Attachment IV

Closure Plans for LAP and UAP

SURFACE IMPOUNDMENT CLOSURE PLAN
LOWER ASH POND
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TABLE OF CONTENTS

Section *Page*

1.0 PLAN CERTIFICATION 1
2.0 INTRODUCTION 2
2.1 General LAP Information 2
3.0 CLOSURE IMPLEMENTATION 3
3.1 Overview of Closure Approach 3
3.2 CCR Transportation Plan 4
3.3 Contact Water Management and Treatment 5
3.4 Erosion and Sediment and Stormwater Controls during Closure 6
4.0 CLOSURE TIMEFRAMES 7
5.0 INVENTORY REMOVAL AND DISPOSAL 7
5.1 Waste Removal, Decontamination and Disposal 7
5.2 Sampling and Testing Program 8
5.3 Other Areas 9
6.0 FINAL CLOSURE AND POST-CLOSURE IMPLEMENTATION 9
6.1 Post-Closure Stormwater Controls 9
6.2 Dam Modification 9
6.3 Posting 10
6.4 Certification 10
6.5 Post-Closure Use 10
7.0 CLOSURE COST ESTIMATE 11

LIST OF TABLES

Table 4-1 Projected LAP Closure Timeline.....7

LIST OF APPENDICES

Appendix A Traffic Impact Analysis

Appendix B Contact Water Pond Design Calculations

Appendix C Stormwater Calculations

Appendix D Closure Cost Estimate

1.0 PLAN CERTIFICATION

This Closure Plan for the Lower Ash Pond (LAP) at the Chesterfield Power Station was prepared by AECOM. The document and Certification/Statement of Professional Opinion are based on and limited to information that AECOM has relied on from Dominion Energy and others, but not independently verified, as well as work products produced by AECOM.

On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Virginia that this document has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the document was prepared consistent with the requirements in §257.102 of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015, with an effective date of October 19, 2015 (40 CFR §257.102), as well as with the requirements in §257.100 resulting from the EPA's "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur" published in the Federal Register on August 5, 2016 with an effective date of October 4, 2016 (40 CFR §257.100).

The use of the word "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

_____
Printed Name of Professional Engineer

_____ _____
Commonwealth of Virginia License No. Signature and Date

2.0 INTRODUCTION

Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion) owns and operates the Chesterfield Power Station (Station) located at 500 Coxendale Road in Chesterfield County, Virginia. The Station includes two Coal Combustion Residuals (CCR) surface impoundments, as well as a Fossil Fuel Combustion Products (FFCP) Management Facility operating under Virginia Department of Environmental Quality (VADEQ) Solid Waste Facility Permit No. 609, issued on June 29, 2016.

This Closure Plan was prepared for one of the Station's CCR surface impoundments, the Lower Ash Pond (LAP), and describes the design for closure of the LAP. A separate Closure Plan is being submitted for the other CCR surface impoundment, the Upper Ash Pond (UAP). This Closure Plan is being submitted to the VADEQ as part of a Part B Solid Waste Closure Permit Application (Permit Application). This Closure Plan was prepared in accordance with 40 CFR 257, Subpart D and is consistent with the requirements of 40 CFR 257.102 for closure of CCR surface impoundments and 9 VAC 20-81-800 of the Virginia Solid Waste Management Regulations (VSWMR). The LAP will be closed by removal pursuant to 40 CFR 257.102(c) and § 10.1-1402.03 of the Code of Virginia.

2.1 General LAP Information

As noted previously, there are three CCR units at the Station, the LAP, the UAP, and the FFCP Management Facility. This Closure Plan is for the LAP only. The LAP is a surface impoundment that was previously used by the Station to settle and manage low-volume wastewaters, including CCR. The LAP is currently regulated under the following permits:

- VADEQ Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004146
- Virginia Department of Conservation and Recreation (DCR) Operation and Maintenance Certification, Inventory No. 00823

It is Dominion's intent to monitor groundwater for the LAP under the solid waste permit and remove these requirements from the referenced VPDES permit.

The LAP is approximately 111 acres in size. The estimated volume of CCR material in the LAP is approximately 2.8 million cubic yards (MCY). The LAP is constructed of earthen dikes, at approximate elevation of 18.5 feet above mean sea level (MSL). The estimated bottom of CCR material grades in the LAP are presented on LAP Drawing No. 004 (Estimated Bottom of CCR Material Plan). The maximum bottom elevation of CCR material is estimated to be approximately minus 10 feet below MSL. The estimated area of disturbance to complete the LAP closure activities is approximately 116 acres.

3.0 CLOSURE IMPLEMENTATION

3.1 Overview of Closure Approach

This Closure Plan provides for the closure of the LAP by removal of the CCR material. Closure is considered complete under 40 CFR 257.102 and 9 VAC 20-81-810 when:

1. A Professional Engineer licensed in the Commonwealth of Virginia certifies all CCR has been removed from the LAP. In addition, consistent with its other closure by removal projects, Dominion will also over-excavate the visually clean certified area by a minimum of six (6) inches of underlying material.

2. The LAP's downgradient groundwater monitoring wells do not exhibit levels in excess of a maximum contaminant limit (MCL) or established groundwater protection standard for any CCR Appendix IV constituent on or after a minimum of ten sampling events have occurred after CCR material has been verified as removed by a Professional Engineer in Virginia.

It is estimated that there is approximately 14.6 MCY of CCR material to be removed from the LAP and UAP combined. Approximately 2.8 MCY of CCR material will be excavated and removed from the LAP; with allowance for over-excavation the total is approximately 2.9 MCY. All CCR material removed from the LAP will be relocated to the FFCP Management Facility or an offsite permitted industrial waste landfill for disposal, or beneficially reused offsite. The expected storage capacity of the FFCP Management Facility is 9.36 MCY. Approximately 0.43 MCY of production CCR material is anticipated from ongoing and future Station operations. A combination of fill material generated from future onsite activities at the Chesterfield

Power Station and soil imported from offsite will be used as backfill material to complete LAP closure and site restoration activities.

Dominion is proposing phased excavation and removal plans for the purposes of managing stormwater and contact water. Once the CCR material has been removed and the LAP backfilled with soil, the LAP will be graded to promote stormwater drainage and seeded to establish cover vegetation.

The final closure grades are shown on Drawing No. 005 (Final Grading Plan); profiles of the final closure grades are shown on Drawing Nos. 007 through 009 and details are provided on Drawing No. 011. The final closure grades will be established at an elevation between 10 and 15 feet above MSL around the perimeter, and then graded at 0.5% minimum upwards towards the center of the pond to approximate elevation 22 feet above MSL. The closure area will consist of the following from top to bottom:

- 1-foot topsoil layer capable of supporting vegetative growth;
- 3-feet of low permeability fill soil ($k < 1 \times 10^{-5}$ cm/sec); and,
- Compacted fill soil, at least 6 inches below the bottom elevation of the CCR material.

Dominion's Construction Quality Assurance (CQA) representative will perform field compaction testing of the compacted, low permeability, and structural fill soils to verify conformance with the compaction standards.

After topsoil placement is completed, Dominion will apply seed, fertilizer, lime, and mulch, in accordance with the VADEQ Erosion & Sediment Control Handbook (VESCH), to achieve a permanent vegetative cover over the closure area.

3.2 CCR Transportation Plan

Dominion is planning to haul the excavated CCR from the LAP to either the FFCP Management Facility or to a potential beneficial use facility on Dominion property located to the northwest of the current pond locations. This will require a rotation of trucks for CCR hauling to circulate between the LAP, the FFCP Management Facility, and the beneficial use facility for an extended duration until the project is complete. The hauling route for trucks between the LAP, the FFCP Management Facility, and the beneficial use

facility involves adding truck traffic associated with the project to public roadways. Therefore, a traffic impact analysis (TIA) was performed to determine if any potential significant impacts to the existing public roadway network or projected traffic operations would result from the proposed project. A copy of the TIA is provided in Appendix A.

Based on the results of operational analysis and the findings of the TIA, it is projected that the CCR truck hauling operations are not expected to have a significant impact on study area traffic operations at any point between existing conditions through final closure conditions (2035 conditions) for any of the anticipated circulating truck loads. A conservative 100-truck schedule is also not projected to impact operations or deteriorate any turning movement below Level of Service B in the study area during the closure timeframe. Therefore, no mitigation is needed in association with the currently projected Dominion trucking operations.

3.3 Contact Water Management and Treatment

Dominion will ensure that contact water, including water from CCR dewatering efforts, and any other non-stormwater flows are kept separate from stormwater at all times during closure activities. Contact water and any other non-stormwater flows will require treatment prior to discharge. A Centralized Source Water Treatment System (CSWTS) will be constructed onsite for wastewater treatment and will have a design capacity of 1,500 gallons per minutes (gpm). A Concept Engineering Report (CER) for the CSWTS was submitted to the VADEQ Water Division under the Station's existing VPDES permit and was approved by the Water Division on September 16, 2020. Treated effluent discharged from the CSWTS will meet all applicable requirements in the VPDES permit. The CSWTS is expected to be operational by April 2021.

For each phase of CCR excavation, Dominion will install Best Management Practices (BMPs), such as lined contact water ponds, for the management of the contact water generated during CCR material excavation. Contact water ponds will be sized to contain the runoff volume from a 100-year, 24-hour storm event for the contributing drainage area (see Appendix B for calculations). Contact water ponds will be lined with 40-mil linear low-density polyethylene (LLDPE), and the liner will be anchored around the entire perimeter top of the contact water pond. For each phase, Dominion will convey the contact water from the contact water pond(s) or other BMPs to a connection on the CSWTS influent pipe.

Contact water from the active excavation area will be conveyed by gravity or pumped from the active excavation area to the contact water pond(s) or other BMPs when possible. For CCR excavation below the lined pond invert, Dominion will install sumps or other BMPs in each active excavation area to convey the contact water from the active excavation area to the contact water pond(s).

Dewatering of the active excavation area will also be provided to maintain safe water levels and facilitate dry excavation of the CCR material. Contact water from dewatering efforts will be conveyed to the contact water ponds or other storage location prior to being sent to the CSWTS for treatment. Dominion will provide other means of storage or management of contact water (e.g. tanks) in addition to the contact water ponds, as needed, to ensure that the discharge flow to the CSWTS does not exceed 1,500 gpm.

3.4 Erosion and Sediment and Stormwater Controls during Closure

Currently, stormwater within the LAP site sheet-flows to ditches draining to the existing stormwater/sedimentation basin in the western portion of the LAP site. Stormwater from this basin leaves the site through an existing VPDES outfall (066) under the Station's VPDES Construction Stormwater Permit. The existing ditches and stormwater/sedimentation basin will remain in place as the removal process starts and will only be removed once additional temporary or permanent measures are implemented.

Temporary sediment and erosion control measures will be utilized throughout all phases of closure activities. The existing stormwater/sedimentation basin in the western portion of the LAP site and the proposed, temporary stormwater/sedimentation basins shown on Drawing No. 006 (Erosion and Sediment Control Plan) will be the primary stormwater and erosion and sediment (E&S) control utilized during CCR excavation and removal. Stormwater will be conveyed to the sedimentation basins by existing drainage ditches, temporary stormwater diversion berms, and/or stormwater pumping operations. The existing LAP perimeter dam will also provide stormwater/flood control for the site, as it will be maintained at its existing condition throughout the CCR excavation and removal process. After stabilization of the final LAP closure area is complete, the temporary stormwater/sedimentation basins will be decommissioned by removing sediment accumulation and the riser structures.

