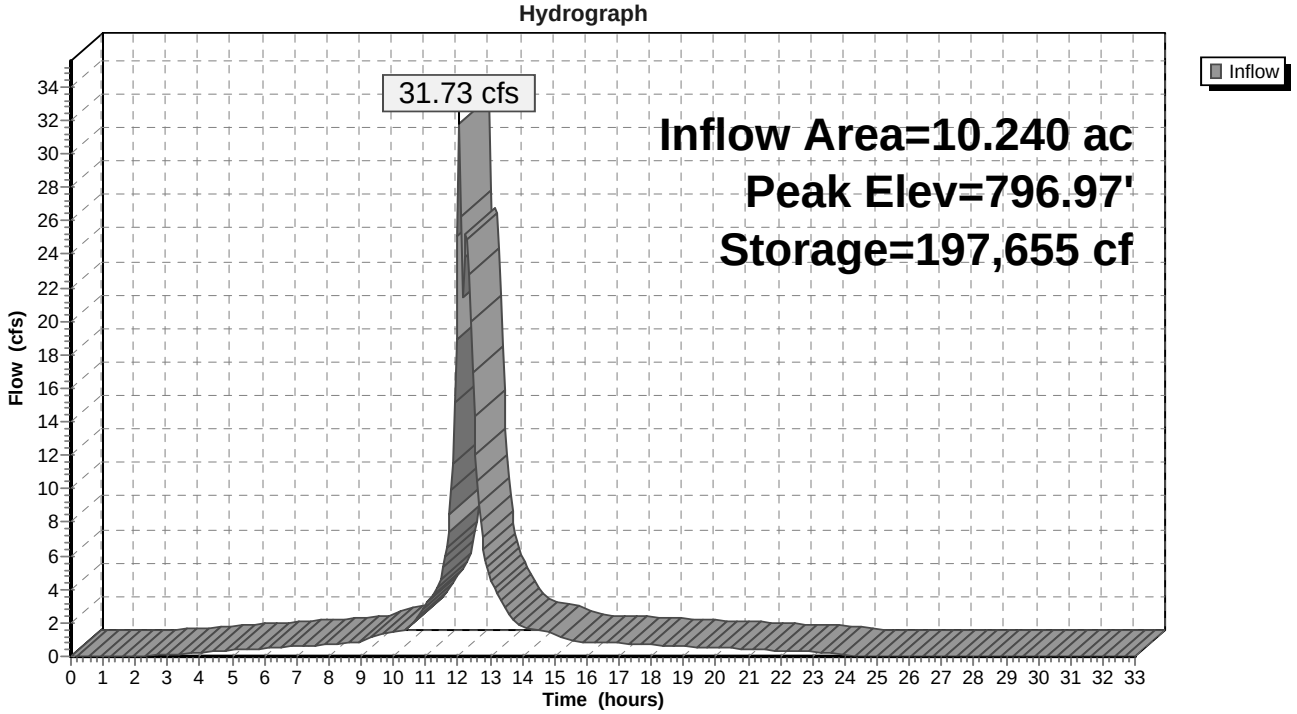
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.39' Surf.Area= 44,199 sf Storage= 58,815 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,588 sf Storage= 197,655 cf (138,840 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (138,832 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 81P: Leachate/Surface Water Pond (10-yr Starting Elev.)



Summary for Pond 94P: Leachate/Surface Water Pond (5-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 3.15" for 5-yr, 24-hr storm event
Inflow = 26.92 cfs @ 12.05 hrs, Volume= 2.685 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

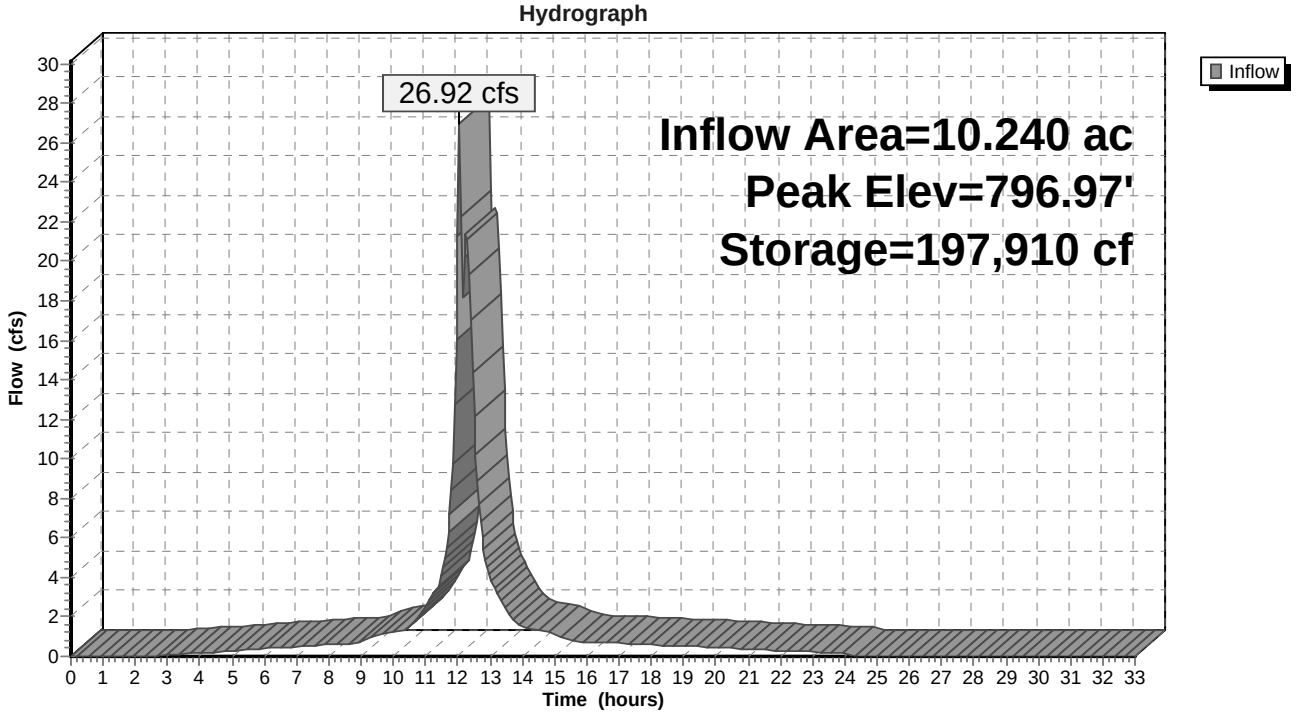
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 794.87' Surf.Area= 47,981 sf Storage= 80,939 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,608 sf Storage= 197,910 cf (116,972 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (116,709 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 94P: Leachate/Surface Water Pond (5-yr Starting Elev.)



Summary for Pond 98P: Leachate/Surface Water Pond (2-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.54" for 2-yr, 24-hr storm event
Inflow = 21.93 cfs @ 12.05 hrs, Volume= 2.167 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

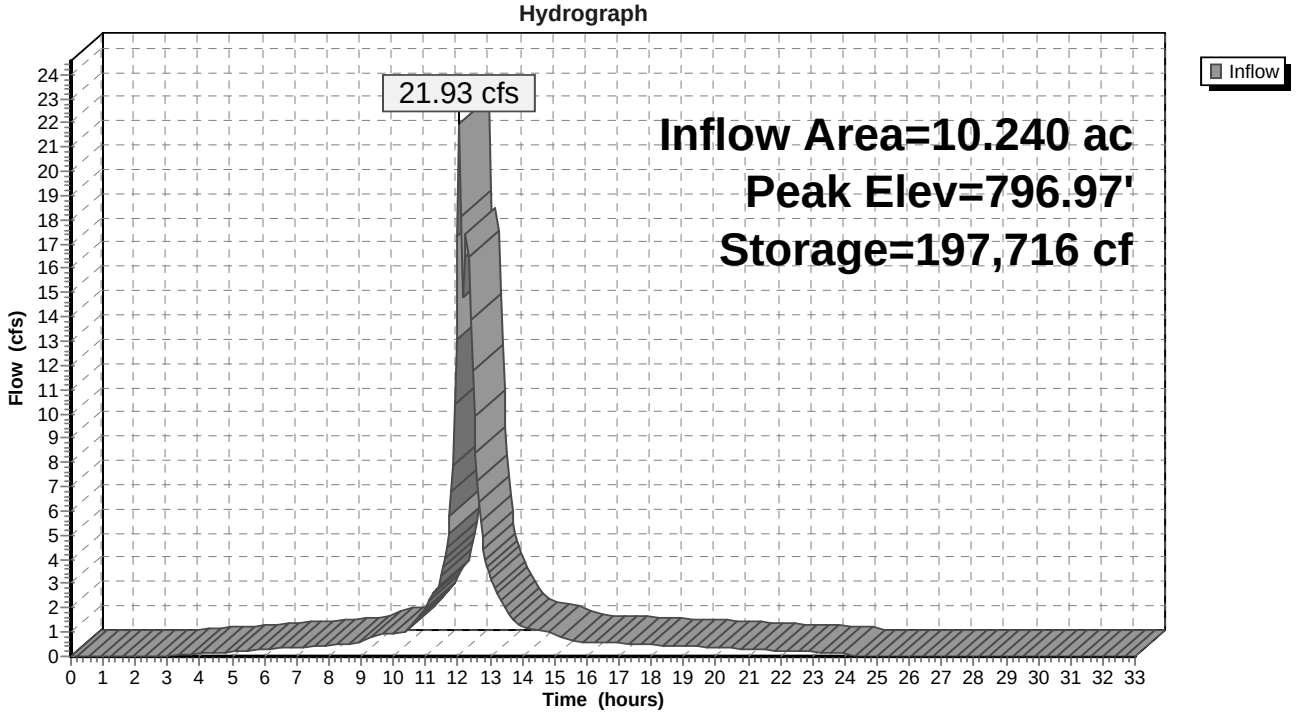
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.32' Surf.Area= 51,527 sf Storage= 103,328 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,593 sf Storage= 197,716 cf (94,388 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (94,319 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 98P: Leachate/Surface Water Pond (2-yr Starting Elev.)



Summary for Pond 102P: Leachate/Surface Water Pond (1-yr Starting Elev.)

Inflow Area = 10.240 ac,100.00% Impervious, Inflow Depth = 2.21" for 1-yr, 24-hr storm event
Inflow = 19.22 cfs @ 12.05 hrs, Volume= 1.887 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

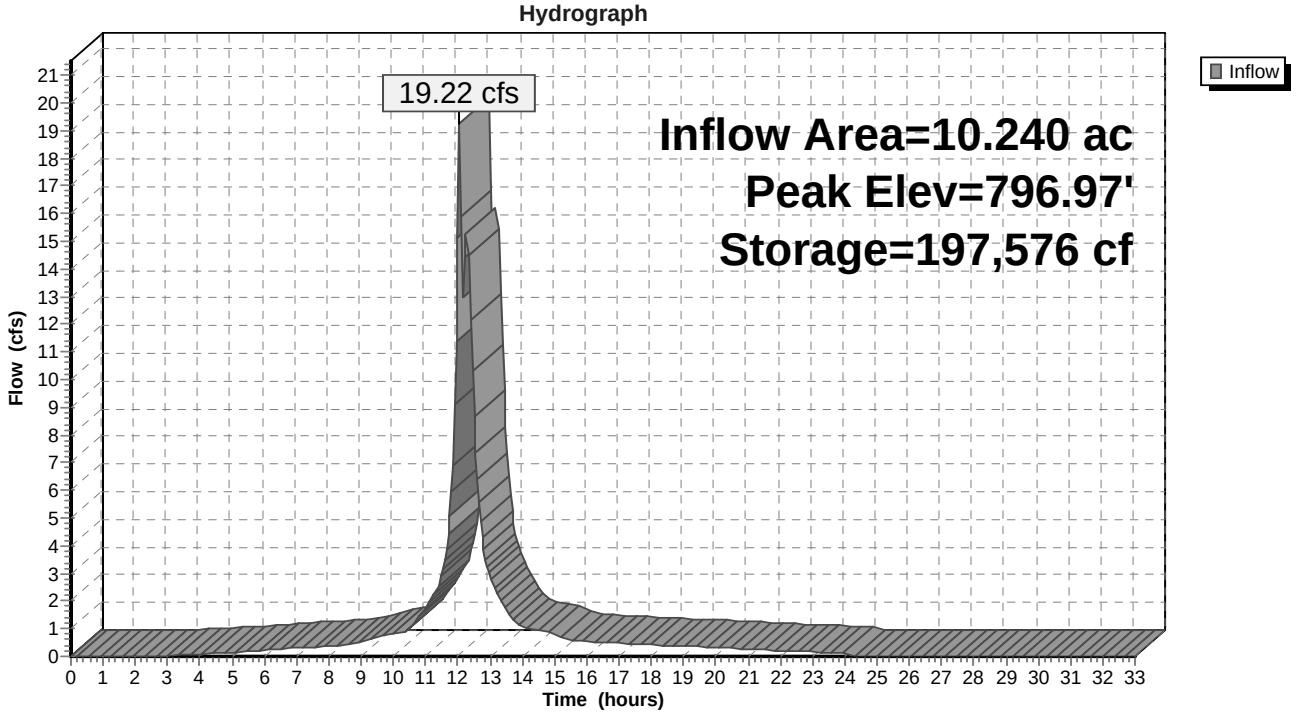
Routing by Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Starting Elev= 795.55' Surf.Area= 53,339 sf Storage= 115,388 cf
Peak Elev= 796.97' @ 25.15 hrs Surf.Area= 61,582 sf Storage= 197,576 cf (82,188 cf above start)
Flood Elev= 796.97' Surf.Area= 61,588 sf Storage= 197,647 cf (82,260 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	792.00'	263,654 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
792.00	1,051	0	0
794.00	41,126	42,177	42,177
796.00	56,885	98,011	140,188
798.00	66,581	123,466	263,654

Pond 102P: Leachate/Surface Water Pond (1-yr Starting Elev.)