Additional E&S controls to be installed during LAP closure activities include dual bay truck washes, super silt fence, and a Flexible Growth Medium (FGM) or equivalent lining for slope stabilization. Details on potential E&S controls to be installed are provided on Drawings No. 006 and 011 in Attachment III of this Permit Application package. Design calculations for the E&S and stormwater controls during closure are provided in Appendix C.

4.0 CLOSURE TIMEFRAMES

Dominion has elected to excavate and remove all CCR material from the LAP for disposal in the FFCP Management Facility or an offsite permitted landfill, or for beneficial reuse offsite. It is anticipated that the LAP closure activities may take approximately 13 years to complete once started.

The projected timeframes for closure activities are provided in Table 4-1 below.

Table 4-1 Projected LAP Closure Timeline

Activity	Tentative Date
Commencement of CCR Removal/Closure Activities – LAP	2nd Quarter 2021
Completion of Closure - LAP	NLT March 2034

Closure is considered complete when the elements of this Closure Plan specified above have been performed as certified by a Professional Engineer licensed in the Commonwealth of Virginia. This certification will be included as part of a closure certification report. In accordance with 40 CFR 257.102(h), Dominion will prepare a notification of closure of the LAP within 30 days of completion of closure and will place the notification in the operating record.

5.0 INVENTORY REMOVAL AND DISPOSAL

5.1 Waste Removal, Decontamination and Disposal

The protocol for closure by removal of the LAP will involve removing accumulated CCR such that no residual materials remain visible, followed by over-excavating the removal footprint by a minimum of six (6) inches. Removed CCR material will be transferred to the FFCP Management Facility or an offsite

permitted industrial waste landfill, or beneficially reused offsite. To facilitate effective management of stormwater and contact water, closure by removal of areas within the LAP will be achieved in phases. The phased closures will be sequenced as necessary to support traffic patterns and other constraints, including the management of stormwater and contact water during a 100-year, 24-hour design storm event. A phased approach will also allow for documentation of certified clean areas within the excavation area that are approved for soil backfill. Temporary CCR excavation slopes will not exceed 5H:1V.

In environmentally-sensitive areas outside of the defined CCR unit boundary, such as Resource Protection Areas (RPAs), groundwater monitoring well locations, or wetlands, a modified excavation protocol will be followed for removal of identified CCR. The CCR will be removed to a visually clean condition using methods that minimize impact to surrounding soils. The 6-inch over-excavation will not be performed in these areas in order to limit the impact to subgrade soils. Following CCR removal, the area will be stabilized to prevent erosion with materials suitable for the area.

Interim soil cover and vegetation (or approved equal) will be installed over excavation slopes. Water levels in the excavation area will be maintained at least 5-feet below the deepest excavation adjacent to the slope.

After CCR removal and certification, the LAP will be graded to promote stormwater drainage to the site's permitted stormwater outfalls. Vegetative stabilization will be established to prevent erosion. The area will be maintained as a grassy open area.

5.2 Sampling and Testing Program

After removal of the CCR material and the 6-inch over-excavation material from the LAP, the area will be visually inspected to verify the CCR removal and over-excavation has been achieved. In addition, the LAP will be further inspected by targeted soil cores, dug by hand using a hand auger or similar tool, to a depth of at least six (6) inches at a frequency of at least one core per acre.

Verification surveys of the pond closure will be prepared by a Commonwealth of Virginia licensed Land Surveyor and will consist of a survey of the "visually clean" surface and a survey of the "over-excavation" surface to verify the minimum 6-inch removal. Certification of the closure by removal will be provided by a Commonwealth of Virginia licensed Professional Engineer.

Groundwater monitoring will be conducted in accordance with the approved Groundwater Monitoring Plan to meet the closure by removal standard set forth in 40 CFR 257.102(c) and the VSWMR.

5.3 Other Areas

A 10-inch diameter water main and a fiber optic cable currently run beneath Coxendale Road and Henricus Park Road along the northern and eastern boundaries of the LAP. It is possible that CCR material may be found beneath the pavement or that the existing utilities may be located within the limits of CCR. If this occurs, Dominion will expose the utility by hand-digging, ensure the utility is appropriately supported, and carefully remove any CCR material in the vicinity of the utility within the waste unit boundary.

Several utility poles with overhead utilities in the eastern and southern portion of the LAP closure area (along Henricus Park Road) will need to be relocated by others prior to closure activities. Dominion will over-excavate and remove the pole foundations for offsite disposal.

6.0 FINAL CLOSURE AND POST-CLOSURE IMPLEMENTATION

6.1 Post-Closure Stormwater Controls

The LAP post-closure stormwater controls are shown on Drawing No. 005 (Final Grading Plan) in Attachment III of this Permit Application package. A concrete perimeter drainage ditch will be constructed around the LAP, and a concrete stormwater ditch will be constructed along Coxendale Road and Henricus Park Road, to convey stormwater runoff from the closure area to proposed stormwater outfalls in the closure area. The western stormwater outfalls will discharge to the Station's Thermal Channel to the west. The eastern stormwater outfalls will discharge to Aiken Swamp in the Dutch Gap Conservation Area. A gravel-surfaced perimeter access road will also be constructed around the LAP closure area. Design calculations for the post-closure stormwater controls are included in Appendix C.

6.2 Dam Modification

Dominion intends to request approval to lower and then decommission the existing dam around the western, southern, and eastern sides of the LAP closure area. Plan and details of the proposed dam modification are

provided on Drawing Nos. 012 and 013 in Attachment III of this Permit Application package. Therefore, once the LAP is closed, the LAP will no longer be regulated as an impounding structure by DCR.

6.3 Posting

A gate will be installed at the entrance to the ponds on Coxendale Road at the conclusion of closure activities. The existing fence along Coxendale Road, Henricus Park Road, and the Henricus Park Hiking Trail will remain on the downstream sides of the LAP. The fence along the upstream sides will be removed during closure construction and will be re-set at the completion of closure activities. A sign will be posted at the site entrance notifying all persons of the final closure of the LAP and the prohibition against further receipt of CCR.

6.4 Certification

Upon completion of closure construction, a certification statement signed by a Professional Engineer registered in the Commonwealth of Virginia will be placed in the operating record and submitted to VADEQ along with the documentation from the Sampling and Testing Program. The certification statement will read as follows:

> "I certify that closure has been completed in accordance with the Closure Plan dated [DATE] for Solid Waste Facility Permit No. XXX issued to the Dominion Chesterfield Power Station, with the exception of the following discrepancies: TBD
>
> In addition, a sign was posted on [DATE] at the site entrance notifying all persons of the closing [and state other notification procedures if applicable] and barriers [indicate type] were installed at [location] to prevent new waste from being deposited.
>
> [Signature, date, and stamp of Professional Engineer]

6.5 Post-Closure Use

Currently, there are no dedicated proposed land use plans for this area. A gravel-surfaced perimeter access road will be constructed around the LAP closure area. The former LAP area will be allowed to revegetate and return to a natural habitat area.

7.0 CLOSURE COST ESTIMATE

The LAP closure cost estimate is estimated to be approximately $223,000,000. The estimate includes the cost of all closure construction activities, as well as costs for inspection, testing, and certification as proposed in this Plan. See Appendix D for the Closure Cost Estimate.

Appendices

Appendix A

Traffic Impact Analysis

AECOM
10 South Jefferson Street
Roanoke, VA 24011
aecom.com

Project name:
Dominion Chesterfield Station

Project ref:
Traffic Impact Analysis

To:
Ginger Phelps - Dominion

From:
Stuart Martin, PE

CC:
Gabe Lang, PE

Date:
September 10, 2020

DRAFT

Memorandum

Subject: Dominion Chesterfield Station - Traffic Impact Analysis

Introduction

AECOM has been tasked with providing professional engineering services such as design and permitting support for Dominion related to proposed activities at Dominion's Chesterfield Power Station in Chester, Virginia. One of the proposed operations involves transporting CCR stored at the facility's Upper and Lower Ash Ponds to the FFCP management facility and to a potential beneficial use facility on Dominion property to the northwest of the current pond locations. This will require a rotation of trucks for CCR hauling to circulate between the ponds and the FFCP and beneficial use facility for an extended duration until the project is complete.

Purpose and Need

The hauling route for trucks between the ponds and the FFCP and beneficial use facility involve adding truck traffic associated with the project to public roadways. Therefore, a traffic impact analysis is required to determine any potential significant impacts to the existing public roadway network or projected traffic operations. The purpose of this memorandum is to summarize the traffic impact analysis performed by AECOM on behalf of Dominion for review by the Virginia Department of Transportation and Chesterfield County.

Study Area

The study area was determined to include any intersection involving public roadways that would be impacted by the CCR haul truck routing. The proposed route between the FFCP and the ponds to the southeast involves trucks departing from the FFCP and accessing Coxendale Road at its intersection with the Dominion Entrance. Truck traffic will continue along Coxendale Road by turning left at its intersection with Old Stage Road south of the Dominion Entrance. Truck traffic will follow Coxendale Road until reaching Henricus Park Road to the east, then turn right and follow Henricus Park Road to the southeast corner of the Lower Ash Pond for truck access to the haul roads for the Upper and Lower Ash Ponds. After loading CCR for transport in the Upper and Lower Ash Ponds, truck traffic will converge at the haul road from the Lower Ash Pond onto Henricus Park Road. Loaded trucks will continue north on Henricus Park Road until its intersection with Coxendale Road, turning left and heading west to follow the same route used to access the ponds in reverse towards the FFCP. Traffic associated with a beneficial use facility is anticipated to follow a similar, but shorter pattern as described above from the ponds.

In total, five intersections involving public roadways will be impacted by the proposed CCR hauling operation. These intersections are as follows, and are shown below in **Figure 1**:

1. Dominion Entrance at Coxendale Road
2. Coxendale Road at Old Stage Road
3. Coxendale Road at Existing Lower Ash Pond Entrance and Beneficial Use facility
4. Henricus Park Road at Coxendale Road
5. Henricus Park Road at Proposed Lower Ash Pond Entrance

Figure 1 – Traffic Impact Analysis Study Area



Existing Conditions

The primary roadway utilized for the CCR truck hauling route is Coxendale Road, which is a two-lane roadway in the study area with soft shoulders. The posted speed limit is 35 miles per hour. Henricus Park Road will also comprise part of the truck circulation route, which is currently a two-lane roadway with soft shoulders and a posted speed limit of 25 miles per hour. Dominion is proposing improvements to Henricus Park Road before CCR hauling operations begin in order to support the truck traffic, which includes widening and paved shoulders. All study intersections are three-way unsignalized intersections with the minor approaches controlled by stop sign. The includes the proposed Henricus Park Road intersection with a new Lower and Upper Ash Pond Entrance as the westbound approach to the intersection across from the 90-degree right turn on the Henricus Park Road eastbound approach.

Peak hour traffic data is utilized as a basis of traffic operations analysis for traffic impact studies such as this. A previous traffic study was performed by consulting firm JMT for a different operation in 2015. Traffic data was collected at three of the study area intersections during the AM and PM peak periods, which was utilized to represent existing conditions peak hour traffic data for this study. The JMT study determined that no traffic volume growth had occurred on Coxendale Road in the study area according to the Average Annual Daily Traffic (AADT) data published by the VDOT Count Program over the five years prior to the 2015 study. This methodology was expanded to include the most recent AADT data published through 2018 in order to determine if growth in the study area occurred that might indicate a need for updated turning movement count data at the study intersections. As shown below in **Table 1**, traffic volume data is still lower in the study area than it was in 2010. The published data has shown a net decrease over time, with a factored count published in 2018 remaining below 2010 levels despite defying the decreasing trend.