SCS ENGINEERS

Sheet No.	1
Calc. No.	1
Rev. No.	0

Job No. 25217156 Job Alliant - Columbia By RJG Date 3/9/18

Client Alliant Subject Module 4 Rain Cover Chk'd BLP Date 3/14/18

Purpose:

Evaluate the required berm height within Module 4 to handle storm events up to 100-yr, 24-hr storm with the rain cover in place over the frost protection layer.

Approach:

Use HydroCAD to model the storm events, based on the following:

* All of Module 4 has rain cover in place above the frost protection layer
* An interior berm will be constructed along the north, east, and south (as needed) edge of Module 4 to provide storage of storm water runoff in the Module for discharge via a culvert to the proposed exterior swale north of the module.
* Model the Module 4 area within the constructed interior berm as a pond with the culvert as the outlet structure. Determine the minimum berm height required based on the peak water elevation in the "pond" resulting during the 100-year storm event.

Assumptions:

* The frost protection layer will be graded to drain to the northeast, providing at least 4 feet of frost protection throughout the module. Figure 1 shows the proposed grading of the frost protection layer.
* Total drainage area = 111,492 sf = 2.56 ac (see attached Figure 1)
* The runoff courve number (CN) for the rain cover = 100
* Runoff from Module 3 will be prevented from entering Module 4 using a berm constructed on the north end of Module 3.
* Use NOAA Atlas 14 precipitation data, with storm distribution MSE 4.
* Model runoff from the 100-year, 24-hour storm event.
* Provide min. 0.5 ft safety factor on berm height.

Calculations:

See the attached HydroCAD model report.

Results:

The bermed area in Module 4 is able to contain the 100-yr storm event without over topping as shown in the table below.

Culvert Size (in.)	Surface Water Peak Elev. (ft)	Berm Height with 0.5 ft freeboard(ft)	Berm Design Height (ft)
12	813.25	813.75	814.0

I:\25217156.00\Data and Calculations\Storm Water\Rain Cover\Berm height\[Rain cover storage_0.5slope.xls]Sheet1

LEGEND

DRAINAGE AREA (114,834 SF)

TIME OF CONCENTRATION FLOW PATH

PROPOSED TEMPORARY INTERIOR BERM (APPROXIMATE)

TIME OF CONCENTRATION FLOW PATH

SHEET FLOW = 100'

SHALLOW CONCENTRATED FLOW = 508'

813

810

808

807

805

811

810

815

814

813

812

MODULE 4

N

60 0 60

SCALE: 1" = 60'

PROJECT NO.	25217156.00	DRAWN BY:	BJM
DRAWN:	02/26/18	CHECKED BY:	RJG
REVISED:	03/14/18	APPROVED BY:	

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W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

SITE

COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

PHASE 1, MODULE 4 RAIN COVER

FIGURE
1

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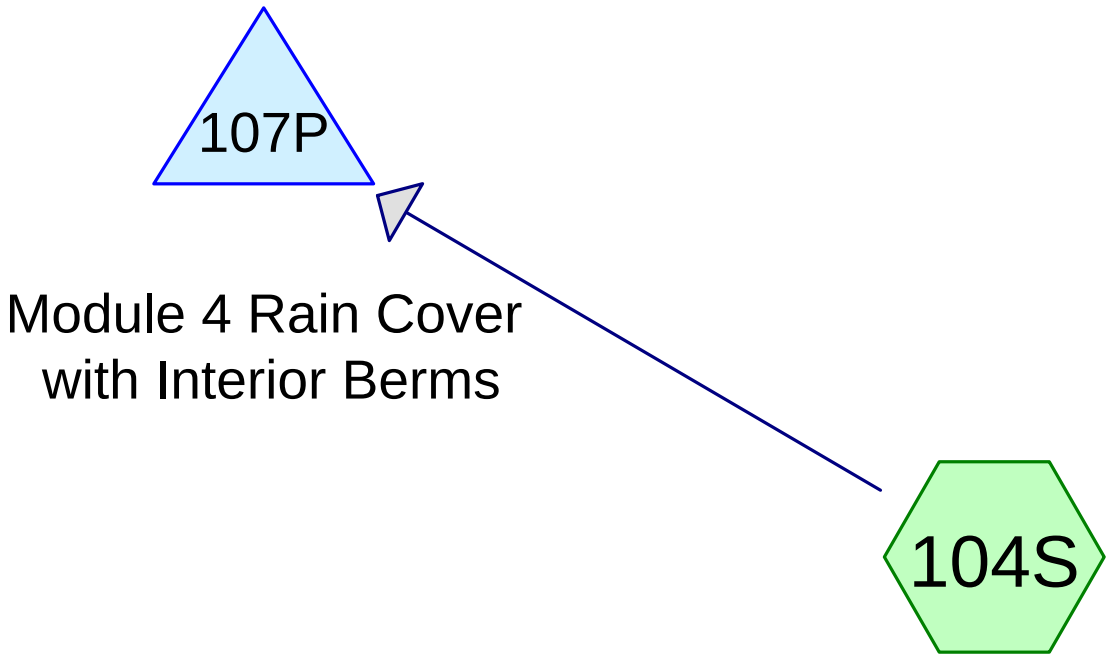


Subcat Reach Pond Link

Routing Diagram for WPL Columbia_Mod 4 Storm Water Model_Rain Cover_180221

Prepared by {enter your company name here}, Printed 3/19/2018

HydroCAD® 10.00-20 s/n 05804 © 2017 HydroCAD Software Solutions LLC

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	107P	811.81	811.31	101.0	0.0050	0.011	12.0	0.0	0.0

Time span=0.00-37.00 hrs, dt=0.02 hrs, 1851 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 104S: Mod 4 Runoff Area=111,492 sf 100.00% Impervious Runoff Depth=6.59"
Flow Length=608' Tc=7.9 min CN=100 Runoff=20.52 cfs 1.406 af

Pond 107P: Module 4 Rain Cover with Peak Elev=813.25' Storage=23,375 cf Inflow=20.52 cfs 1.406 af
12.0" Round Culvert n=0.011 L=101.0' S=0.0050 '/' Outflow=2.90 cfs 1.406 af

Total Runoff Area = 2.560 ac Runoff Volume = 1.406 af Average Runoff Depth = 6.59"
0.00% Pervious = 0.000 ac 100.00% Impervious = 2.560 ac

Summary for Subcatchment 104S: Mod 4

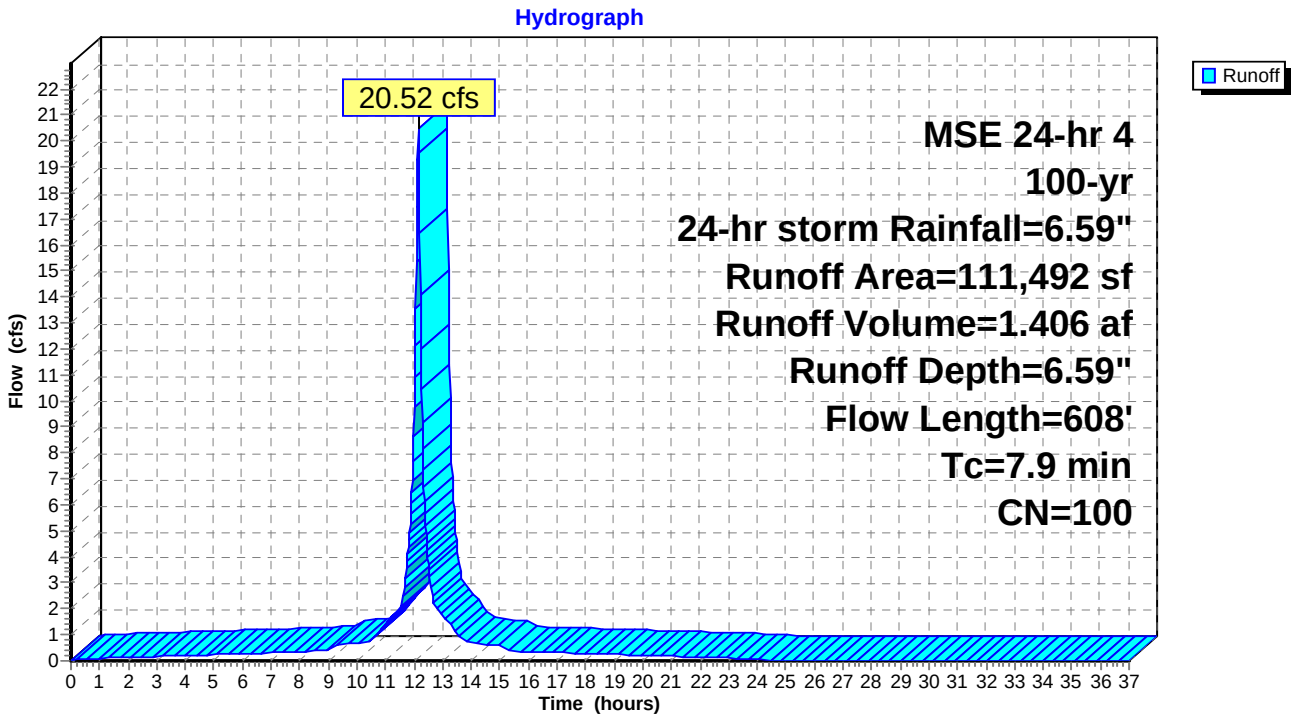
Runoff = 20.52 cfs @ 12.15 hrs, Volume= 1.406 af, Depth= 6.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-37.00 hrs, dt= 0.02 hrs
MSE 24-hr 4 100-yr, 24-hr storm Rainfall=6.59"

	Area (sf)	CN	Description
*	111,492	100	impervious
	111,492		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0070	0.84		**Sheet Flow, sheet** Smooth surfaces n= 0.011 P2= 2.77"
5.9	508	0.0050	1.44		**Shallow Concentrated Flow, flow across cell** Paved Kv= 20.3 fps
7.9	608	Total			

Subcatchment 104S: Mod 4



Summary for Pond 107P: Module 4 Rain Cover with Interior Berms

Inflow Area = 2.560 ac,100.00% Impervious, Inflow Depth = 6.59" for 100-yr, 24-hr storm event
Inflow = 20.52 cfs @ 12.15 hrs, Volume= 1.406 af
Outflow = 2.90 cfs @ 12.58 hrs, Volume= 1.406 af, Atten= 86%, Lag= 26.1 min
Primary = 2.90 cfs @ 12.58 hrs, Volume= 1.406 af

Routing by Stor-Ind method, Time Span= 0.00-37.00 hrs, dt= 0.02 hrs
Peak Elev= 813.25' @ 12.58 hrs Surf.Area= 39,856 sf Storage= 23,375 cf

Plug-Flow detention time= 71.3 min calculated for 1.406 af (100% of inflow)
Center-of-Mass det. time= 71.3 min (798.8 - 727.5)

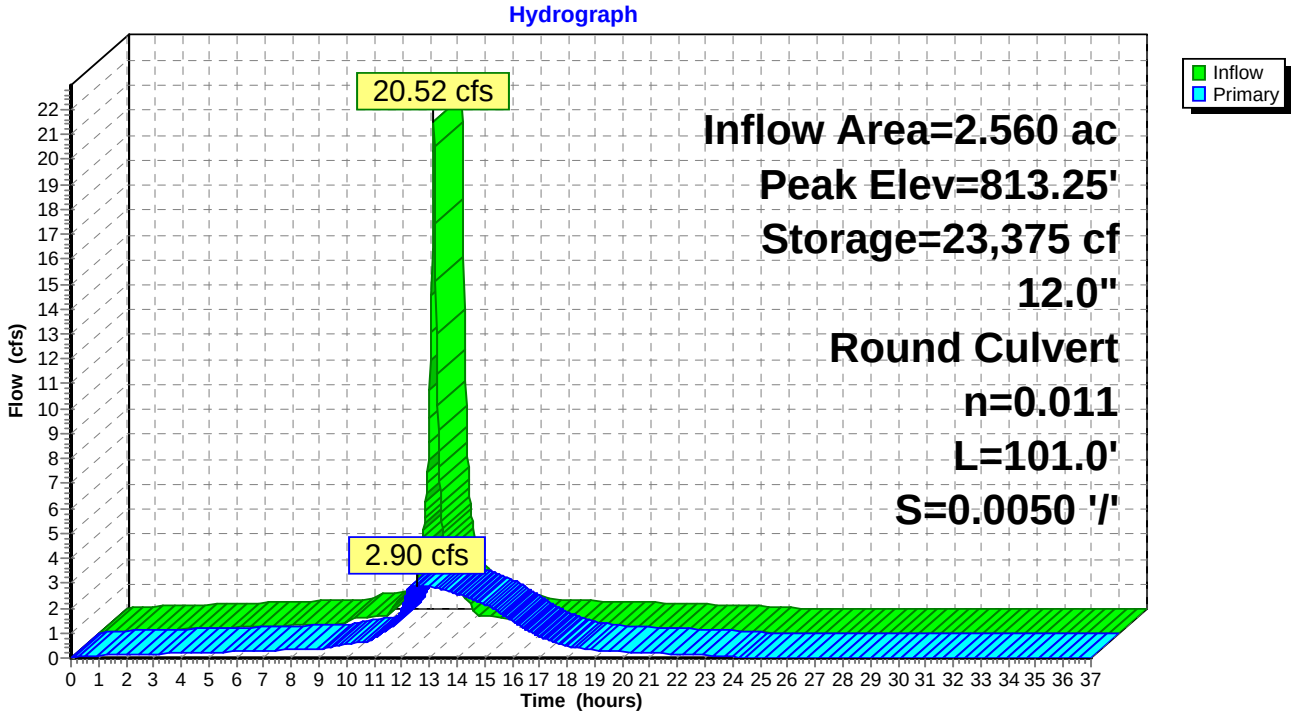
Volume	Invert	Avail.Storage	Storage Description
#1	812.00'	196,195 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
812.00	747	0	0
813.00	28,571	14,659	14,659
814.00	72,868	50,720	65,379
815.00	105,146	89,007	154,386
815.39	109,260	41,809	196,195

Device	Routing	Invert	Outlet Devices
#1	Primary	811.81'	**12.0" Round Culvert** L= 101.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 811.81' / 811.31' S= 0.0050 '/' Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.90 cfs @ 12.58 hrs HW=813.25' (Free Discharge)
1=Culvert (Inlet Controls 2.90 cfs @ 3.69 fps)

Pond 107P: Module 4 Rain Cover with Interior Berms



Storm Water Management Calculations – Module 4 Construction

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the proposed swales and culverts north and east of Module 4 are adequately sized to divert run-on from the 25-year, 24-hour storm event around Module 4.

Approach:
Hydrograph Generation
To properly size the swales and culverts, a runoff hydrograph for the 25-year, 24-hour storm event was developed. HydroCAD was used to generate the hydrograph using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm event, contributing drainage areas, runoff curve numbers, and time of concentration. The contributing watersheds are shown on **Figure 1** and **Figure 2**.

Swale Sizing
The two proposed swales of Module 4, North Swale and East Swale, were sized for the 25-year, 24-hour storm event using Manning's equation to determine the depth of flow and stability in the swale based on the swale geometry and peak flow in the swale (as determined by the Hydrograph Generation calculation). The Wisconsin Department of Transportation (WisDOT) Grass Lined Swale spreadsheet (from WisDOT Facilities Development Manual Chapter 13, Section 30-15 – Grass Lined Channels) was used to evaluate the swale capacity and swale stability. The size and stability of the existing swale east of Modules 1-3 was also checked.

Culvert Sizing
The proposed culverts were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration. The existing culvert at a road crossing east of Modules 1-3 was also checked for proper sizing with the construction of Module 4. Culvert locations are shown on **Figure 1** and **Figure 2**. The culvert connecting the Module 4 rain cover to the North Swale was sized in HydroCAD as part of the Module 4 storage area (node 110P).

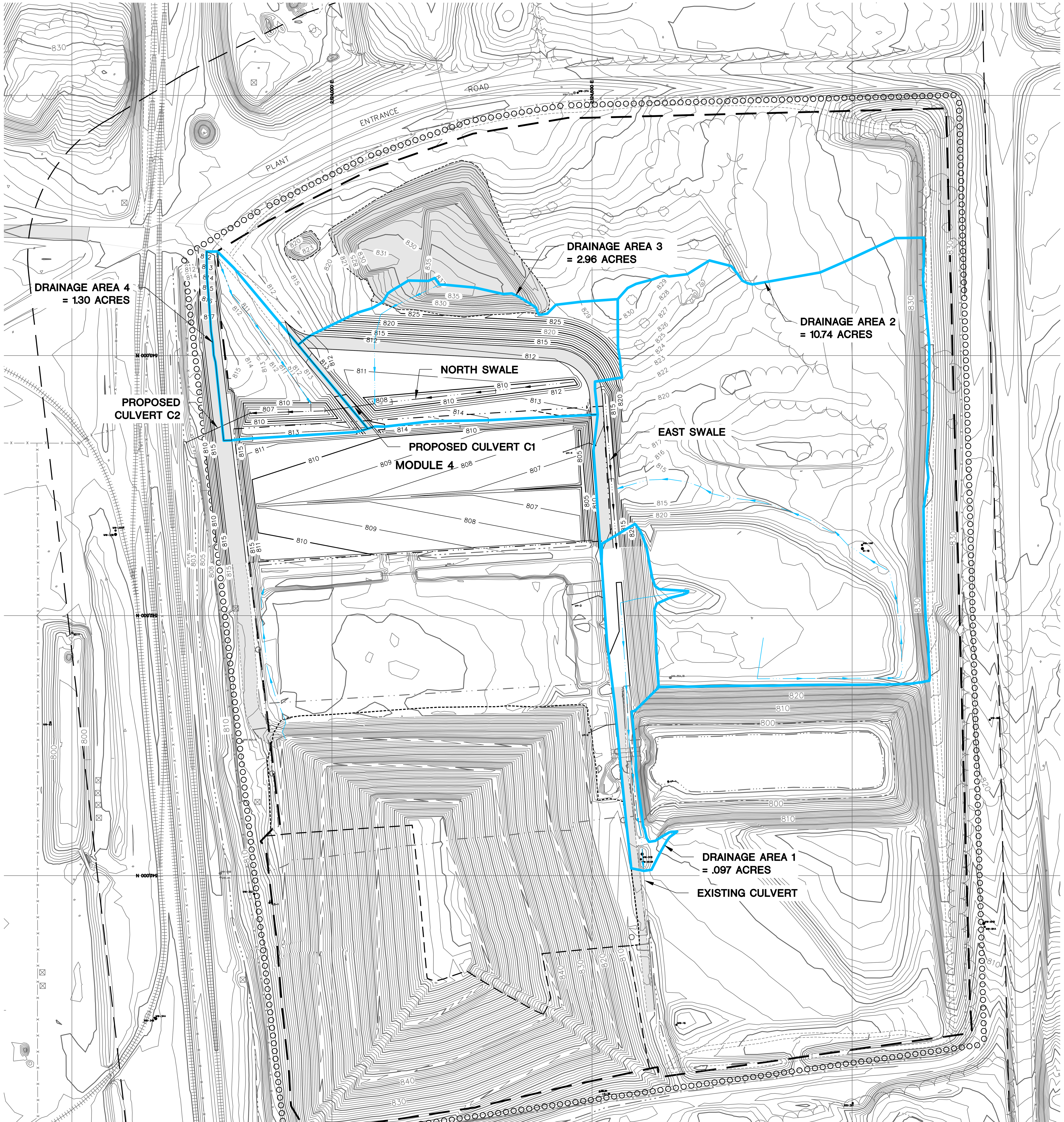
Key Assumptions:
- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows

Cover Type	CN
Grass areas	49 – Grass cover in fair condition, hydrologic soil group A
Woods/grass combination	43 – Woods/grass combination in fair condition, hydrologic soil group B
Gravel access road	96 – Compacted gravel surface
Rain Cover with Frost Protection Layer	98 – Impervious

- The NOAA Atlas 14 precipitation depth of 4.91 inches and storm distribution MSE4 was used.
- Other assumptions are included with the attached calculations.

Results:
The proposed and existing swales and culverts north and east of Module 4 will accommodate runoff from the 25-year, 24-hour storm event without overtopping.

Figure 1



LEGEND

Symbol	Description
·○○○○○○○○○·	DRY ASH DISPOSAL FACILITY LIMITS
▬ ▬ ▬	APPROVED LIMITS OF ASH FILL
▪-▪-▪-▪	PHASE/MODULE LIMIT
— · · — · · —	EXISTING 2' THICK CLAY LINER LIMITS
× 824.6	EXISTING SPOT ELEVATION
—825—	EXISTING GRADES (5' INTERVAL)
—821—	EXISTING GRADES (1' INTERVAL)
(blue line)	DRAINAGE DIVIDE
(blue arrow line)	TIME OF CONCENTRATION FLOW PATH
—806—	PROPOSED MODULE 4 LEACHATE/ PERIMETER GRADE (1' CONTOUR)
—805—	PROPOSED MODULE 4 LEACHATE/ PERIMETER GRADE (5' CONTOUR)
— · · — · · —	PROPOSED 2' THICK CLAY LINER LIMITS

100 0 100

SCALE: 1" = 100'

N

PROJECT NO. 25217156.00	DRAWN BY: KP		
DRAWN: 09/18/17	CHECKED BY: JO		
REVISED: 01/08/2018	APPROVED BY:		

CLIENT: Wisconsin Power and Light Company
WISCONSIN POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

ENGINEER: SCS ENGINEERS
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PHONE: (608) 224-2830

SITE: 2018 MODULE 4 LINER CONSTRUCTION
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

STORM WATER DRAINAGE AREAS

FIGURE 1

Figure 2

FUTURE MODULE

EXISTING MODULE

LIMITS OF RAIN COVER

FLOW PATH

CLEAN STORM WATER COLLECTION/PUMPING LOCATIONS

2.0%

0.5%

0.5%

N

60 0 60

SCALE: 1" = 60'

LEGEND

- DRY ASH DISPOSAL FACILITY LIMITS
- APPROVED LIMITS OF ASH FILL
- PHASE/MODULE LIMIT
- EXISTING 2' THICK CLAY LINER LIMITS
- × 824.6 EXISTING SPOT ELEVATION
- 825 EXISTING GRADES (5' INTERVAL)
- 821 EXISTING GRADES (1' INTERVAL)
- 806 PROPOSED DRAINAGE LAYER GRADE (1' CONTOUR)
- 805 PROPOSED DRAINAGE LAYER GRADE (5' CONTOUR)
- PROPOSED 2' THICK CLAY LINER LIMITS
- PROPOSED CULVERT
- PROPOSED SWALE/PERIMETER DITCH
- PROPOSED RAIN COVER LIMITS

NOTES

1. PROPOSED CONTINUOUS CONTOURS WITHIN MODULE LIMITS REPRESENT TOP OF DRAINAGE LAYER.

MODULE 4 RAIN COVER LIMITS

RAIN COVER PLAN MOD
COLUMBIA DRY ASH DISPOSAL FACILITY
TOWN OF PACIFIC, WISCONSIN

SITE

WISCONSON POWER AND LIGHT
COLUMBIA ENERGY CENTER
W8375 MURRAY ROAD
PARDEEVILLE, WISCONSIN 53954

Wisconsin Power and Light Company

CLIENT

FIGURE 1

SCS ENGINEERS
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ENGINEER

PROJECT NO.	25217156.00
DRAWN:	01/05/18
REVISED:	01/05/18
DRAWN BY:	RG/KP
CHECKED BY:	BP
APPROVED BY:	

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Hydrograph Generation

- North Swale (25-year, 24-hour Storm Event)
- East Swale (25-year, 24-hour Storm Event)

North Swale (25-year, 24-hour Storm Event)

WPL Columbia_Mod 4 Storm Water Model_180329

Pipe Listing (selected 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	107P	811.81	811.31	101.0	0.0050	0.011	12.0	0.0	0.0

Summary for Subcatchment 3: Drainage Area 3 (to North Swale Culvert C1)

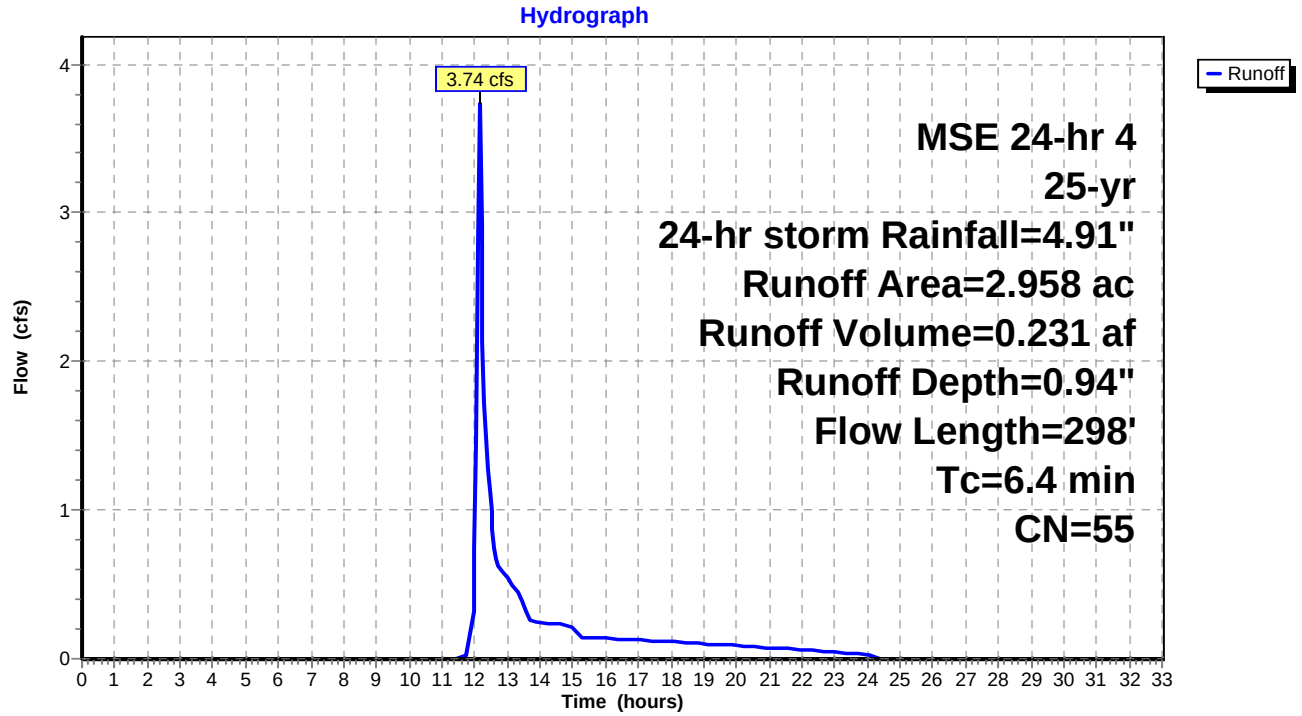
Runoff = 3.74 cfs @ 12.15 hrs, Volume= 0.231 af, Depth= 0.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (ac)	CN	Description
2.572	49	Pasture/grassland/range, Fair, HSG A
0.386	96	Gravel surface, HSG A
2.958	55	Weighted Average
2.958		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	100	0.1050	0.31		**Sheet Flow, sheet flow** Grass: Short n= 0.150 P2= 2.78"
0.1	27	0.0700	4.26		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	50	0.2500	8.05		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	121	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.4	298	Total			