Table 1 – Average Annual Daily Traffic Summary

Year	Average Annual Daily Traffic	Percent Trucks and Buses
2010	1300	10%
2011	1300	10%
2012	1100	9%
2013	1000	9%
2014	1100	9%
2015	990	9%
2016	930	9%
2017	910	9%
2018	1200	12%

Data obtained from: https://www.virginiadot.org/info/ct-TrafficCounts.asp

Considering there has been no growth in traffic volumes in the study area over the last nine years of published count data, it was determined that using the 2015 turning movement count data would be satisfactory as a basis for determining the impacts of proposed truck traffic on the study area roadway network. The counts indicated that the AM peak hour was from 6:15 to 7:15 AM and the PM peak was from 3:30 to 4:30 PM.

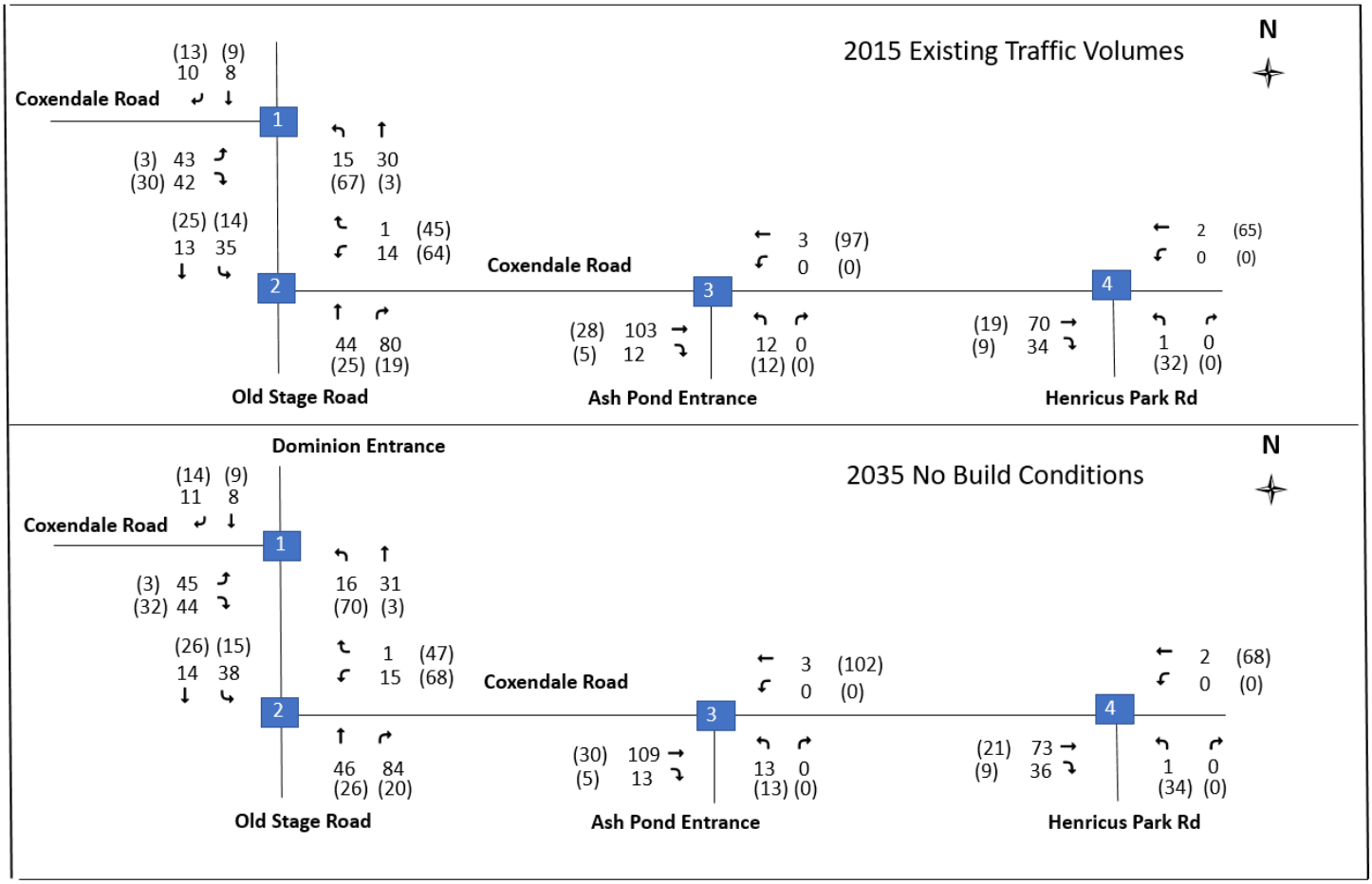
Future Conditions

In order to determine future traffic volumes for use in operations analysis, background growth must be projected. Based on the information in Table 1 that demonstrated no growth in approximately a decade, the conservative assumption from the 2015 JMT study to add 5% total background growth to existing conditions volumes was also employed for this study. The JMT study did not include the Henricus Park Road intersection with Coxendale Road in the study area, so peak hour turning movement counts were not available. However, the segment volumes on Coxendale Road at this location are known from the previous count data. To project Henricus Park Road turning movements, a conservative estimate of one-third of Coxendale Road traffic west of the Ash Pond Entrance was projected to originate from or be destined to Henricus Park Road, even though this minor roadway only serves a small park facility to the south of the study area as opposed to the heavier Dominion development and a boat ramp to the east on Coxendale Road. This is a conservative estimate for an operations analysis as it would involve more traffic on Henricus Park Road sharing a stop-controlled left-turning movement with the projected truck traffic to generate a worst-case scenario for delay and Level of Service projections.

It is projected that all hauling activities and associated truck traffic will be completed by 2035. This 5% additional growth was added to the existing conditions peak hour turning movement count data to generate projected 2035 'No-Build' (no truck traffic associated with CCR haul operations) traffic volumes for use in

operations analysis. The operations for existing and No-Build conditions will be compared to Build condition (with trucks) projected volumes to determine if the Dominion CCR haul operations have a significant impact on traffic operations in the study area. The projected AM and PM peak hour volumes for existing conditions and 2035 No-Build are shown in **Figure 2** with PM volumes in parentheses, or: 'AM (PM)'.

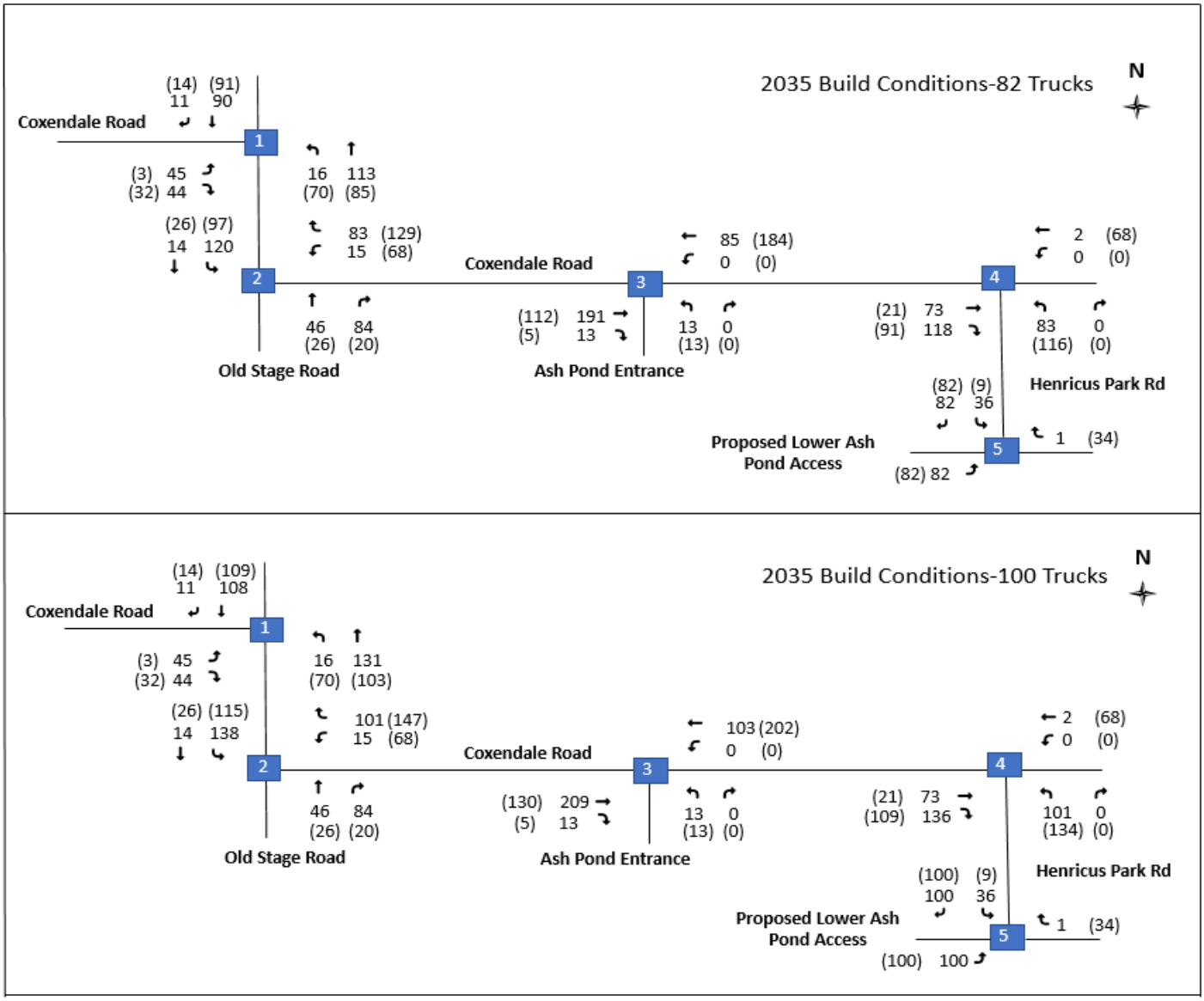
Figure 2 – Peak Hour Turning Movement Counts for Existing and 2035 No-Build Analysis



The anticipated haul truck frequency for each operation that will occur at differing intervals between existing conditions and the projected 2035 completion date is scheduled to vary depending on active projects in the study area. The year 2025 and half of 2026 when trucking operations are expected to be the most active is projected as follows: 30 trucks per hour hauling CCR from the ponds to the FFCP, 33 trucks per hour hauling CCR to a beneficial facility and 19 trucks per hour hauling fill material from the FFCP to the ponds. Therefore, an hourly truck loading of 82 trucks per hour is projected. To be conservative, this level of truck traffic will be analyzed with the full 5% background growth projection by 2035.

Two future traffic operations scenarios were analyzed for this study in order to account for the expected peak of truck traffic and also account for all of the anticipated background traffic growth: a projected 2035 analysis with the projection of 82 trucks per hour circulating within the study area, and also a conservative projected 2035 analysis with 100 trucks circulating to serve as a maximum loading and to determine how close the Dominion operations may be to negatively impacting traffic operations in the study area, if at all. The trucks were distributed to the network along the route as previously discussed and added to 2035 No-Build volumes to generate 2035 Build condition volumes for operational analysis. The two 2035 AM and PM Build condition scenario peak hour traffic volume projections are shown in **Figure 3**.

Figure 3 – Peak Hour Turning Movement Counts for 2035 Build Analysis



Traffic Operations Analysis

Traffic operations analysis was performed for the scenarios described previously using Synchro software for the five study area intersections. A base network was built in Synchro using existing roadway geometry that included inputs for lane configuration, stop control, design speed and lane width. In addition to inputting the traffic volumes for each analysis scenario, additional factors such as heavy vehicle percentage and peak hour factor were input. The existing conditions heavy vehicle percentages were based on the 8% heavy vehicle percentage recorded in a count from the 2015 JMT study, and these values were updated in each scenario based on the changes in truck traffic for each Build condition analyzed. The peak hour factor for each turning movement was assumed to be 0.92 to match the JMT study, which did not publish the count data or actual peak hour factors.