Subcatchment 3: Drainage Area 3 (to North Swale Culvert C1)



Summary for Subcatchment 4: Drainage Area 4 (to North Swale Culvert C2)

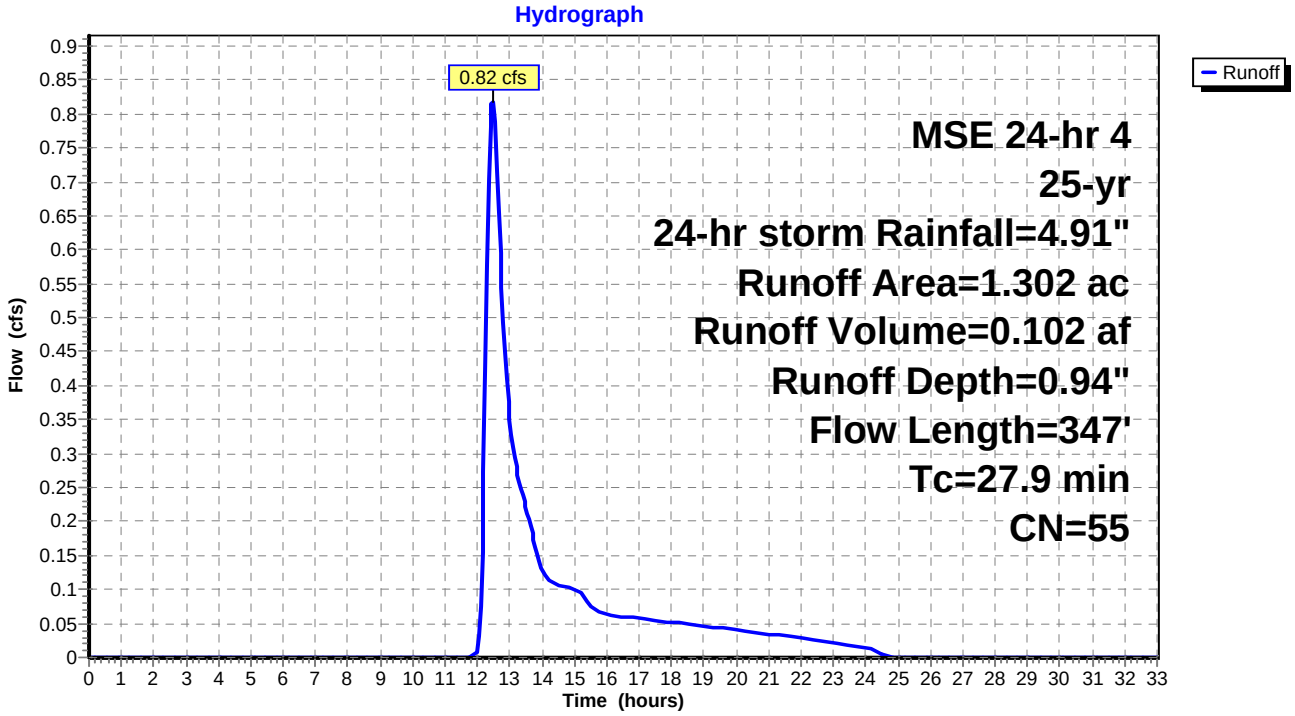
Runoff = 0.82 cfs @ 12.47 hrs, Volume= 0.102 af, Depth= 0.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (ac)	CN	Description
1.126	49	Pasture/grassland/range, Fair, HSG A
0.176	96	Gravel surface, HSG A
1.302	55	Weighted Average
1.302		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.0	88	0.0114	0.06		**Sheet Flow, sheet flow** Woods: Light underbrush n= 0.400 P2= 2.78"
1.9	259	0.0040	2.33	41.90	**Channel Flow, swale** Area= 18.0 sf Perim= 28.1' r= 0.64' n= 0.030 Earth, grassed & winding
27.9	347	Total			

Subcatchment 4: Drainage Area 4 (to North Swale Culvert C2)



Summary for Subcatchment 105S: Mod 4

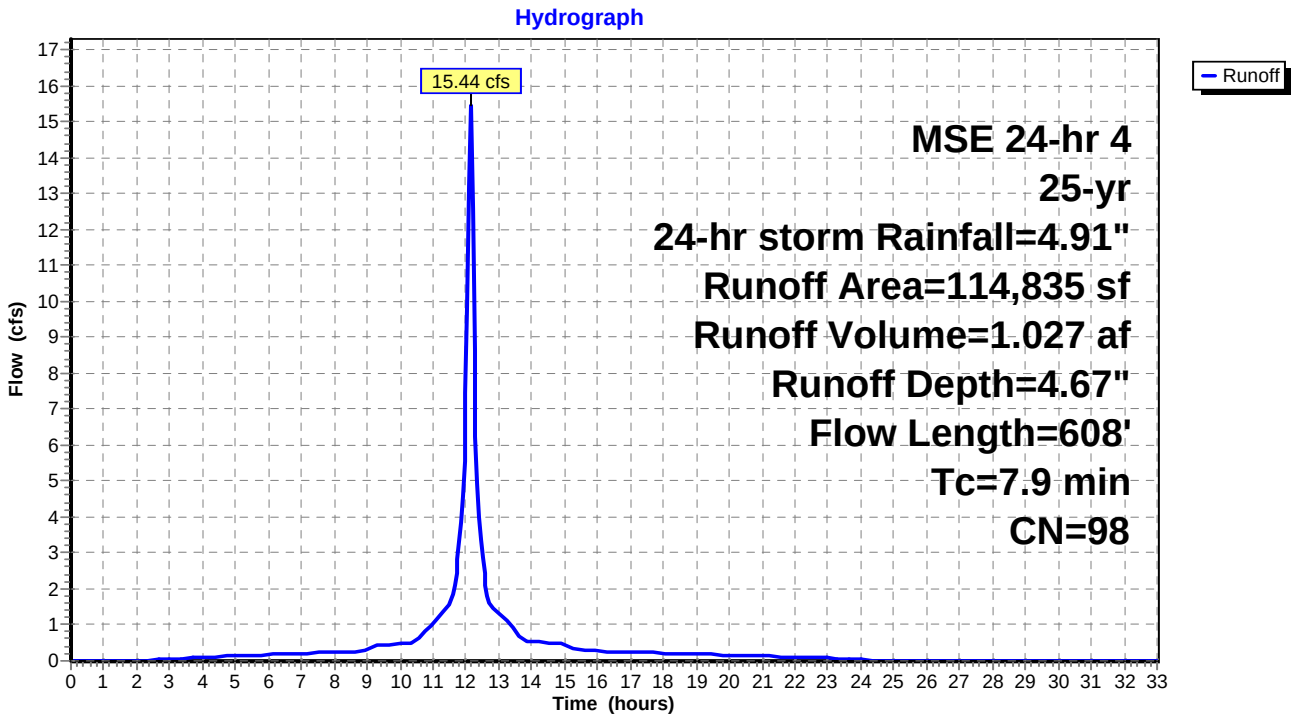
Runoff = 15.44 cfs @ 12.15 hrs, Volume= 1.027 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

	Area (sf)	CN	Description
*	114,835	98	impervious
	114,835		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0070	0.84		**Sheet Flow, sheet** Smooth surfaces n= 0.011 P2= 2.78"
5.9	508	0.0050	1.44		**Shallow Concentrated Flow, flow across cell** Paved Kv= 20.3 fps
7.9	608	Total			

Subcatchment 105S: Mod 4



Summary for Pond 107P: Module 4 Rain Cover with Interior Berms

Inflow Area = 2.636 ac,100.00% Impervious, Inflow Depth = 4.67" for 25-yr, 24-hr storm event
Inflow = 15.44 cfs @ 12.15 hrs, Volume= 1.027 af
Outflow = 2.59 cfs @ 12.53 hrs, Volume= 1.027 af, Atten= 83%, Lag= 23.2 min
Primary = 2.59 cfs @ 12.53 hrs, Volume= 1.027 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
Peak Elev= 813.07' @ 12.53 hrs Surf.Area= 31,636 sf Storage= 16,722 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 58.6 min (807.1 - 748.5)

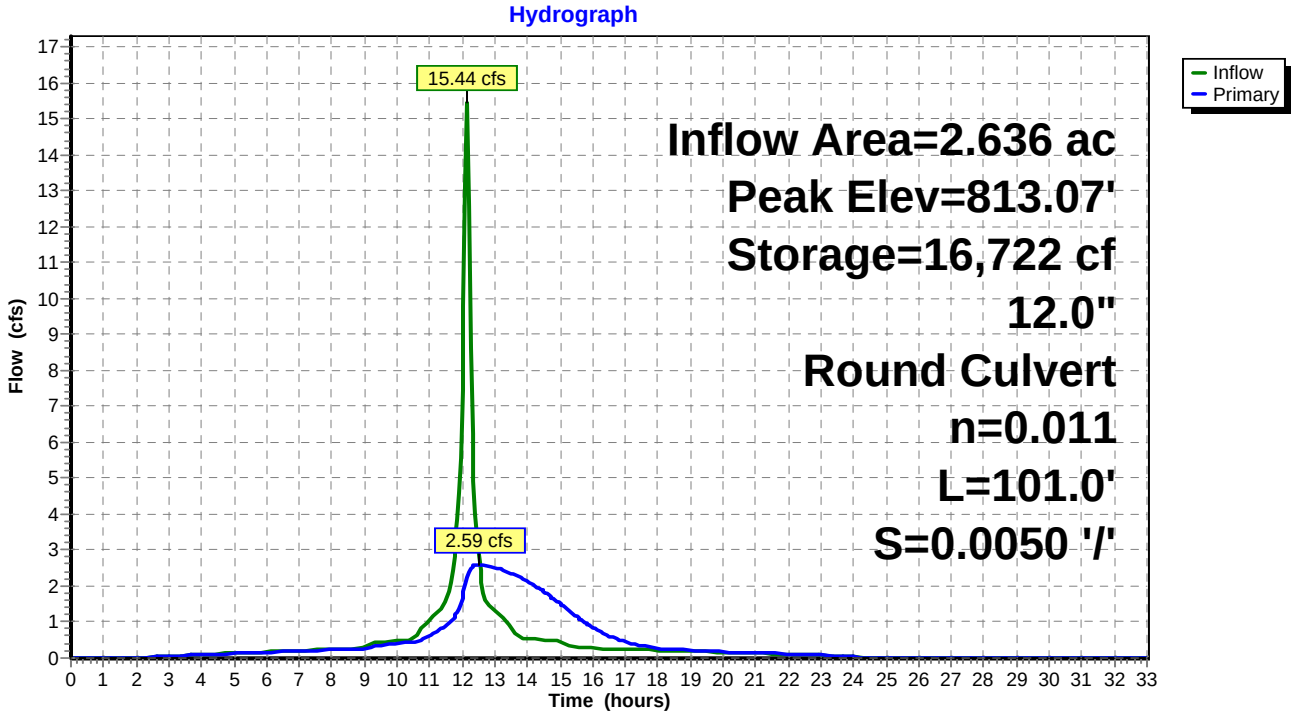
Volume	Invert	Avail.Storage	Storage Description
#1	812.00'	65,571 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
812.00	747	0	0
813.00	28,763	14,755	14,755
814.00	72,868	50,816	65,571

Device	Routing	Invert	Outlet Devices
#1	Primary	811.81'	**12.0" Round Culvert** L= 101.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 811.81' / 811.31' S= 0.0050 '/' Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.59 cfs @ 12.53 hrs HW=813.06' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.59 cfs @ 3.30 fps)

Pond 107P: Module 4 Rain Cover with Interior Berms



Stage-Discharge for Pond 107P: Module 4 Rain Cover with Interior Berms

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
812.00	0.00	812.52	1.35	813.04	2.55	813.56	3.34
812.01	0.13	812.53	1.38	813.05	2.57	813.57	3.35
812.02	0.15	812.54	1.41	813.06	2.59	813.58	3.36
812.03	0.16	812.55	1.44	813.07	2.60	813.59	3.38
812.04	0.18	812.56	1.47	813.08	2.62	813.60	3.39
812.05	0.19	812.57	1.50	813.09	2.64	813.61	3.40
812.06	0.21	812.58	1.53	813.10	2.65	813.62	3.42
812.07	0.22	812.59	1.56	813.11	2.67	813.63	3.43
812.08	0.24	812.60	1.59	813.12	2.69	813.64	3.44
812.09	0.26	812.61	1.62	813.13	2.70	813.65	3.46
812.10	0.27	812.62	1.65	813.14	2.72	813.66	3.47
812.11	0.29	812.63	1.68	813.15	2.74	813.67	3.48
812.12	0.31	812.64	1.71	813.16	2.75	813.68	3.49
812.13	0.33	812.65	1.74	813.17	2.77	813.69	3.51
812.14	0.35	812.66	1.76	813.18	2.78	813.70	3.52
812.15	0.37	812.67	1.79	813.19	2.80	813.71	3.53
812.16	0.39	812.68	1.82	813.20	2.82	813.72	3.55
812.17	0.41	812.69	1.85	813.21	2.83	813.73	3.56
812.18	0.43	812.70	1.87	813.22	2.85	813.74	3.57
812.19	0.45	812.71	1.90	813.23	2.86	813.75	3.58
812.20	0.48	812.72	1.92	813.24	2.88	813.76	3.60
812.21	0.50	812.73	1.95	813.25	2.89	813.77	3.61
812.22	0.52	812.74	1.97	813.26	2.91	813.78	3.62
812.23	0.55	812.75	2.00	813.27	2.93	813.79	3.63
812.24	0.57	812.76	2.02	813.28	2.94	813.80	3.64
812.25	0.59	812.77	2.04	813.29	2.96	813.81	3.66
812.26	0.62	812.78	2.06	813.30	2.97	813.82	3.67
812.27	0.64	812.79	2.08	813.31	2.99	813.83	3.68
812.28	0.67	812.80	2.10	813.32	3.00	813.84	3.69
812.29	0.69	812.81	2.11	813.33	3.02	813.85	3.70
812.30	0.72	812.82	2.13	813.34	3.03	813.86	3.72
812.31	0.75	812.83	2.15	813.35	3.04	813.87	3.73
812.32	0.77	812.84	2.17	813.36	3.06	813.88	3.74
812.33	0.80	812.85	2.19	813.37	3.07	813.89	3.75
812.34	0.83	812.86	2.21	813.38	3.09	813.90	3.76
812.35	0.85	812.87	2.23	813.39	3.10	813.91	3.78
812.36	0.88	812.88	2.25	813.40	3.12	813.92	3.79
812.37	0.91	812.89	2.27	813.41	3.13	813.93	3.80
812.38	0.94	812.90	2.29	813.42	3.15	813.94	3.81
812.39	0.97	812.91	2.31	813.43	3.16	813.95	3.82
812.40	1.00	812.92	2.33	813.44	3.17	813.96	3.83
812.41	1.02	812.93	2.35	813.45	3.19	813.97	3.85
812.42	1.05	812.94	2.37	813.46	3.20	813.98	3.86
812.43	1.08	812.95	2.39	813.47	3.22	813.99	3.87
812.44	1.11	812.96	2.41	813.48	3.23	814.00	**3.88**
812.45	1.14	812.97	2.43	813.49	3.24		
812.46	1.17	812.98	2.44	813.50	3.26		
812.47	1.20	812.99	2.46	813.51	3.27		
812.48	1.23	813.00	2.48	813.52	3.28		
812.49	1.26	813.01	2.50	813.53	3.30		
812.50	1.29	813.02	2.52	813.54	3.31		
812.51	1.32	813.03	2.53	813.55	3.32		

Stage-Area-Storage for Pond 107P: Module 4 Rain Cover with Interior Berms

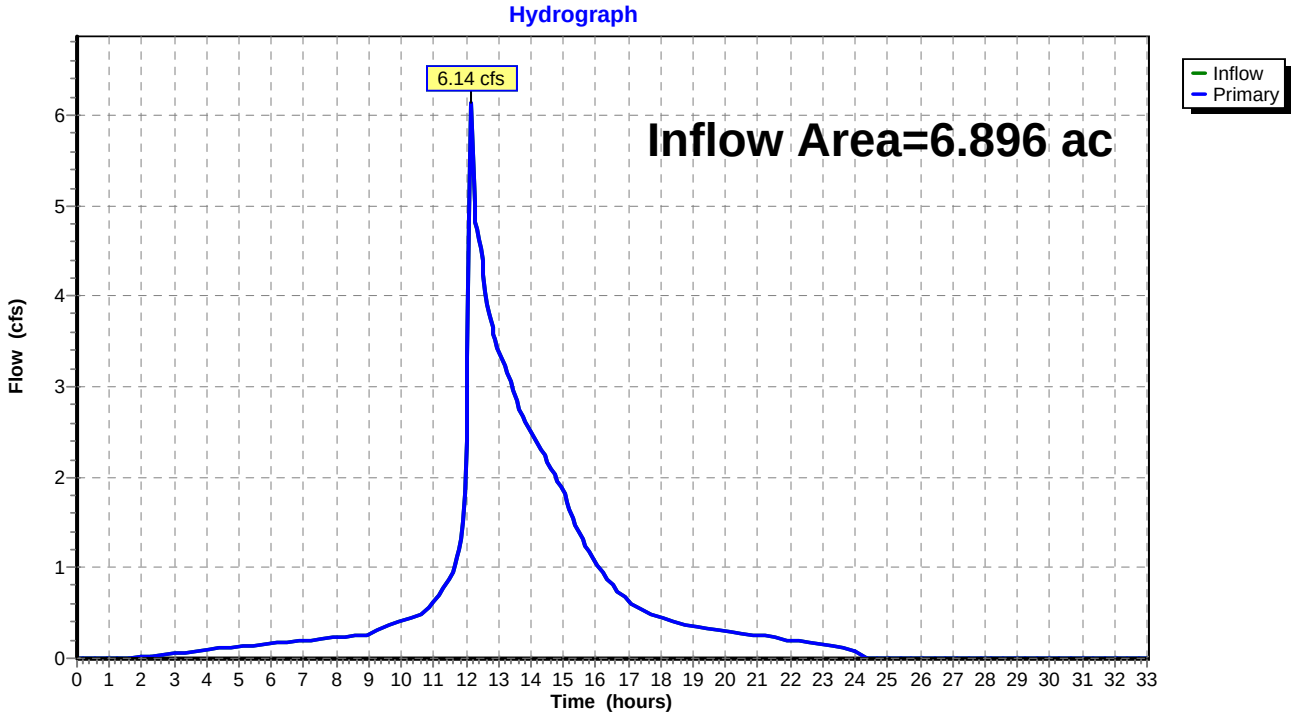
Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
812.00	747	0
812.02	1,307	21
812.04	1,868	52
812.06	2,428	95
812.08	2,988	149
812.10	3,549	215
812.12	4,109	291
812.14	4,669	379
812.16	5,230	478
812.18	5,790	588
812.20	6,350	710
812.22	6,911	842
812.24	7,471	986
812.26	8,031	1,141
812.28	8,591	1,307
812.30	9,152	1,485
812.32	9,712	1,673
812.34	10,272	1,873
812.36	10,833	2,084
812.38	11,393	2,307
812.40	11,953	2,540
812.42	12,514	2,785
812.44	13,074	3,041
812.46	13,634	3,308
812.48	14,195	3,586
812.50	14,755	3,876
812.52	15,315	4,176
812.54	15,876	4,488
812.56	16,436	4,811
812.58	16,996	5,146
812.60	17,557	5,491
812.62	18,117	5,848
812.64	18,677	6,216
812.66	19,238	6,595
812.68	19,798	6,985
812.70	20,358	7,387
812.72	20,919	7,800
812.74	21,479	8,224
812.76	22,039	8,659
812.78	22,599	9,105
812.80	23,160	9,563
812.82	23,720	10,032
812.84	24,280	10,512
812.86	24,841	11,003
812.88	25,401	11,505
812.90	25,961	12,019
812.92	26,522	12,544
812.94	27,082	13,080
812.96	27,642	13,627
812.98	28,203	14,185
813.00	28,763	14,755
813.02	29,645	15,339
813.04	30,527	15,941
813.06	31,409	16,560
813.08	32,291	17,197
813.10	33,174	17,852
813.12	34,056	18,524
813.14	34,938	19,214
813.16	35,820	19,922
813.18	36,702	20,647
813.20	37,584	21,390
813.22	38,466	22,150
813.24	39,348	22,928
813.26	40,230	23,724
813.28	41,112	24,538
813.30	41,994	25,369
813.32	42,877	26,217
813.34	43,759	27,084
813.36	44,641	27,968
813.38	45,523	28,869
813.40	46,405	29,789
813.42	47,287	30,726
813.44	48,169	31,680
813.46	49,051	32,652
813.48	49,933	33,642
813.50	50,816	34,650
813.52	51,698	35,675
813.54	52,580	36,718
813.56	53,462	37,778
813.58	54,344	38,856
813.60	55,226	39,952
813.62	56,108	41,065
813.64	56,990	42,196
813.66	57,872	43,345
813.68	58,754	44,511
813.70	59,637	45,695
813.72	60,519	46,896
813.74	61,401	48,116
813.76	62,283	49,352
813.78	63,165	50,607
813.80	64,047	51,879
813.82	64,929	53,169
813.84	65,811	54,476
813.86	66,693	55,801
813.88	67,575	57,144
813.90	68,457	58,504
813.92	69,340	59,882
813.94	70,222	61,278
813.96	71,104	62,691
813.98	71,986	64,122
814.00	**72,868**	**65,571**

Summary for Link 101L: Total to Culvert C2

Inflow Area = 6.896 ac, 38.23% Impervious, Inflow Depth = 2.36" for 25-yr, 24-hr storm event
Inflow = 6.14 cfs @ 12.16 hrs, Volume= 1.359 af
Primary = 6.14 cfs @ 12.16 hrs, Volume= 1.359 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs

Link 101L: Total to Culvert C2



East Swale (25-year, 24-hour Storm Event)

Summary for Subcatchment 1: Drainage Area 1 (to Existing 24" Culvert)

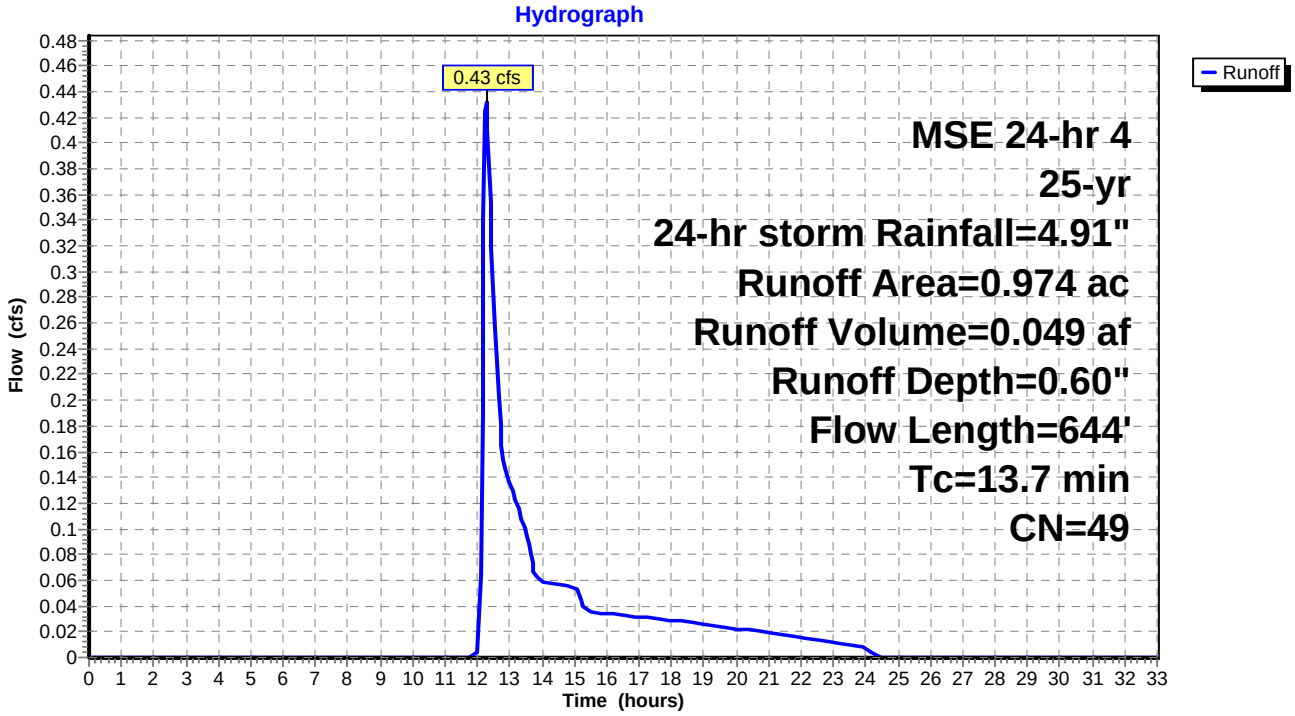
Runoff = 0.43 cfs @ 12.28 hrs, Volume= 0.049 af, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (ac)	CN	Description
0.974	49	Pasture/grassland/range, Fair, HSG A
0.974		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	70	0.0500	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.78"
1.9	30	0.3300	0.26		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.78"
0.1	32	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.7	512	0.0083	2.32	16.25	**Trap/Vee/Rect Channel Flow,** Bot.W=4.00' D=1.00' Z= 3.0 '/' Top.W=10.00' n= 0.045
13.7	644	Total			

Subcatchment 1: Drainage Area 1 (to Existing 24" Culvert)



Summary for Subcatchment 2: Drainage Area 2 (East Swale)

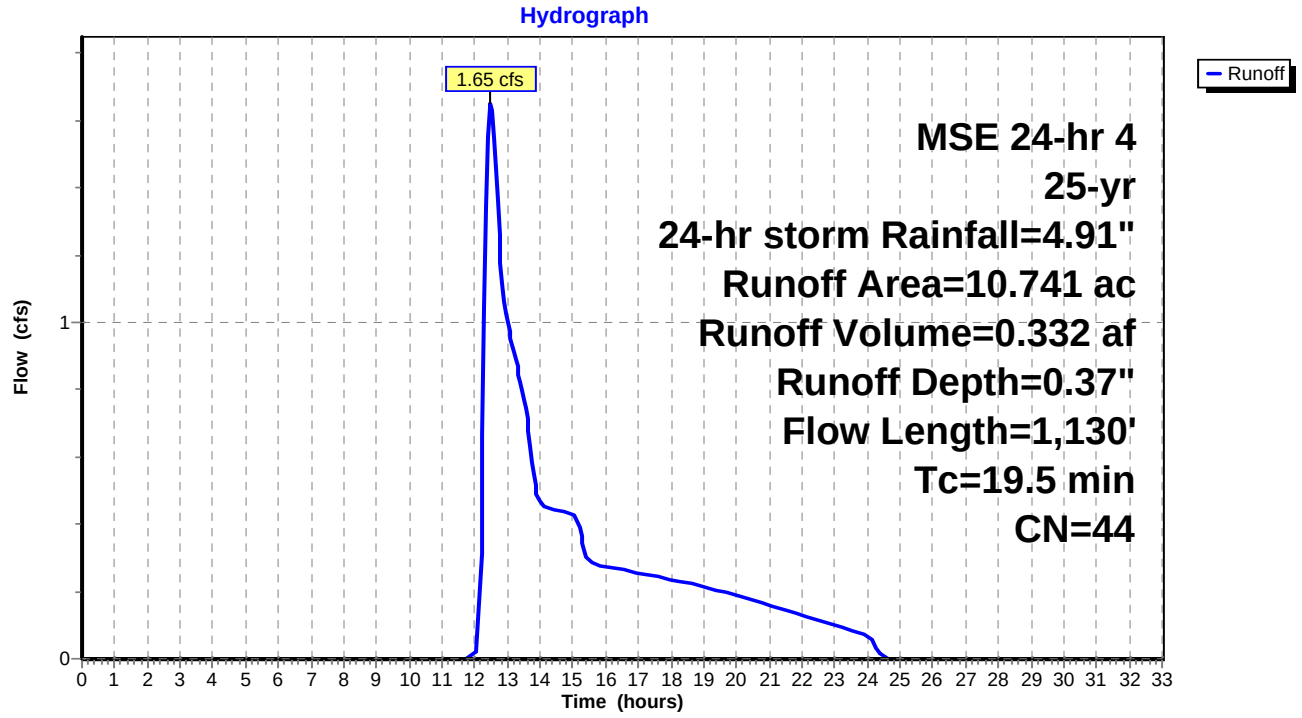
Runoff = 1.65 cfs @ 12.49 hrs, Volume= 0.332 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr storm Rainfall=4.91"