For each analysis scenario, Synchro generated projections for delays and Levels of Service (LOS). The LOS is a qualitative representation of factors such as flow rate, delays and driver comfort that reflect how well a facility is serving the traffic demand relative to available capacity. It is generally accepted that the threshold of

acceptable LOS for roadways and intersections is LOS C or better for rural conditions and LOS D or better for urban conditions.

All Synchro analysis results were generated and reviewed for each of the five analysis scenarios: Existing Conditions, 2035 No-Build, 2035 Build with 82 Trucks, and 2035 Build with 100 Trucks. The LOS results were reviewed and the lowest LOS for any turning movement at the study intersections is reported in **Table 2** below. With the poorest LOS being shown in Table 2, all other turning movements at each intersection are projected to be as good or better than the reported lowest LOS.

Table 2 – Traffic Operations Analysis Results (Synchro, Unsignalized Intersections)

	2015 Existing Conditions		2035 No-Build		2035 Build with 82 Trucks		2035 Build with 100 Trucks	
	AM	PM	AM	PM	AM	PM	AM	PM
Coxendale Road / Dominion Entrance	Eastbound LOS A	Eastbound LOS A	Eastbound LOS A	Eastbound LOS A	Southbound LOS A	Southbound LOS A	Southbound LOS B	Southbound LOS B
Coxendale Road / Old Stage Road	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A
Coxendale Road / Existing Ash Pond Access	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS B	Northbound LOS B	Northbound LOS B	Northbound LOS B
Coxendale Road / Henricus Park Road	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS B	Northbound LOS B	Northbound LOS B	Northbound LOS B
Henricus Park Road / Proposed Ash Pond Access	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Eastbound LOS B	Eastbound LOS B	Eastbound LOS B	Eastbound LOS B

As shown in Table 2, all turning movements at all study area intersections are projected to operate at an acceptable LOS B or better for all analysis scenarios, including the 2035 Build condition with 100 trucks that exceeds the projected operation level of 82 circulating trucks per hour by Dominion at any point between now and 2035. There are no significant delays or queuing projected anywhere in the study area for any of the trucking scenarios modeled.

Conclusions and Recommendations

As indicated by Synchro operational analysis and as displayed in Table 2, there are no existing operational concerns in the study area under existing and 2035 No-Build conditions. All turning movements operate at LOS A under these conditions. Build condition analysis of the truck traffic scenarios indicates that all turning movements are projected to operate at an acceptable LOS B or better throughout the duration of the project until 2035 when the hauling operations are expected to be complete. For the expected operation of 82 trucks per hour, LOS B or better was maintained throughout the study area for all movements, as well as for the conservative 100 truck operations estimate.

Based on the results of operational analysis and the findings of this Traffic Impact Analysis, it is projected that the Dominion CCR haul trucking operations are not expected to have a significant impact on study area traffic operations at any point between existing and 2035 conditions for any of the anticipated circulating trucking loads. The conservative 100 truck operation is also not projected to impact operations or deteriorate any turning movement below LOS B in the study area during either peak period. Throughout most of the project schedule, it is estimated that 82 trucks per hour or less will be circulating. Therefore, no mitigation is recommended in association with the Dominion trucking operations as scheduled and anticipated.

Appendix B

Contact Water Ponds Design Calculations

Contact Water Pond Sizing 100 year, 24 hour storm event = 8.45" rainfall

Subphase*	Excavation Area (AC)	Contact Water Pond Area (AC)	Other Areas Exposed to Contact Water (AC)	Volume of Storage Required (CF)	Volume of Storage Provided (CF)**	Pond Bottom Area (SF)	Pond Top Area (SF)	Pond Depth (FT)
	4.0	2.0	2.0	98,271	241,700	71,400	87,120	3.0
	5.0	2.0	3.0	122,839	241,700	71,400	87,120	3.0
	6.0	2.0	4.0	147,407	241,700	71,400	87,120	3.0
	7.0	2.0	5.0	171,975	241,700	71,400	87,120	3.0
	8.0	2.0	6.0	196,543	241,700	71,400	87,120	3.0
	9.0	2.0	7.0	221,111	241,700	71,400	87,120	3.0
	10.0	2.0	8.0	245,678	529,955	29,100	106,100	7.2
	11.0	2.0	9.0	270,246	529,955	29,100	106,100	7.2
	12.0	2.0	10.0	294,814	529,955	29,100	106,100	7.2
	13.0	2.0	11.0	319,382	529,955	29,100	106,100	7.2
	14.0	2.0	12.0	343,950	529,955	29,100	106,100	7.2
	15.0	2.0	13.0	368,518	529,955	29,100	106,100	7.2

* The contact water pond size is based on the subphase excavation area, therefore a range of conceptual subphase excavation areas have been used to show the required size of the contact water pond.

** An existing sediment pond will be modified and used as the contact water pond for the majority of the excavation, which is substantially larger than what is required. Once the CCR below and/or around the contact water pond needs to be removed, a smaller contact water pond can be constructed due to the small excavation area. This includes excavation areas up to and including 9 acres.

Appendix C

Stormwater Calculations

STORMWATER REPORT
LOWER ASH POND (LAP) HYDROLOGIC AND HYDRAULIC STORMWATER CALCULATIONS REPORT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TABLE OF CONTENTS

Section ***Page***

1.0 INTRODUCTION AND OBJECTIVES 1
2.0 FACILITY BACKGROUND AND PROPOSED CONDITIONS 1
3.0 DESIGN CRITERIA 2
3.1 Erosion and Sediment Control 2
3.2 Stormwater Quality Management 3
3.3 Run-On and Run-Off Criteria 3
3.4 Stormwater Quantity Management 3
3.5 Floodplain Management 3
3.6 Dam Permit Requirements 4
4.0 METHODOLOGY 4
4.1 Hydrology Methods 4
4.2 Hydraulics Methods 5
5.0 DESIGN COMPLIANCE 6
5.1 Erosion and Sediment Control Compliance 6
5.2 Stormwater Quality Management Compliance 6
5.3 Run-On and Run-Off Control System Compliance 6
5.4 Stormwater Quantity Management Compliance 9
5.5 Floodplain Management Compliance 10
5.6 Dam Permit Requirements Compliance 10
6.0 REFERENCES 11

LIST OF FIGURES

Figure 1 Overall Site Aerial
Figure 2 Lower Ash Pond Stormwater Drainage Areas

LIST OF TABLES

Table 1 NOAA Atlas 14 24-Hour Rainfall Depths for Chester, Virginia, Latitude: 37.3702°, Longitude: -77.3698°
Table 2 Sediment Basin Required and Provided Volumes
Table 3 Drainage Area Peak Flows
Table 4 LAP Storage Basin Performance
Table 5 Two-Year Culvert Peak Flows and Velocities
Table 6 10-Year Stormwater Channel Peak Flows

LIST OF APPENDICES

Appendix 1 Site Hydrologic Calculations Supporting Data
Appendix 2 HydroCAD Inputs and Outputs—Post-Closure Condition
Appendix 3 Sediment Basin Design Calculations
Appendix 4 Water Quality Calculations (VRRM)
Appendix 5 HydroCAD Inputs and Outputs—Existing Condition

LIST OF ACRONYMS

BMP	Best Management Practice
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CLOMR	Conditional Letter of Map Revision
CN	Curve Number
CSWTS	Centralized Source Water Treatment System
FEMA	Federal Emergency Management Agency
FFCP	Fossil Fuel Combustion Products
FIRM	Flood Insurance Rate Map
HydroCAD	HydroCAD Stormwater Modeling Software
H&H	Hydrologic and Hydraulic
LAP	Lower Ash Pond
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
PMP	Probable Maximum Precipitation
RCP	Reinforced Concrete Pipe
SCS	Soil Conservation Service
Tc	Time of Concentration
TR	Technical Reference
UAP	Upper Ash Pond
USDA	United States Department of Agriculture
VADEQ	Virginia Department of Environmental Quality
VDCR	Virginia Department of Conservation and Recreation
VESCH	Virginia Erosion and Sediment Control Handbook
VPDES	Virginia Pollution Discharge Elimination System
VRRM	Virginia Runoff Reduction Method
VSWMR	Virginia Solid Waste Management Regulations

1.0 INTRODUCTION AND OBJECTIVES

This Hydrologic and Hydraulic (H&H) calculation package for the Chesterfield Power Station Lower Ash Pond (LAP) has been prepared on behalf of the Virginia Electric and Power Company (d/b/a Dominion Energy Virginia) by AECOM. The included calculations support closure activities at the LAP of the Chesterfield Power Station located at 500 Coxendale Road, Chester, Virginia 23836 (Figure 1).

This document and the following calculations support the Virginia Department of Environmental Quality's (VADEQ) Part B Permit Application for Solid Waste Disposal Facilities and the County of Chesterfield's Land Disturbance Permit Application. The calculations were prepared following the Virginia Solid Waste Management Regulations (VSWMR) (§9VAC20-81-470) and the Chesterfield County Environmental Engineering Reference Manual (2011). The closure plan meets the requirements of 40 CFR §257.81, which are incorporated as part of §9VAC-20-81, including §9VAC-20-81-800, the Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.

The objectives of this package are to: (1) review applicable regulations and establish the appropriate design criteria, (2) discuss the H&H methods used in this analysis, and (3) include appropriate calculations and modeling that supported stormwater design.

All vertical elevations reference the North American Vertical Datum of 1988 (NAVD88).

2.0 FACILITY BACKGROUND AND PROPOSED CONDITIONS

The LAP is located northwest of the UAP and southeast of the Chesterfield Power Station (Figure 1). It is bordered to the north by Coxendale Road, to the east by the Henricus Park Road, to the south by the Dutch Gap Conservation Area, and to the west by the James River. The LAP is located in the Federal Emergency Management Agency's (FEMA) floodplain Zone X (unshaded), which designates areas of minimal flood risk outside the 1-percent and 0.2-percent-annual-chance floodplains according to the FEMA Digital Flood Insurance Rate Maps and Flood Insurance Rate Maps (FIRM) 51041C0169D and 51041C0335D (12/18/2012). Under the existing

condition, the LAP has a perimeter dike with a top elevation of approximately 18.5 feet, separating the LAP from the James River 1-percent-annual-chance floodplain, coded Zone A.

The LAP contains approximately 2.8 million cubic yards of CCR, and the pond is approximately 111 acres in size. Currently, there is a protective liner covering the pond surface so that minimum infiltration occurs during precipitation events. Stormwater runoff in LAP stages up and overtops a spillway in the western edge of the pond to discharge offsite into the Thermal Channel leading to the James River.

The proposed LAP excavation and removal plan consists of a phased closure approach limited to areas less than 20 acres in size at any one time so that stormwater and contact water may be managed separately. The final grades range from about 10 to 22 feet NAVD88, following the Final Grading Plan within the Closure Plan - Lower Ash Pond, Issued for Construction (drawing no. 010), included in Attachment III of this Solid Waste Permit application package (2020).

The proposed design divides the LAP site down the middle into eastern and western halves with three graded stormwater channels going towards each side. Within each side, the channels are designed to route the stormwater to perimeter channels that route the runoff to five stormwater detention basins. The detention basins will be designed to function as a stormwater sediment basin during construction as an erosion and sediment control measure, and to function as a stormwater detention pond to manage post-closure runoff discharge once the LAP is closed. The detention basins each discharge offsite via an outlet and an emergency spillway.

3.0 DESIGN CRITERIA

3.1 Erosion and Sediment Control

The erosion and sediment control plan must follow the Virginia Erosion and Sediment Control Handbook (VESCH) under §9VAC25-840. The regulations determine that if drainage areas are greater than or equal to three acres, they must be controlled by a temporary sediment basin with a minimum capacity of 134 cubic yards per acre of drainage area, and the outfall must be able to maintain the structural integrity of the basin during a 25-year, 24-hour storm (§9VAC25-840-40 6b.).

3.2 Stormwater Quality Management

For development on prior developed lands disturbing greater than or equal to one acre with no net increase in impervious cover, the total phosphorus load must be reduced by at least 20% below the pre-development total phosphorus load (§9VAC25-870-63). The LAP site must show compliance following the Virginia Runoff Reduction Method (VRRM) or another equivalent method. The site may use approved Best Management Practices (BMPs) from this criteria or those listed on the Virginia Stormwater BMP Clearinghouse Website (§9VAC25-870-65).

3.3 Run-On and Run-Off Criteria

In accordance with §9VAC20-81-130, which specifies the design requirements for landfills under VSWMR, and 40 CFR §257.81, which specifies controls for CCR landfills, the run-on control system must collect and control water during the peak discharge from a 25-year, 24-hour storm, and the run-off control system must be designed and constructed to control the water volume from the 25-year, 24-hour storm.

3.4 Stormwater Quantity Management

The system must be designed to ensure there is no erosion from the two-year, 24-hour peak flow rate in manmade stormwater conveyance systems as required by the channel protection criteria (§9VAC-870-66 B1.). The system must also be designed to ensure no localized flooding from the 10-year, 24-hour peak flow rate and that the limits of analysis to comply with flood protection are met in accordance with §9VAC-870-66 C.

3.5 Floodplain Management

The site is proposed to discharge into FEMA Zone A floodplains for the James River within the watershed HUC 020802060106 (Virginia 6th-order JL06). When FEMA-regulated waterways or floodplains are on or within the vicinity of a site, the project must comply with the National Flood Insurance Program (NFIP) regulations, accounting for the base flood elevations, floodplains, and floodways.

3.6 Dam Permit Requirements

The Virginia Department of Conservation and Recreation (VDCR) Dam Safety Program regulates impounding structures 25 feet or greater in height with a maximum impounding capacity of 15 acre-feet or greater (§4VAC50-20-30). Hydraulic structures for existing impounding structures with a high hazard potential must be designed for the 0.9 probable maximum precipitation (PMP) event, which is theoretically the greatest depth of a precipitation for a given duration that is meteorologically possible.

4.0 METHODOLOGY

4.1 Hydrology Methods

HydroCAD Stormwater Modeling software (HydroCAD) (version 10.00) was used to calculate the hydrology and hydraulics for the LAP site. Design storm rainfall amounts were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Data Server (2020), as listed in Table 1. The rainfall total depths were input into HydroCAD, and the Soil Conservation Service (SCS) 24-hour, Type II curve was applied in the model for the rainfall distribution.

Table 1 NOAA Atlas 14 24-Hour Rainfall Depths for Chester, Virginia
Latitude: 37.3702, Longitude: -77.3698

Design Storm	Total Rainfall Depth (Inches)
1-Year	2.78
2-Year	3.36
10-Year	5.11
25-Year	6.31
100-Year	8.45

The United States Department of Agriculture's (USDA) SCS Technical Reference 20 (TR-20) method was used within HydroCAD to calculate the runoff. Hydrology inputs into HydroCAD included curve numbers (CNs) and times of concentration (Tc). The CNs were determined following the USDA's National Resources Conservation Service (NRCS) TR-55 (1986) guidelines, and the Tc values were determined through TR-20 within HydroCAD. To be conservative, the

post-closure condition assumed that the site would have 50-75% grass cover and soil group D, resulting in a CN of 84. Although the grass cover is expected to be greater than 50-75%, this estimate was used to size the stormwater infrastructure conservatively. For the existing condition, a CN of 98 was used, since a liner covers the site, rendering it impervious. For some of the smaller subcatchments, a Tc direct input of either six or 10 minutes was used based on the size of the basin and the length of the flow path. Six minutes is the minimum time (0.1 hours) recommended in TR-55. In the remaining basins, the flow path was measured, with the first 150 feet considered sheet flow, followed by one or two measured sections of shallow concentrated flow.

4.2 Hydraulics Methods

Hydraulic routing and calculations within HydroCAD were used to determine peak flow values, water surface elevations, and velocities, to ensure compliance with relevant stormwater criteria. The HydroCAD layout and complete input and output parameters are in Appendix 2. The Dynamic Storage-Indication method was used within HydroCAD for the reach routing and pond routing.

Reaches were used for the concrete-lined perimeter channels in the post-closure model. Dimensions, such as channel depth, side slopes, length, and inlet/outlet elevations are as indicated on the closure plan drawings (drawing nos. 010, 036, and 037) included in Attachment III of this Solid Waste Permit application package (2020).

The elevation-area storage curves for storage units were derived from the proposed grading. The outlets for the storage areas include three 18-inch, one 36-inch, three 18” x 12” elliptical, or one 48-inch RCPs. The pipe sizes, lengths, inverts, and other attributes are as indicated on the closure plan drawings (drawing no. 010) included in Attachment III of the Solid Waste Permit application package (2020). The storage units in the proposed condition also incorporate an emergency spillway that is modeled as a rectangular broad-crested weir. The invert elevation, crest length, and crest breadth are as indicated on the closure plan drawings (drawing no. 038) included in Attachment III of this Solid Waste Permit application package (2020), and HydroCAD tabulates a head-coefficient table based on the crest breadth value.

5.0 DESIGN COMPLIANCE

5.1 Erosion and Sediment Control Compliance

All conveyances have been designed to convey the 100-year, 24-hour storm (which is larger than the required 25-year, 24-hour storm), and all outlet protection and energy dissipation, following the VESCH, will provide stable outlets for this design storm.

The five stormwater sediment basins were designed to hold a minimum volume of 134 cubic yards per acre of drainage area, half of which must be wet storage. The minimum required volumes and actual volumes are listed in Table 2. All provided volumes are greater than the required volumes. The full sediment basin calculations are in Appendix 3.

Table 2 Sediment Basin Required and Provided Volumes

Basin ID	Drainage Area (ac.)	Bottom Elevation (Feet)	Riser Elevation (Feet)	Wet Storage		Total Storage	
				Volume Required (Cubic Yard)	Volume Provided (Cubic Yard	Volume Required (Cubic Yard)	Volume Provided (Cubic Yard)
East 1	10.68	9.3	12.0	716	1,232	1,431	2,022
East 2	9.76	11.5	13.2	654	721	1,308	1,654
East 3	15.64	11.2	13.0	1,048	1,716	2,096	3,028
West 1	39.33	6.3	8.8	2,635	3,376	5,270	6,335
West 2	31.84	6.0	8.0	2,133	3,109	4,267	7,906

5.2 Stormwater Quality Management Compliance

Following the VRRM, the different sites undergoing land disturbance within the Chesterfield Power Station were analyzed to determine if water quality treatment is needed. The total phosphorus load reduction requirement for the entire site is less than zero, so the water quality management requirements are met with no further action. The full stormwater quality results are included in Appendix 4.

5.3 Run-On and Run-Off Control System Compliance

Run-on and run-off control systems for the LAP site were designed to account for the temporary construction and post-closure conditions. The LAP site is topographically above the surrounding

grades in many areas before and after closure. In areas that are not above the surrounding grade in the post-closure condition, perimeter channels will be built to capture any run-on from offsite.

5.3.1 Run-Off Control Systems During Construction

The LAP excavation and removal plan consists of phases, limited to areas less than 20 acres in size at any one time, in order to effectively manage stormwater and contact water separately for run-off control. The goal of this approach is to place fill in the “clean” areas so that those areas will not require future removal. One BMP utilized will be a temporary lined contact water pond. This will be used to handle contact water to prevent CCR resaturation. All contact water will be pumped to the new CSWTS, at a maximum rate of 1,500 gallons per minute for the duration of the project. Contact water will be managed up to a 100-year storm event.

Currently, stormwater within the LAP site drains west towards a spillway with a crest elevation of about 18 feet. Under conditions that exceed the 100-year design storm event, water will be controlled by the spillway and discharged into the Thermal Channel, which drains to the James River. The existing spillway and dike will remain in place until the final phase of construction and will only be removed once new outlets are constructed.

Temporary sediment and erosion control measures will be utilized throughout all phases of closure activities. Stormwater runoff from events up to and including the 0.9 PMP event will be handled until the embankment is declassified by VDCR as an existing dam. Throughout construction, five sediment basins will be constructed, as shown in the closure plan drawings (drawing no. 012) included in Attachment III of this Solid Waste Permit application package (2020).

5.3.2 Run-Off Control Systems Post-Construction

Post-construction, the stormwater storage basins at the bottom of the drainage channels are designed to provide adequate detention volumes to hold runoff from the 100-year storm below the engineered spillways. The outlets of the storage basins are designed to adequately convey the 100-year storm event. The entire site is divided into 16 drainage areas that convey runoff to five stormwater outfalls.

The 25-year and 100-year peak discharge and stormwater volume from each drainage catchment are listed in Table 3. The total 100-year runoff stormwater volume throughout the LAP site is 58.3 acre-feet. The storage basin performance for the 25-year and 100-year, 24-hour storm events is listed in Table 4. The storage basins provide between 1,000 and 6,000 cubic yards of volume, and the peak outflow rates are reduced by 16-39% compared to the peak inflow rates, as a result of the detention.

Supporting calculations and modeling results for all stormwater management criteria are included in Appendix 2.

Table 3 Drainage Area Peak Flows

Drainage Area	Curve Number	Time of Concentration (min)	Size (Acres)	25-Year Storm		100-Year Storm	
				Peak Flow (cfs)	Water Volume (acre-feet)	Peak Flow (cfs)	Water Volume (acre-feet)
East 1	84	19.9	8.090	39.88	3.025	57.10	4.401
East 2	84	19.5	9.110	45.48	3.407	65.12	4.956
East 3	84	19.5	8.380	41.83	3.134	59.90	4.559
East 4	84	18.4	3.750	19.27	1.402	27.58	2.040
East 5	84	10.0	1.110	7.43	0.415	10.58	0.604
East 6	84	10.0	1.480	9.90	0.553	14.11	0.805
East 7	84	6.0	0.650	4.98	0.243	7.07	0.354
East 8	84	10.0	3.510	23.49	1.313	33.47	1.909
West 1	84	35.3	9.130	31.70	3.414	45.60	4.967
West 2	84	40.3	24.910	78.99	9.315	113.58	13.551
West 3	84	40.2	24.990	79.59	9.345	114.38	13.595
West 4	84	32.8	2.770	10.10	1.036	14.50	1.507
West 5	84	10.0	3.650	24.42	1.365	34.80	1.986
West 6	84	6.0	1.640	12.56	0.613	17.84	0.892
West 7	84	6.0	1.490	11.41	0.557	16.21	0.811
West 8	84	6.0	2.590	19.83	0.969	28.18	1.409

Table 4 LAP Storage Basin Performance

Basin ID	Drainage Area (ac.)	Berm Top Elev. (NAVD88 Feet)	25-Year							
			Q In (cfs)	Q Out (cfs)	Storm Elevation (NAVD88 ft)	Freeboard (ft)	Q In (cfs)	Q Out (cfs)	Storm Elevation (NAVD88 ft)	Freeboard (ft)
East 1	10.68	15.00	49.35	38.54	12.47	2.53	71.22	47.10	13.29	1.71
East 2	9.76	15.50	46.71	39.20	13.89	1.16	66.86	43.38	15.02	0.03
East 3	15.64	15.50	76.25	55.56	14.32	1.18	109.63	66.74	15.23	0.27
West 1	39.33	11.25	115.92	87.76	10.41	0.84	166.62	103.50	11.23	0.02
West 2	31.84	11.00	92.89	77.83	9.81	1.19	133.34	98.69	10.66	0.34

5.4 Stormwater Quantity Management Compliance

Since the post-closure stormwater conveyance has been sized for the 100-year, 24-hour design storm, the design satisfies the two-year and 10-year design criteria in the Virginia Stormwater Management Program and Chesterfield County regulations (2011). Since the channels are concrete-lined, erosion is not expected. At the downstream ends of the culverts draining the detention basins, Class 1 riprap will be used as classified by the Virginia Department of Transportation to dissipate any erosive velocities. The maximum two-year velocities in the culverts are listed in Table 5 and the 10-year stormwater channels peak flows are listed in Table 6. Additionally, since the culverts from the storage areas take stormwater offsite to an area within the base flood elevation of the James River (Zone A), the limits of analysis criteria are satisfied.