Area (ac)	CN	Description
10.594	43	Woods/grass comb., Fair, HSG A
0.147	96	Gravel surface, HSG A
10.741	44	Weighted Average
10.741		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.1	80	0.0190	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.78"
3.5	700	0.0100	3.31	44.95	**Channel Flow, Section 2** Area= 13.6 sf Perim= 19.8' r= 0.69' n= 0.035 Earth, dense weeds
2.9	350	0.0190	2.03	43.31	**Channel Flow, Section 3** Area= 21.3 sf Perim= 30.1' r= 0.71' n= 0.080 Earth, long dense weeds
19.5	1,130	Total			

Subcatchment 2: Drainage Area 2 (East Swale)

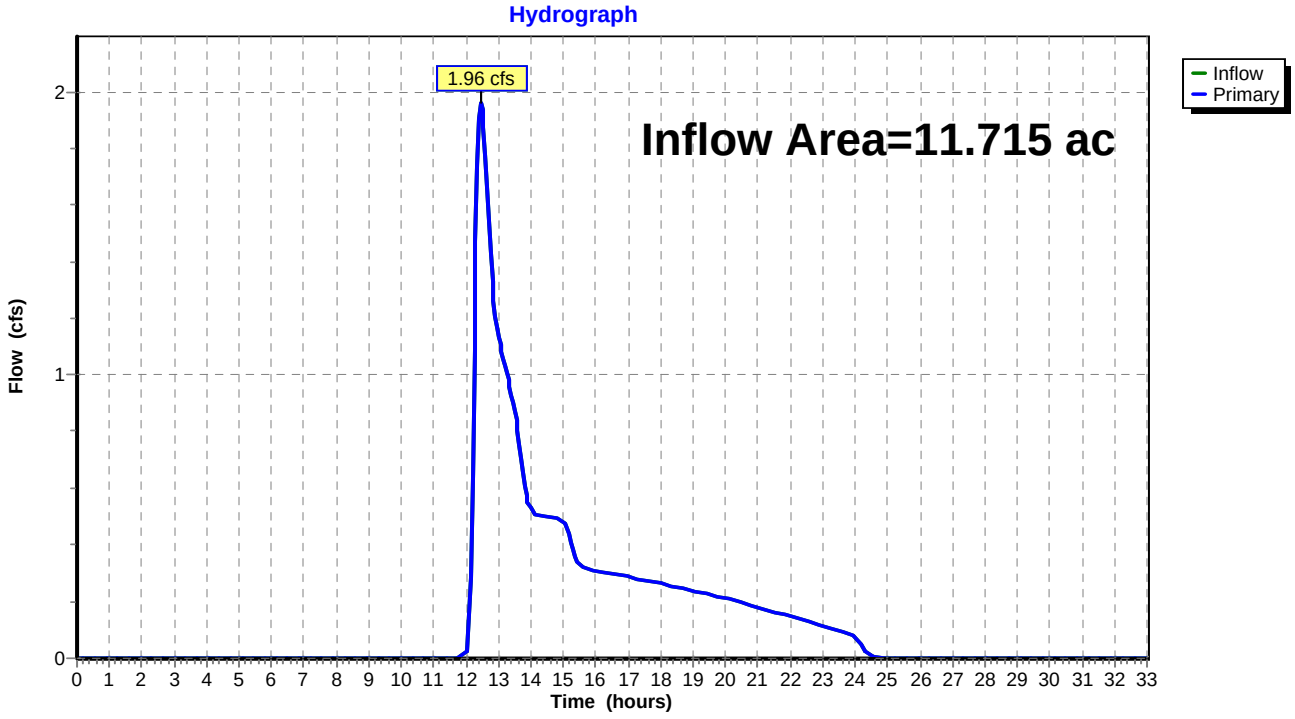


Summary for Link 5L: Total to Existing 24" Culvert

Inflow Area = 11.715 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 24-hr storm event
Inflow = 1.96 cfs @ 12.46 hrs, Volume= 0.381 af
Primary = 1.96 cfs @ 12.46 hrs, Volume= 0.381 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-33.00 hrs, dt= 0.05 hrs

Link 5L: Total to Existing 24" Culvert



Swale Sizing

Lining Type: Vegetation

Project ID:	**25217156.00**
Location:	**Columbia Module 4 Construction**
Designer/Checker:	**RJG/JMO**
Date:	**3/19/18 checked: 3/29/18**

Swale	East Swale	North Swale	East Existing (further downstream)
HydroCAD Node	2	101L	5L
Storm Event	25-yr	25-yr	25-yr
Channel/Ditch Geometry			
Channel Slope, S_o (ft/ft)	**0.005**	**0.005**	**0.005**
Channel Bottom Width, B (ft)	**10**	**10**	**10**
Channel Side Slope, z_1	**2**	**4**	**2**
Channel Side Slope, z_2	**2**	**4**	**2**
Flow Depth, d (ft) Solve iteratively	**0.37**	**0.69**	**0.40**
Safety Factor, SF	**1.0**	**1.0**	**1.0**
Vegetation/Soil Parameters			
Vegetation Retardance Class	**C**	**C**	**C**
Vegetation Condition	**good**	**good**	**good**
Vegetation Growth Form	**turf**	**turf**	**turf**
Soil Type	**cohesive**	**cohesive**	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)			
ASTM Soil Class	**SC**	**SC**	**SC**
Plasticity Index, PI	**16**	**16**	**16**
Results Summary			
Design Q (ft^3/s)	**1.65**	**6.14**	**1.96**
Calculated Q (ft^3/s)	1.7	6.2	1.9
Difference Between Design & Calc. Flow (%)	0.3%	0.8%	-1.7%
Stable (Yes or No)	**YES**	**YES**	**YES**
Channel Parameters			
Vegetation Height, h (ft)	0.67	0.67	0.67
Grass Roughness Coefficient, C_n	0.238	0.238	0.238
Cover Factor, C_f	0.90	0.90	0.90
Noncohesive Soil			
Soil Grain Roughness, n_s	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A	N/A
Cohesive Soil			
Porosity, e	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	3.985	8.804	4.320
Wetted Perimeter, P (ft)	11.66	15.69	11.79
Hydraulic Radius, R (ft)	0.342	0.561	0.366
Top Width, T (ft)	11.48	15.52	11.60
Hydraulic Depth, D (ft)	0.347	0.567	0.372
Froude Number (Q design)	0.124	0.164	0.129
Channel Shear Stress, τ_o (lb/ft^2)	0.11	0.18	0.11
Actual Sheer Stress, τ_d (lb/ft^2)	0.12	0.22	0.12
Mannings n	0.124	0.102	0.121
Average Velocity, V (ft/s)	0.41	0.70	0.45
Calculated Flow, Q (ft^3/s)	1.7	6.2	1.9
Difference Between Design & Calc. Flow (%)	0.3%	0.8%	-1.7%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.000	0.001	0.000
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	48.12	32.56	45.82
Stable (Y or N)	YES	YES	YES

Culvert Sizing

- Proposed Culvert C1
- Proposed Culvert C2
- Proposed Temporary Culvert (from Rain Cover)
- Existing Culvert (at Road Crossing in East Swale, East of Modules 1-3)

Proposed Culvert C1

HY-8 Culvert Analysis Report
Culvert C1

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5.97 cfs

Design Flow: 5.97 cfs

Maximum Flow: 5.97 cfs

Site Data - Culvert C1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 807.83 ft

Outlet Station: 97.00 ft

Outlet Elevation: 807.35 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Culvert C1

Tailwater Channel Option: Rectangular Channel

Bottom Width: 10.00 ft

Channel Slope: 0.0050

Channel Manning's n: 0.0450

Channel Invert Elevation: 807.35 ft

Roadway Data for Crossing: Culvert C1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 26.00 ft

Crest Elevation: 815.00 ft

Roadway Surface: Gravel

Roadway Top Width: 25.00 ft

Table 1 - Summary of Culvert Flows at Crossing: Culvert C1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
809.27	5.97	5.97	0.00	1
815.00	24.72	24.72	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert C1

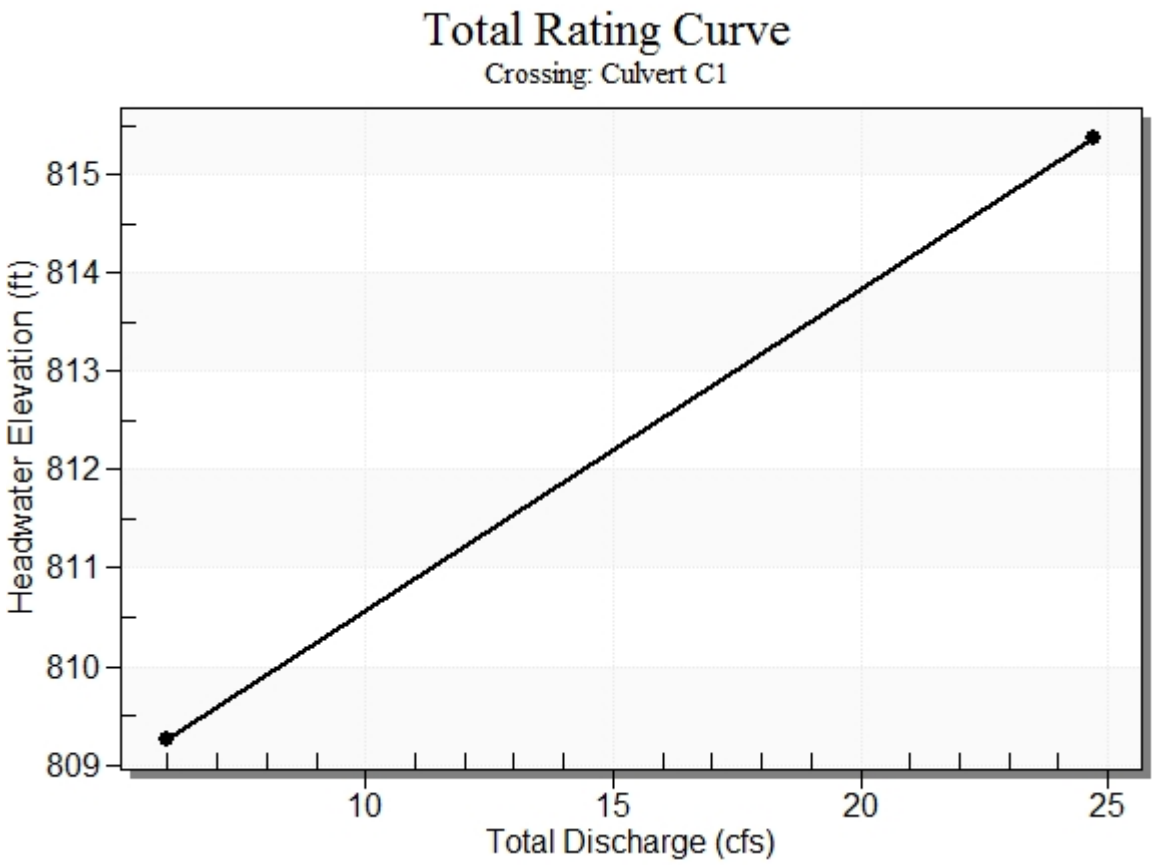


Table 2 - Culvert Summary Table: Culvert C1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307
5.97	5.97	809.27	1.316	1.439	2-M2c	1.112	0.863	0.863	0.457	4.602	1.307