Table 5 Two-Year Culvert Peak Flows and Velocities

Channel ID	Q_2 (cfs)	V_2 (ft/s)
East 1	17.56	5.35
East 2	18.75	3.64
East 3	28.09	4.17
West 1	41.10	7.28
West 2	34.60	6.90

Table 6 10-Year Stormwater Channel Peak Flows

Channel ID	Q_{10} (cfs)	Avg. Depth at Peak Storage (ft)	Total Depth (ft)
East 1	33.97	0.72	3.00
East 2	30.96	0.68	3.00
East 3	29.37	0.60	3.00
West 1	28.22	0.54	3.00
West 2	8.70	0.39	3.00
West 3	7.98	0.36	3.00
West 4	16.09	0.41	3.00

The complete HydroCAD stormwater quantity modeling inputs and results are included in Appendix 2.

5.5 Floodplain Management Compliance

A hydraulic analysis is being conducted simultaneously to determine the potential project impacts on the James River and its floodplains. A Conditional Letter of Map Revision (CLOMR) will be prepared if an impact is identified.

5.6 Dam Permit Requirements Compliance

In the post-closure condition, the existing LAP dike, which is considered a dam by the VDCR, will be decommissioned. Prior to the dam decommissioning, the design criteria for the existing facility is that the hydraulic structures be designed for the 0.9 PMP event. The existing dike will be left in place as long as possible throughout the LAP closure process.

The maximum modeled water surface elevation in the existing condition during the 6-hour, 0.9 PMP storm is 14.52 feet, which is well below the height of the dike at 18.5 feet. The full existing HydroCAD results for the 0.9 PMP storm are included in Appendix 5.

6.0 REFERENCES

Chesterfield County Department of Environmental Engineering. 2011. Environmental Engineering Reference Manual. Retrieved from: https://www.chesterfield.gov/DocumentCenter/View/393/Environmental-Engineering-Reference-Manual-PDF?bidId=.March

Dominion Energy. 2020. Dominion Energy Chesterfield Power Station Closure Plan – Upper Ash Pond: Issued for Construction. Prepared by AECOM. March.

FEMA. 2012. FIRM 51041C0335D and 51041C0351D. Effective Date: December 18, 2012.

USDA NRCS. 1986. Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds. June.

Figures

REYMENT FFCP LANDFIILL

CHESTERFIELD POWER STATION

TANKS HAVE BEEN REMOVED

COXENDALE ROAD

INTERSTATE 95

CENTRALIZED SOURCE WATER TREATMENT SYSTEM (CSWTS)

LOWER ASH POND (LAP)

UPPER ASH POND (UAP)

HENRICUS PARK ROAD

DUTCH GAP CONSERVATION AREA (AIKEN SWAMP)

HENRICUS PARK

JAMES RIVER

JAMES RIVER

JAMES RIVER

JAMES RIVER

JAMES RIVER

LEGEND

- CCR POND BOUNDARY (APPROXIMATE)
- 50 PROPERTY BOUNDARY
- TWO-WAY CONSTRUCTION TRAFFIC
- RAILROAD

NOTES

1. BASIS OF BEARINGS: NAD83, VIRGINIA STATE PLANE, SOUTH ZONE.
2. SITE ADDRESS: 500 COXENDALE ROAD, CHESTER, CHESTERFIELD COUNTY, VIRGINIA

N

0 1,200 2,400 3,600

GRAPHIC SCALE (IN FEET)

AECOM

TITLE

OVERALL SITE AERIAL

CHESTERFIELD POWER STATION
CLOSURE PLAN - **LOWER** ASH POND
CHESTERFIELD COUNTY, VIRGINIA

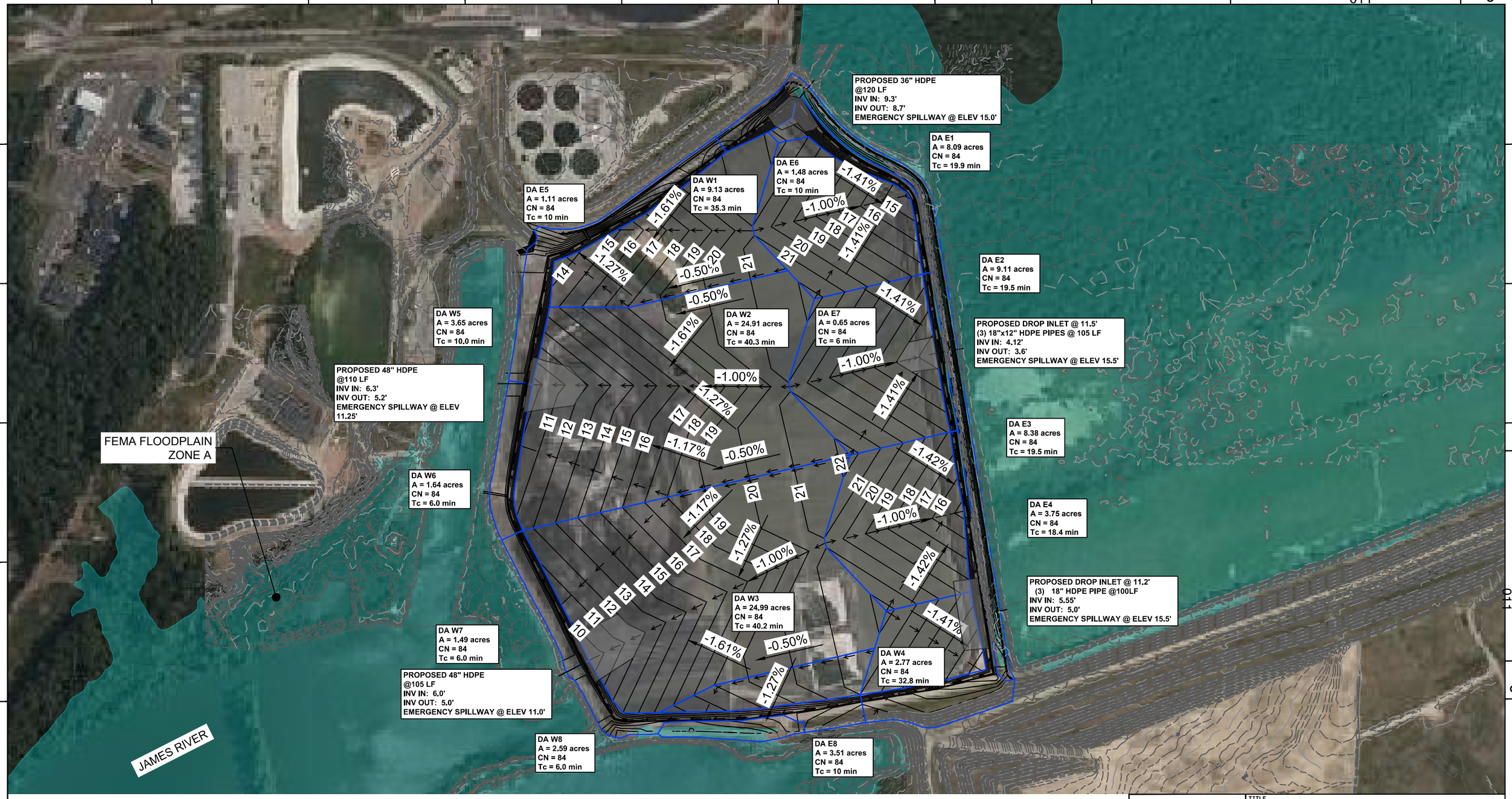
FOR

PERMITTING

SEAL

SCALE: 1"=1,200'	DES: MSR
DWG TYPE: .DWG	DFTR: JBM
JOB NO: 60614683	CHKD: RJB
DATE: 06-17-2020	ENGR: GWL
FILENAME: EXISTING CONDITION PLAN WITH AERIAL.DWG	APPD: GWL
DWG SIZE: ANSI B 11.0"x17.0"	FIGURE NO.1
REVISION: 0	EXISTING CONDITIONS

0 INCHES 1 2 3 TENTHS 10 20 30



LEGEND

- PROPOSED MAJOR TOPOGRAPHIC CONTOUR (10)
- PROPOSED MINOR TOPOGRAPHIC CONTOUR (8)
- DRAINAGE BASIN
- FEMA FLOODPLAIN ZONE A
- SEDIMENT BASIN

NOTES

1. BASIS OF BEARINGS: NAD83, VIRGINIA STATE PLANE, SOUTH ZONE. ELEVATIONS ARE BASED ON NAVD88.

N

0 400 800 1,200
GRAPHIC SCALE (IN FEET)

AECOM

TITLE
LOWER ASH POND STORMWATER DRAINAGE AREAS
CHESTERFIELD POWER STATION
CLOSURE PLAN - **LOWER** ASH POND
CHESTERFIELD COUNTY, VIRGINIA

FOR
PERMITTING

SEAL

SCALE: 1"=300'	DES: MSR
DWG TYPE: .DWG	DFTR: JBM
JOB NO: 60614683	CHKD: RJB
DATE: 06-17-2020	ENGR: GWL
FILENAME: DRAINAGE AREA MAP LAP-JUNE2020.DWG	APPD: GWL
DWG SIZE: ANSI B 11.0"x17.0"	FIGURE NO. 2 — REVISION: 0

LAP DRAINAGE AREAS

0 INCHES 1 2 3 TENTHS 10 20 30

Appendices

Calculations

Appendix 1

Site Hydrologic Calculations Supporting Data

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Chesterfield County, Virginia, and Henrico County, Virginia



March 30, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....6
Soil Map.....9
Soil Map.....10
Legend.....11
Map Unit Legend.....13
Map Unit Descriptions.....15
Chesterfield County, Virginia.....17
1A—Fluvaquents.....17
3A—Fluvaquents, ponded.....17
8B—Tetotum fine sandy loam, ponded.....18
15—Made land.....19
17B—Gritney fine sandy loam, 2 to 6 percent slopes.....20
17C—Gritney fine sandy loam, 6 to 12 percent slopes.....21
21B—Atlee silt loam, 0 to 4 percent slopes.....22
26B—Toccoa fine sandy loam, 0 to 4 percent slopes.....23
28—Chewacla loam.....24
30B—Lenoir silt loam, 0 to 4 percent slopes.....25
31—Chastain loam.....26
33B—Coxville loam, 2 to 6 percent slopes.....27
37—Forestdale silt loam.....28
41B—Craven fine sandy loam, 2 to 6 percent slopes.....29
49B—Bourne fine sandy loam, 2 to 6 percent slopes.....30
51B—Pamunkey loam, 0 to 6 percent slopes.....31
67B—Lenoir loam, flooded, 0 to 4 percent slopes.....32
68B—Dogue loam, variant, 0 to 4 percent slopes.....33
70B—Norfolk fine sandy loam, 0 to 6 percent slopes.....34
71B—Buncombe loamy fine sand, 0 to 4 percent slopes.....35
80B—Colfax fine sandy loam, variant, 0 to 4 percent slopes.....36
82B—Kempsville-Bourne complex, 2 to 6 percent slopes.....37
92B—Rumford loamy fine sand, 2 to 6 percent slopes.....39
100—Hydraquents.....40
112B—Orangeburg-Faceville sandy loams, 2 to 6 percent slopes.....41
157B—Faceville-Gritney fine sandy loams, 2 to 6 percent slopes.....42
158B—Tetotum loam, clayey substratum, 2 to 6 percent slopes.....44
169B—Bourne sandy loam, 2 to 6 percent slopes.....45
172D—Nevarc-Remlik complex, 6 to 12 percent slopes.....46
172E—Nevarc-Remlik complex, 12 to 20 percent slopes.....47
172F—Nevarc-Remlik complex, 20 to 35 percent slopes.....49
188—Dunbar fine sandy loam, 0 to 4 percent slopes.....50
191—Myatt loam, 0 to 2 percent slopes, rarely flooded.....51
212B—Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes.....52
244B—Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes.....54
W—Water.....55

Henrico County, Virginia....56
AgA—Angie loam, 0 to 2 percent slopes....56
Ak—Angie loam, concretionary subsoil variant....56
Ch—Chewacla silt loam....57
FL—Fluvaquents....58
Le—Lenoir silt loam....59
OUF—Nevarc-Remlik complex, 15 to 50 percent slopes....60
PmA—Pamunkey fine sandy loam, 0 to 2 percent slopes....62
PmB—Pamunkey fine sandy loam, 2 to 6 percent slopes....63
PmD—Pamunkey fine sandy loam, 6 to 15 percent slopes....64
Ro—Roanoke silt loam....65
To—Toccoa fine sandy loam....66
UE—Udorthents, loamy....67
W—Water....67
Soil Information for All Uses....69
Soil Properties and Qualities....69
Soil Qualities and Features....69
Hydrologic Soil Group....69
References....77

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

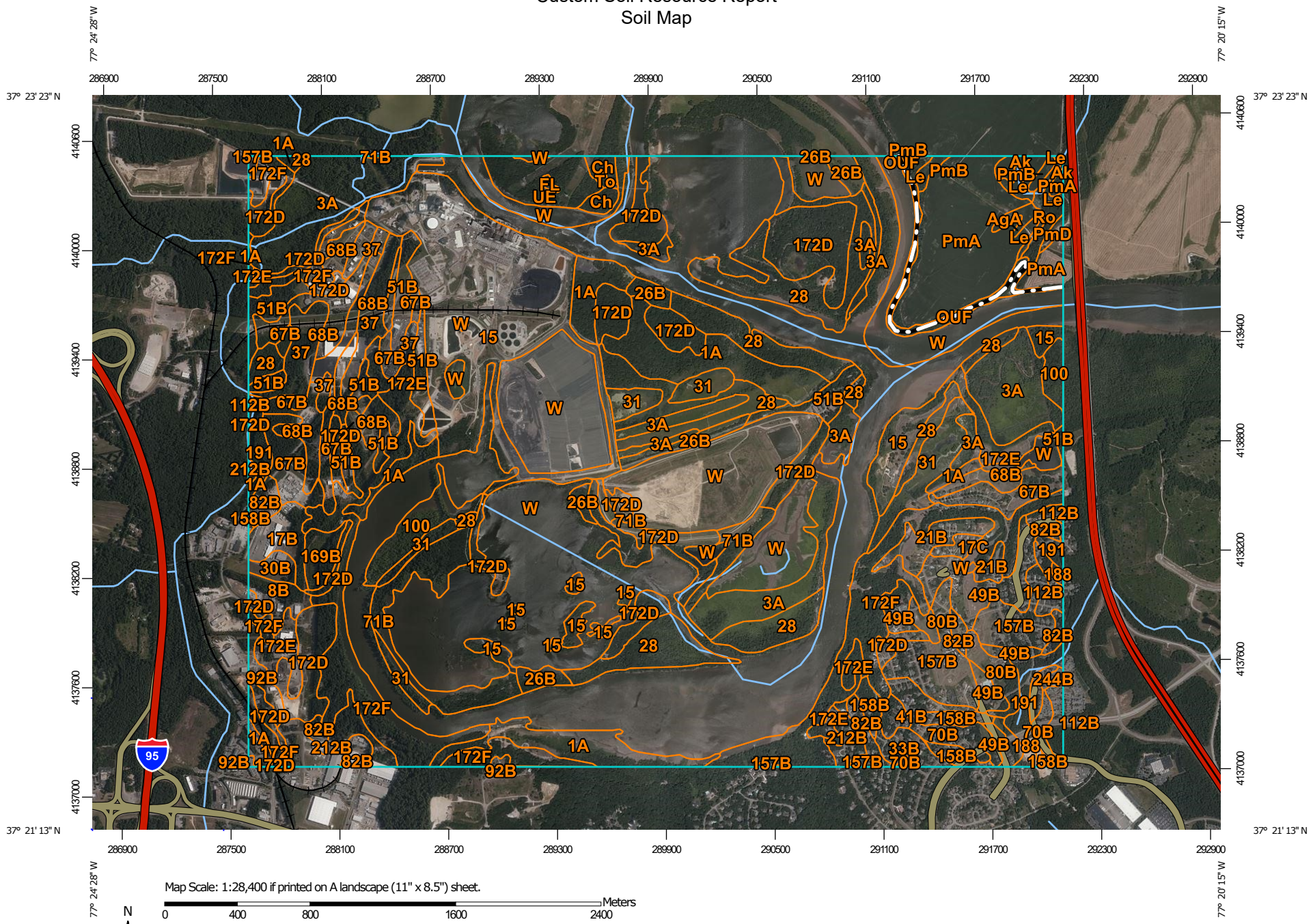
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Chesterfield County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Soil Survey Area: Henrico County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 1, 2019—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1A	Fluvaquents	140.1	3.7%
3A	Fluvaquents, ponded	211.9	5.7%
8B	Tetotum fine sandy loam, ponded	14.2	0.4%
15	Made land	298.5	8.0%
17B	Gritney fine sandy loam, 2 to 6 percent slopes	20.8	0.6%
17C	Gritney fine sandy loam, 6 to 12 percent slopes	5.3	0.1%
21B	Atlee silt loam, 0 to 4 percent slopes	24.1	0.6%
26B	Toccoa fine sandy loam, 0 to 4 percent slopes	38.4	1.0%
28	Chewacla loam	212.6	5.7%
30B	Lenoir silt loam, 0 to 4 percent slopes	8.0	0.2%
31	Chastain loam	62.5	1.7%
33B	Coxville loam, 2 to 6 percent slopes	13.1	0.4%
37	Forestdale silt loam	59.4	1.6%
41B	Craven fine sandy loam, 2 to 6 percent slopes	6.6	0.2%
49B	Bourne fine sandy loam, 2 to 6 percent slopes	67.4	1.8%
51B	Pamunkey loam, 0 to 6 percent slopes	89.9	2.4%
67B	Lenoir loam, flooded, 0 to 4 percent slopes	60.8	1.6%
68B	Dogue loam, variant, 0 to 4 percent slopes	79.2	2.1%
70B	Norfolk fine sandy loam, 0 to 6 percent slopes	30.5	0.8%
71B	Buncombe loamy fine sand, 0 to 4 percent slopes	62.4	1.7%
80B	Colfax fine sandy loam, variant, 0 to 4 percent slopes	19.3	0.5%
82B	Kempsville-Bourne complex, 2 to 6 percent slopes	35.6	1.0%
92B	Rumford loamy fine sand, 2 to 6 percent slopes	10.8	0.3%
100	Hydraquents	34.5	0.9%
112B	Orangeburg-Faceville sandy loams, 2 to 6 percent slopes	16.2	0.4%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
157B	Faceville-Gritney fine sandy loams, 2 to 6 percent slopes	66.2	1.8%
158B	Tetotum loam, clayey substratum, 2 to 6 percent slopes	20.2	0.5%
169B	Bourne sandy loam, 2 to 6 percent slopes	13.2	0.4%
172D	Nevarc-Remlik complex, 6 to 12 percent slopes	221.0	5.9%
172E	Nevarc-Remlik complex, 12 to 20 percent slopes	43.0	1.2%
172F	Nevarc-Remlik complex, 20 to 35 percent slopes	245.8	6.6%
188	Dunbar fine sandy loam, 0 to 4 percent slopes	7.9	0.2%
191	Myatt loam, 0 to 2 percent slopes, rarely flooded	28.5	0.8%
212B	Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes	38.3	1.0%
244B	Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes	2.4	0.1%
W	Water	1,119.1	30.0%
Subtotals for Soil Survey Area		**3,427.5**	**91.8%**
Totals for Area of Interest		**3,735.7**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AgA	Angie loam, 0 to 2 percent slopes	4.8	0.1%
Ak	Angie loam, concretionary subsoil variant	7.7	0.2%
Ch	Chewacla silt loam	9.8	0.3%
FL	Fluvaquents	1.2	0.0%
Le	Lenoir silt loam	10.4	0.3%
OUF	Nevarc-Remlik complex, 15 to 50 percent slopes	18.5	0.5%
PmA	Pamunkey fine sandy loam, 0 to 2 percent slopes	123.0	3.3%
PmB	Pamunkey fine sandy loam, 2 to 6 percent slopes	6.7	0.2%
PmD	Pamunkey fine sandy loam, 6 to 15 percent slopes	2.3	0.1%
Ro	Roanoke silt loam	9.7	0.3%
To	Toccoa fine sandy loam	1.4	0.0%
UE	Udorthents, loamy	33.8	0.9%
W	Water	78.9	2.1%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Subtotals for Soil Survey Area		**308.2**	**8.2%**
Totals for Area of Interest		**3,735.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Chesterfield County, Virginia

1A—Fluvaquents

Map Unit Setting

National map unit symbol: 3zp3
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Fluvaquents and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 40 inches: silty clay loam
H3 - 40 to 50 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

3A—Fluvaquents, ponded

Map Unit Setting

National map unit symbol: 3zqh
Elevation: 10 to 350 feet

Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition
Fluvaquents, ponded and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents, Ponded

Setting
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile
H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 50 inches: clay
H3 - 50 to 72 inches: very gravelly sandy clay loam

Properties and qualities
Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

8B—Tetotum fine sandy loam, ponded

Map Unit Setting
National map unit symbol: 3zrp
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Tetotum and similar soils: 85 percent
Minor components: 3 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tetotum

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 54 inches: clay loam
H3 - 54 to 70 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

15—Made land

Map Unit Setting

National map unit symbol: 3zn9
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Made land: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

17B—Gritney fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3znz
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Gritney and similar soils: 85 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gritney

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 52 inches: clay
H3 - 52 to 85 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

17C—Gritney fine sandy loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 3zp0
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Gritney and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gritney

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 52 inches: clay
H3 - 52 to 85 inches: sandy loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Hydric soil rating: No

21B—Atlee silt loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zpk
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Atlee and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Atlee

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: silt loam
H2 - 11 to 20 inches: loam
H3 - 20 to 36 inches: clay loam
H4 - 36 to 72 inches: clay loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions