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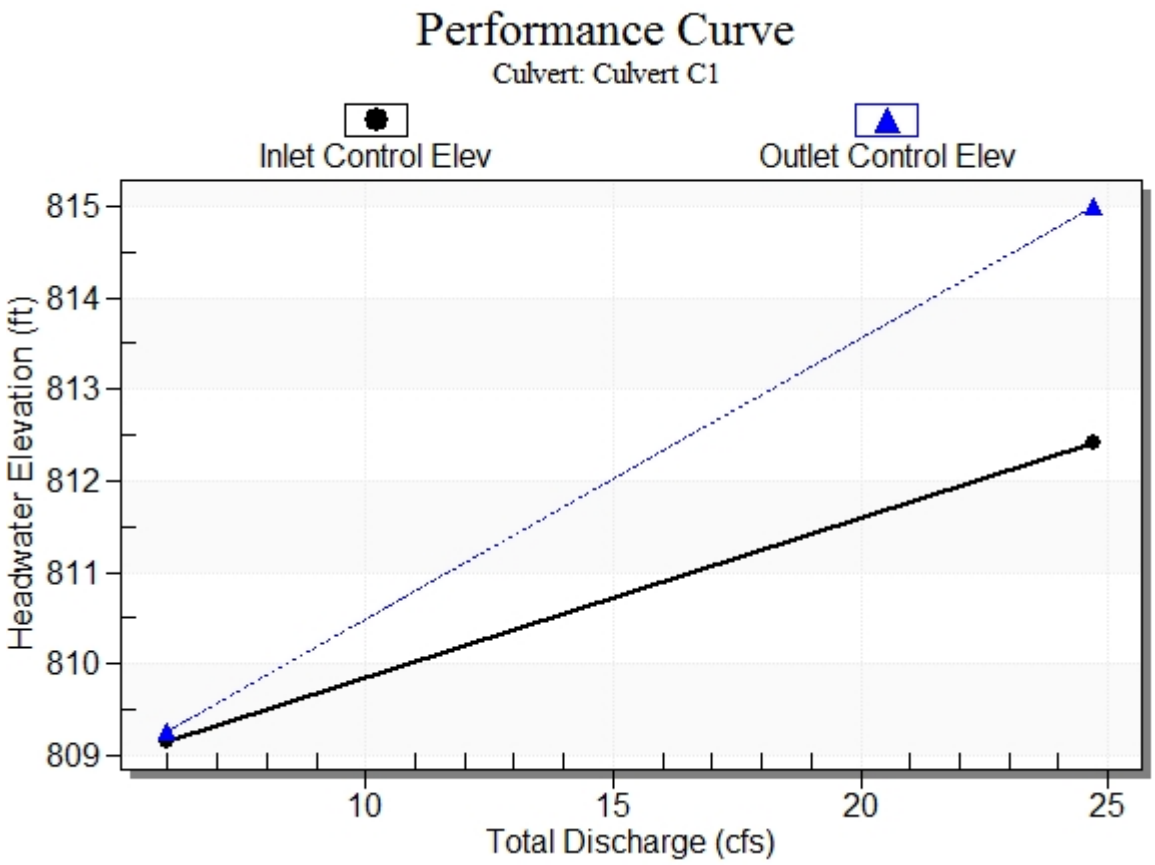
Straight Culvert

Inlet Elevation (invert): 807.83 ft, Outlet Elevation (invert): 807.35 ft

Culvert Length: 97.00 ft, Culvert Slope: 0.0049

****

Culvert Performance Curve Plot: Culvert C1



Water Surface Profile Plot for Culvert: Culvert C1

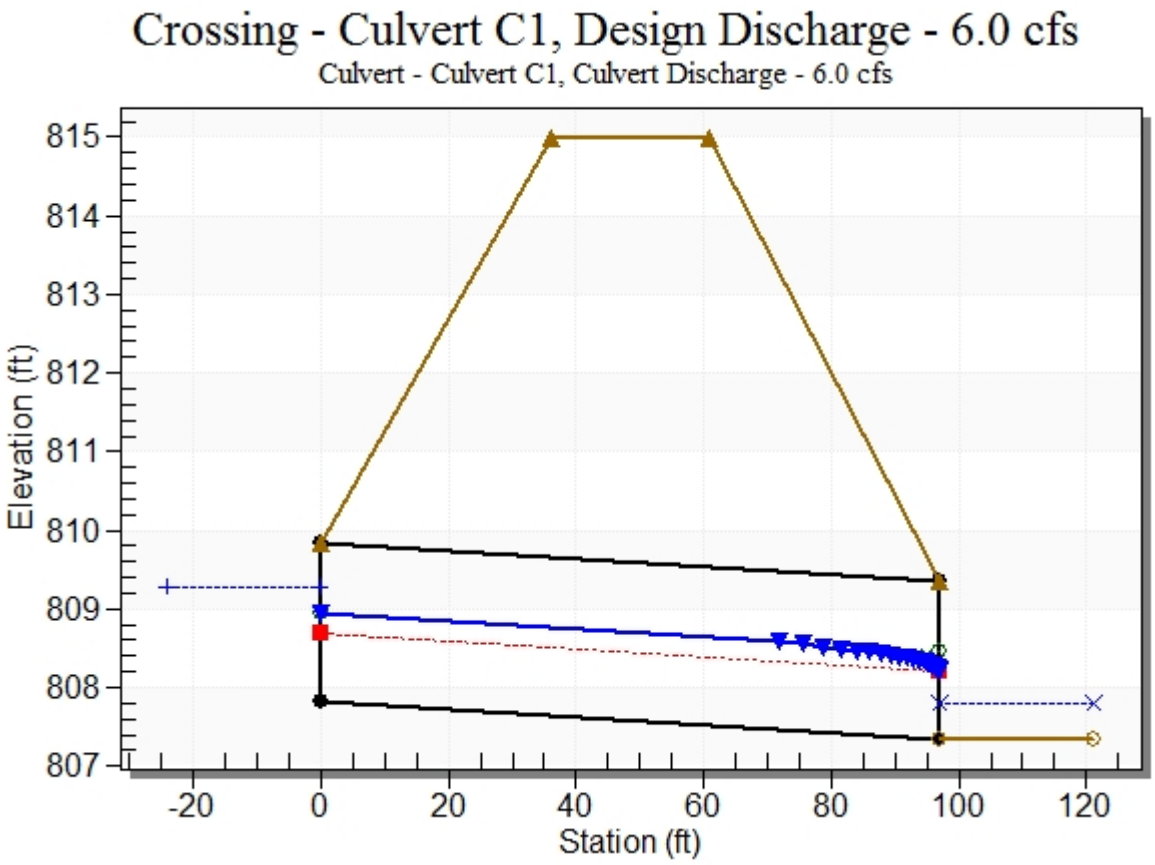


Table 3 - Downstream Channel Rating Curve (Crossing: Culvert C1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34
5.97	807.81	0.46	1.31	0.14	0.34

Proposed Culvert C2

HY-8 Culvert Analysis Report
Culvert C2

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 6.14 cfs

Design Flow: 6.14 cfs

Maximum Flow: 6.14 cfs

Site Data - Culvert C2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 806.62 ft

Outlet Station: 135.00 ft

Outlet Elevation: 805.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert C2

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Culvert C2

Tailwater Channel Option: Rectangular Channel

Bottom Width: 10.00 ft

Channel Slope: 0.0050

Channel Manning's n: 0.0450

Channel Invert Elevation: 805.00 ft

Roadway Data for Crossing: Culvert C2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 52.00 ft

Crest Elevation: 813.00 ft

Roadway Surface: Gravel

Roadway Top Width: 33.00 ft

Table 1 - Summary of Culvert Flows at Crossing: Culvert C2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert C2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
807.95	6.14	6.14	0.00	1
813.00	22.69	22.69	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert C2

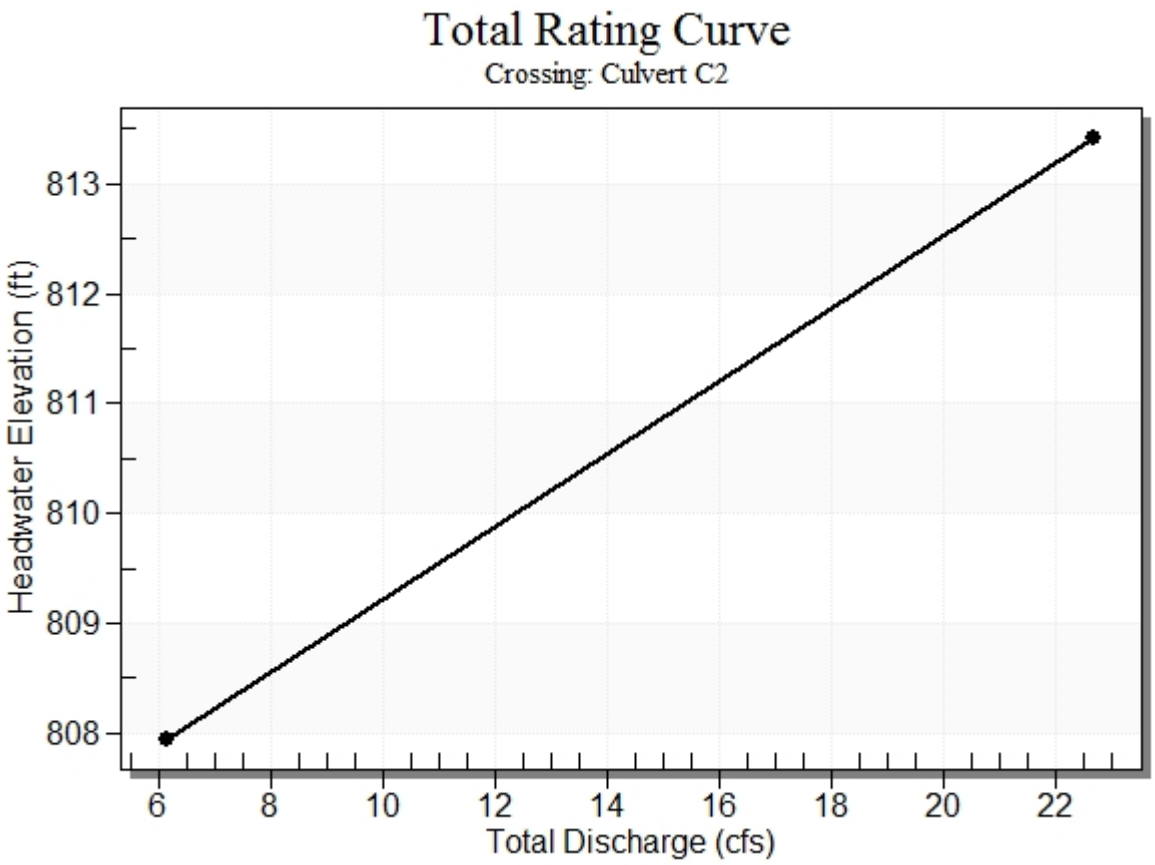


Table 2 - Culvert Summary Table: Culvert C2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321
6.14	6.14	807.95	1.331	0.0*	1-S2n	0.861	0.876	0.861	0.465	4.192	1.321

* Full Flow Headwater elevation is below inlet invert.

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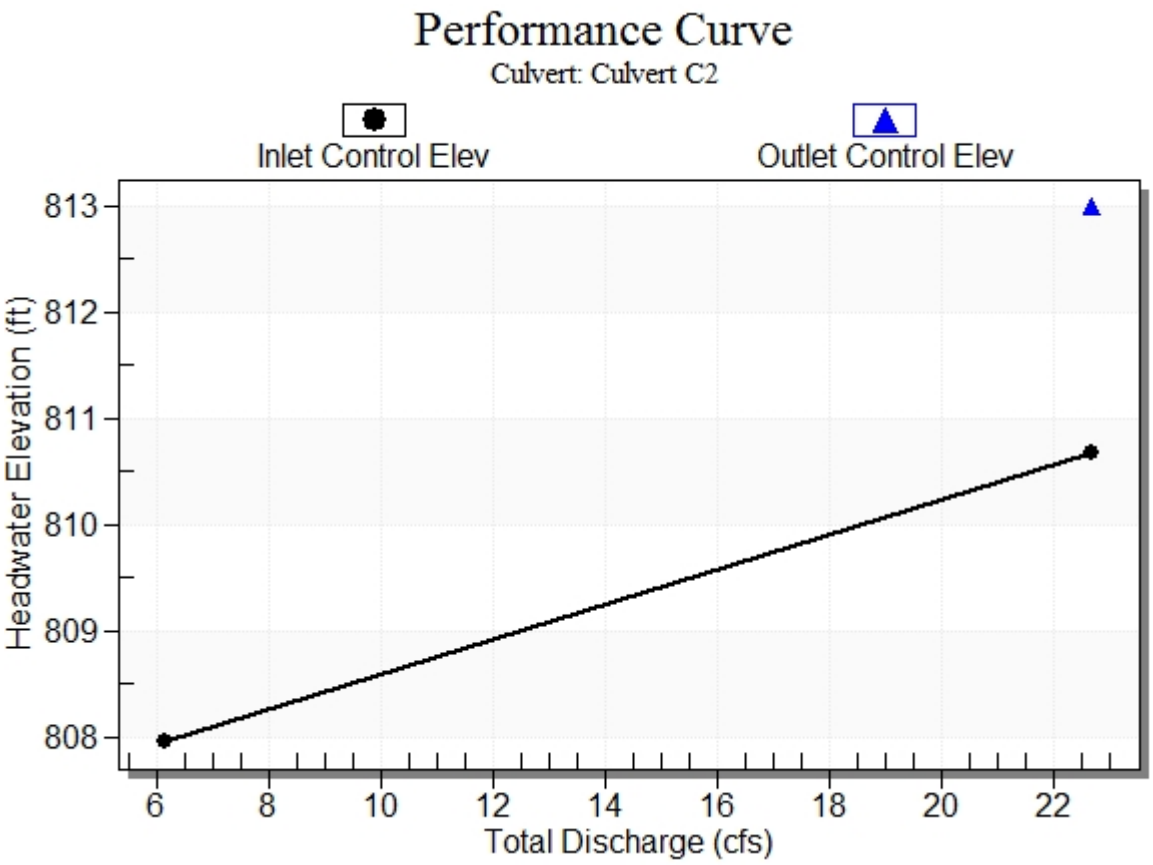
Straight Culvert

Inlet Elevation (invert): 806.62 ft,   Outlet Elevation (invert): 805.00 ft

Culvert Length: 135.01 ft,   Culvert Slope: 0.0120

****

Culvert Performance Curve Plot: Culvert C2



Water Surface Profile Plot for Culvert: Culvert C2

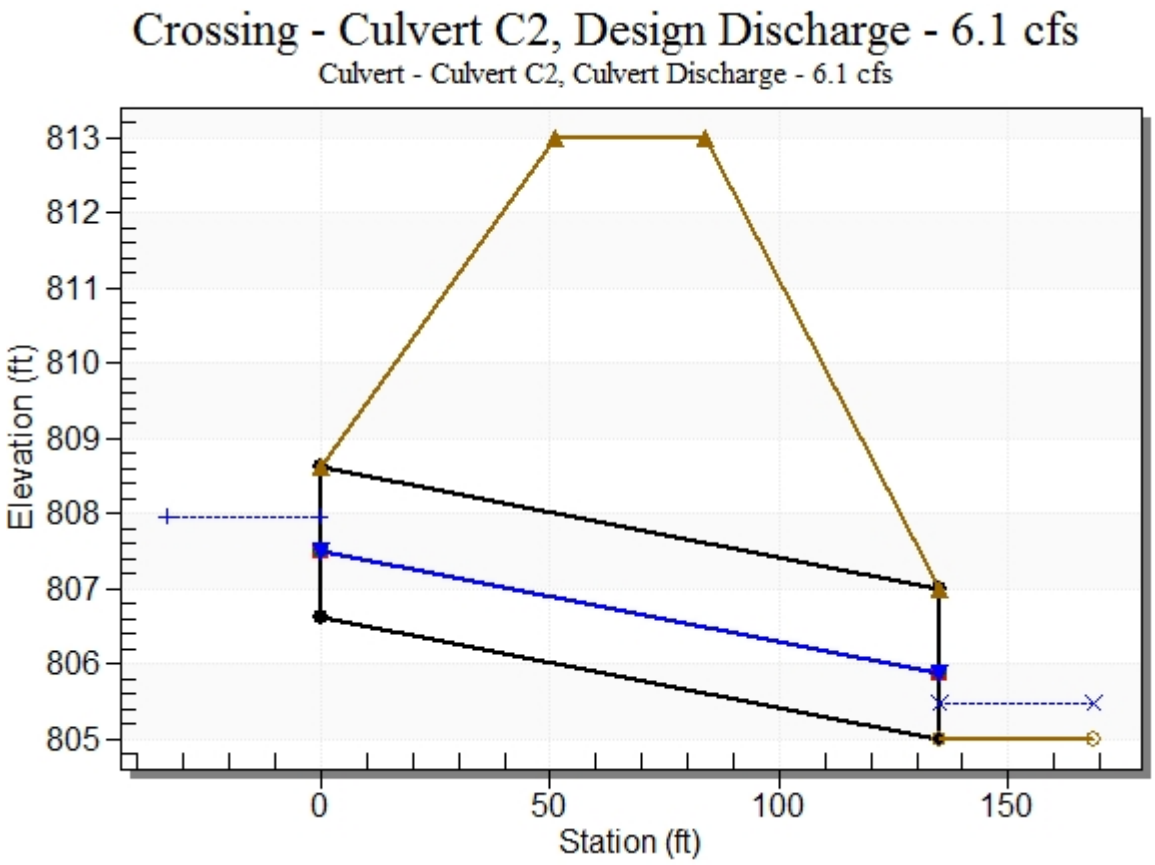


Table 3 - Downstream Channel Rating Curve (Crossing: Culvert C2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34
6.14	805.46	0.46	1.32	0.15	0.34

Existing Culvert
(at Road Crossing in East Swale, East of Modules 1-3)

HY-8 Culvert Analysis Report
Existing Culvert

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.98 cfs

Design Flow: 1.98 cfs

Maximum Flow: 1.98 cfs

Site Data - Existing Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 805.83 ft

Outlet Station: 100.00 ft

Outlet Elevation: 804.56 ft

Number of Barrels: 1

Culvert Data Summary - Existing Culvert

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Existing Culvert

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 8.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0083

Channel Manning's n: 0.0450

Channel Invert Elevation: 804.56 ft

Roadway Data for Crossing: Existing Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 808.50 ft

Roadway Surface: Gravel

Roadway Top Width: 100.00 ft

Table 1 - Summary of Culvert Flows at Crossing: Existing Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Existing Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
806.54	1.98	1.98	0.00	1
808.50	15.67	15.67	0.00	Overtopping

Rating Curve Plot for Crossing: Existing Culvert

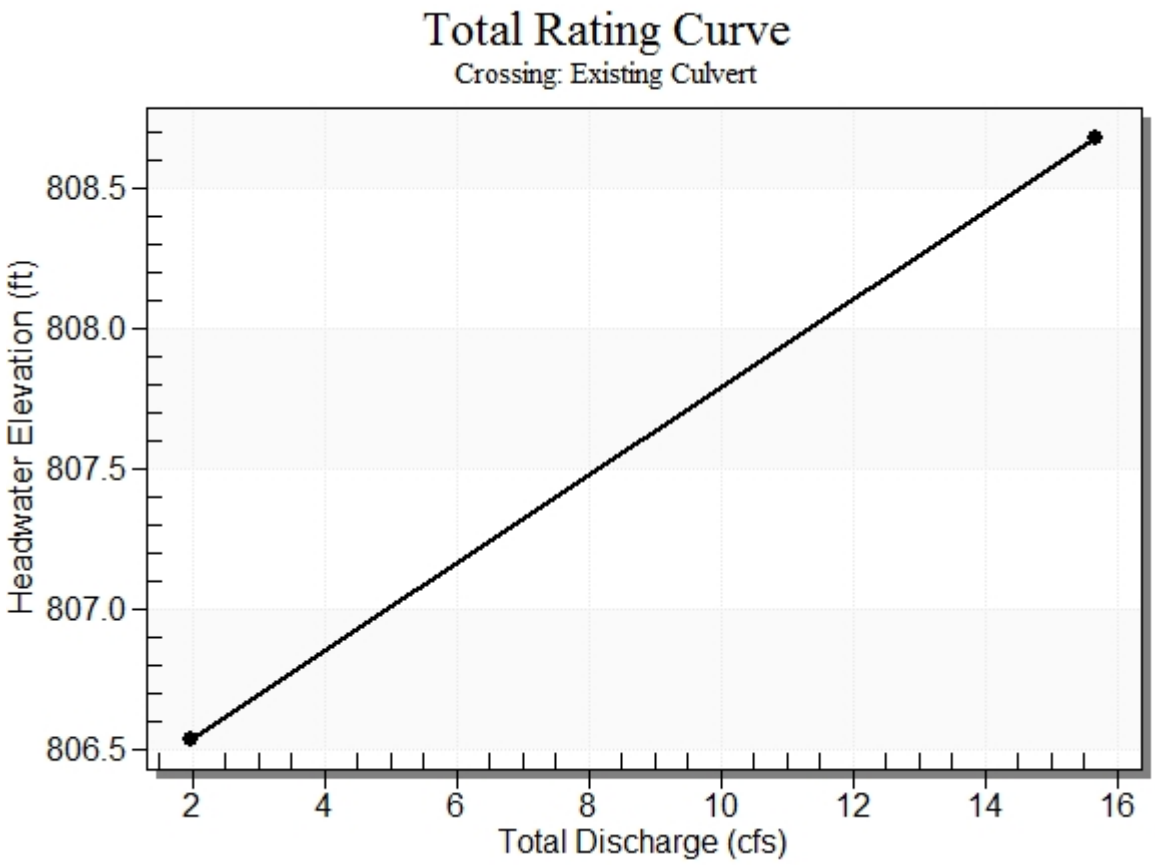


Table 2 - Culvert Summary Table: Existing Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039
1.98	1.98	806.54	0.710	0.0*	1-S2n	0.457	0.482	0.457	0.220	3.171	1.039

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 805.83 ft, Outlet Elevation (invert): 804.56 ft

Culvert Length: 100.01 ft, Culvert Slope: 0.0127

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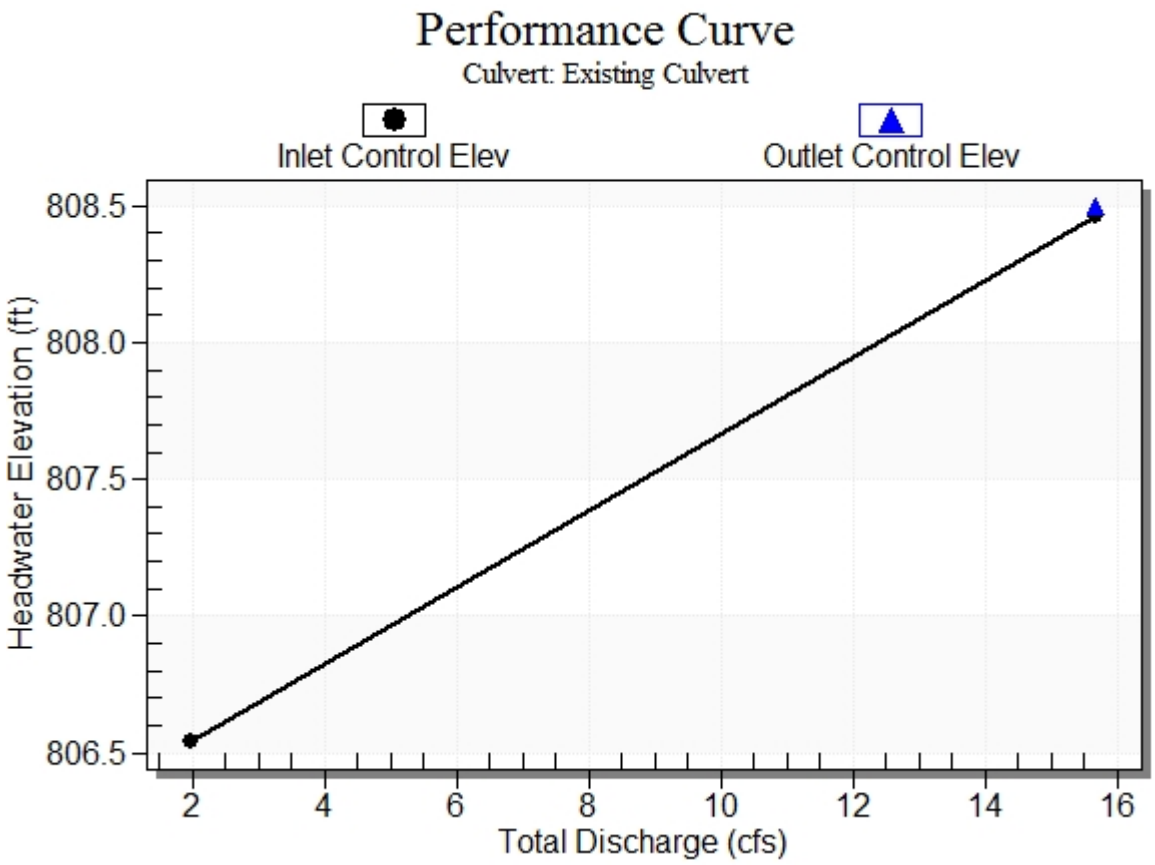
Culvert Performance Curve Plot: Existing Culvert



Water Surface Profile Plot for Culvert: Existing Culvert

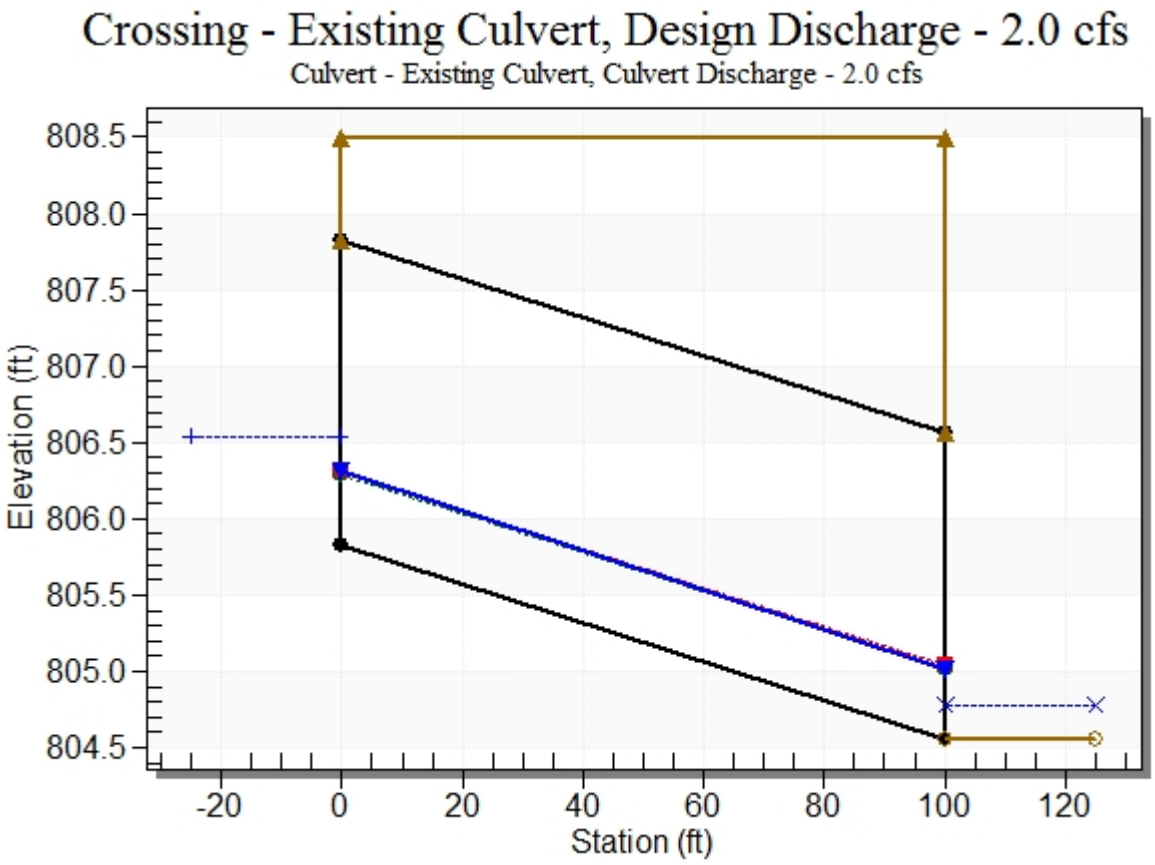


Table 3 - Downstream Channel Rating Curve (Crossing: Existing Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40
1.98	804.78	0.22	1.04	0.11	0.40