Hydric soil rating: Yes

26B—Toccoa fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zpz
Elevation: 470 to 1,500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Toccoa and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Toccoa

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 15 inches: fine sandy loam
H2 - 15 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 36 to 60 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A
Hydric soil rating: No

28—Chewacla loam

Map Unit Setting

National map unit symbol: 3zq0
Elevation: 0 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Chewacla and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chewacla

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 5 inches: loam
H2 - 5 to 13 inches: clay loam
H3 - 13 to 26 inches: sandy clay loam
H4 - 26 to 40 inches: clay loam
H5 - 40 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B/D
Hydric soil rating: No

Minor Components

Fluvaquents
Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Hydraquents
Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

Chastain
Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

30B—Lenoir silt loam, 0 to 4 percent slopes

Map Unit Setting
National map unit symbol: 3zq5
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Lenoir and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenoir

Setting
Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loamy alluvium

Typical profile
H1 - 0 to 16 inches: silt loam
H2 - 16 to 60 inches: clay

Properties and qualities
Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

31—Chastain loam

Map Unit Setting

National map unit symbol: 3zq6
Elevation: 10 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Chastain and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chastain

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium

Typical profile

H1 - 0 to 13 inches: loam
H2 - 13 to 36 inches: clay loam
H3 - 36 to 80 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Fluvaquents

Percent of map unit: 8 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Forestdale

Percent of map unit: 7 percent
Landform: Flood plains
Hydric soil rating: Yes

33B—Coxville loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zq7
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Coxville and similar soils: 85 percent
Minor components: 6 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Coxville

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 10 inches: loam
H2 - 10 to 75 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Fluvaquents

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Pouncey

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

37—Forestdale silt loam

Map Unit Setting

National map unit symbol: 3zqc
Mean annual precipitation: 31 to 54 inches

Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition
Forestdale and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Forestdale

Setting
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium

Typical profile
H1 - 0 to 9 inches: silt loam
H2 - 9 to 43 inches: clay
H3 - 43 to 74 inches: silt loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Hydric soil rating: Yes

41B—Craven fine sandy loam, 2 to 6 percent slopes

Map Unit Setting
National map unit symbol: 3zqj
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Craven and similar soils: 85 percent
Minor components: 3 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Craven

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 15 inches: fine sandy loam
H2 - 15 to 59 inches: clay
H3 - 59 to 95 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

49B—Bourne fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zqr
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Bourne and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bourne

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 22 inches: sandy clay loam
H3 - 22 to 44 inches: fine sandy loam
H4 - 44 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: About 22 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

51B—Pamunkey loam, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zqy
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Pamunkey and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 14 inches: loam
H2 - 14 to 50 inches: clay loam
H3 - 50 to 72 inches: loamy fine sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

67B—Lenoir loam, flooded, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrd
Elevation: 10 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Lenoir and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenoir

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 16 inches: loam
H2 - 16 to 60 inches: clay

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Forestdale

Percent of map unit: 3 percent
Landform: Flood plains
Hydric soil rating: Yes

Chastain

Percent of map unit: 2 percent
Landform: Flood plains
Hydric soil rating: Yes

68B—Dogue loam, variant, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrf
Elevation: 10 to 750 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Dogue, variant, and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dogue, Variant

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey alluvium

Typical profile

H1 - 0 to 9 inches: loam
H2 - 9 to 42 inches: clay
H3 - 42 to 72 inches: loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

70B—Norfolk fine sandy loam, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zrh
Elevation: 30 to 450 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Norfolk and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Norfolk

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 31 inches: sandy clay loam
H3 - 31 to 90 inches: clay
H4 - 90 to 107 inches: sandy loam

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

71B—Buncombe loamy fine sand, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrj
Elevation: 10 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Buncombe and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Buncombe

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 9 inches: loamy fine sand

H2 - 9 to 57 inches: loamy fine sand
H3 - 57 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Chastain

Percent of map unit: 3 percent
Landform: Flood plains
Hydric soil rating: Yes

80B—Colfax fine sandy loam, variant, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrl
Elevation: 150 to 400 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Colfax, variant, and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colfax, Variant

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy granite and gneiss

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 16 inches: sandy clay loam
H3 - 16 to 21 inches: sandy clay loam
H4 - 21 to 52 inches: sandy clay loam
H5 - 52 to 73 inches: clay

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: About 21 inches to fragipan
Natural drainage class: Somewhat poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

Pouncey

Percent of map unit: 2 percent
Landform: Depressions
Hydric soil rating: Yes

82B—Kempsville-Bourne complex, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zrm
Elevation: 100 to 400 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Kempsville and similar soils: 45 percent
Bourne and similar soils: 40 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kempsville

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 19 inches: sandy loam
H2 - 19 to 37 inches: sandy clay loam
H3 - 37 to 65 inches: sandy clay
H4 - 65 to 150 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Bourne

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 22 inches: sandy clay loam
H3 - 22 to 44 inches: fine sandy loam
H4 - 44 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: About 22 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

92B—Rumford loamy fine sand, 2 to 6 percent slopes

Map Unit Setting
National map unit symbol: 3zrq
Elevation: 80 to 150 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Rumford and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rumford

Setting
Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile
H1 - 0 to 21 inches: loamy fine sand
H2 - 21 to 40 inches: fine sandy loam
H3 - 40 to 72 inches: fine sand

Properties and qualities
Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Hydric soil rating: No

100—Hydraquents

Map Unit Setting

National map unit symbol: 3zmg
Elevation: 0 to 10 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Hydraquents and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hydraquents

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 8 inches: mucky clay loam
H2 - 8 to 44 inches: silty clay
H3 - 44 to 60 inches: sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Available water storage in profile: High (about 10.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

112B—Orangeburg-Faceville sandy loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zmy
Elevation: 170 to 500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Orangeburg and similar soils: 50 percent
Faceville and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Orangeburg

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 16 inches: sandy loam
H2 - 16 to 24 inches: sandy loam
H3 - 24 to 43 inches: sandy clay loam
H4 - 43 to 72 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Faceville

Setting

Landform: Marine terraces

Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 12 inches: sandy loam
H2 - 12 to 18 inches: sandy clay loam
H3 - 18 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

157B—Faceville-Gritney fine sandy loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3znf
Elevation: 200 to 450 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Faceville and similar soils: 50 percent
Gritney and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Faceville

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 18 inches: sandy clay loam
H3 - 18 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Gritney

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 52 inches: clay
H3 - 52 to 85 inches: loamy sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

158B—Tetotum loam, clayey substratum, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zng
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Tetotum and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tetotum

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 11 inches: loam
H2 - 11 to 54 inches: clay loam
H3 - 54 to 70 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

169B—Bourne sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3znt
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Bourne and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bourne

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: sandy loam
H2 - 11 to 22 inches: sandy clay loam
H3 - 22 to 44 inches: fine sandy loam
H4 - 44 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: About 22 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

172D—Nevarc-Remlik complex, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2y7k2
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F
Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Hydric soil rating: No

172E—Nevarc-Remlik complex, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2y7k3
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F
Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Hydric soil rating: No

172F—Nevarc-Remlik complex, 20 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2y7k4
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F
Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

188—Dunbar fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zp1
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Dunbar and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dunbar

Setting

Landform: Marine terraces

Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 20 inches: sandy clay loam
H3 - 20 to 72 inches: clay

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

Pouncey

Percent of map unit: 2 percent
Landform: Depressions
Hydric soil rating: Yes

191—Myatt loam, 0 to 2 percent slopes, rarely flooded

Map Unit Setting

National map unit symbol: 2y7jv
Elevation: 500 to 1,100 feet
Mean annual precipitation: 31 to 52 inches
Mean annual air temperature: 48 to 66 degrees F
Frost-free period: 210 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Myatt, rarely flooded, and similar soils: 93 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Myatt, Rarely Flooded

Setting

Landform: Depressions
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Fluviomarine deposits

Typical profile

A - 0 to 9 inches: loam
Btg - 9 to 50 inches: clay loam
Cg - 50 to 80 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

212B—Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes

Map Unit Setting

National map unit symbol: 3zph
Elevation: 170 to 500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Lucy and similar soils: 45 percent
Orangeburg and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lucy

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 26 inches: loamy sand
H2 - 26 to 60 inches: sandy clay loam
H3 - 60 to 90 inches: loamy sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Orangeburg

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 16 inches: loamy sand
H2 - 16 to 24 inches: sandy loam
H3 - 24 to 43 inches: sandy clay loam
H4 - 43 to 72 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Moderate (about 6.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

244B—Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zpm
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Edgehill and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Edgehill

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 17 inches: very gravelly fine sandy loam
H2 - 17 to 41 inches: very gravelly clay
H3 - 41 to 80 inches: very gravelly sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B

Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Properties and qualities

Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Henrico County, Virginia

AgA—Angie loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 400x
Elevation: 150 to 600 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Angie and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Angie

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 79 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: D
Hydric soil rating: No

Ak—Angie loam, concretionary subsoil variant

Map Unit Setting

National map unit symbol: 4012

Elevation: 150 to 600 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Angie, variant, and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Angie, Variant

Setting
Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile
H1 - 0 to 7 inches: loam
H2 - 7 to 30 inches: silty clay loam
H3 - 30 to 79 inches: very gravelly silty clay loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: D
Hydric soil rating: No

Ch—Chewacla silt loam

Map Unit Setting
National map unit symbol: 401r
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Chewacla and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chewacla

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 44 inches: silt loam
H3 - 44 to 79 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 11.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C
Hydric soil rating: Yes

FL—Fluvaquents

Map Unit Setting

National map unit symbol: 4025
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Fluvaquents and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 4 inches: loam
H2 - 4 to 52 inches: sandy clay loam
H3 - 52 to 74 inches: gravelly sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Le—Lenoir silt loam

Map Unit Setting

National map unit symbol: 402v
Elevation: 10 to 350 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Lenoir and similar soils: 85 percent
Minor components: 6 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenoir

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 79 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Roanoke

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: Yes

Coxville

Percent of map unit: 3 percent
Landform: Marine terraces, depressions
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: Yes

OUF—Nevarc-Remlik complex, 15 to 50 percent slopes

Map Unit Setting

National map unit symbol: 2y7jz
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F

Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 15 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 15 to 50 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

PmA—Pamunkey fine sandy loam, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 4039
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Pamunkey and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile
H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 57 inches: sandy clay loam
H3 - 57 to 99 inches: sandy clay loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Hydric soil rating: No

PmB—Pamunkey fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 403b
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Pamunkey and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 57 inches: sandy clay loam
H3 - 57 to 99 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

PmD—Pamunkey fine sandy loam, 6 to 15 percent slopes

Map Unit Setting

National map unit symbol: 403c
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Pamunkey and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 57 inches: sandy clay loam
H3 - 57 to 99 inches: sandy clay loam

Properties and qualities

Slope: 6 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Ro—Roanoke silt loam

Map Unit Setting

National map unit symbol: 403l
Elevation: 10 to 350 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Roanoke and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Roanoke

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 79 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.57 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

To—Toccoa fine sandy loam

Map Unit Setting

National map unit symbol: 4040
Elevation: 470 to 1,500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Toccoa and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Toccoa

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 15 inches: fine sandy loam
H2 - 15 to 79 inches: fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 36 to 60 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Chewacla

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

UE—Udorthents, loamy

Map Unit Setting

National map unit symbol: 4047
Elevation: 50 to 300 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 85 percent
Minor components: 1 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Minor Components

Kinston

Percent of map unit: 1 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

W—Water

Map Unit Setting

National map unit symbol: 4049
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days

Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

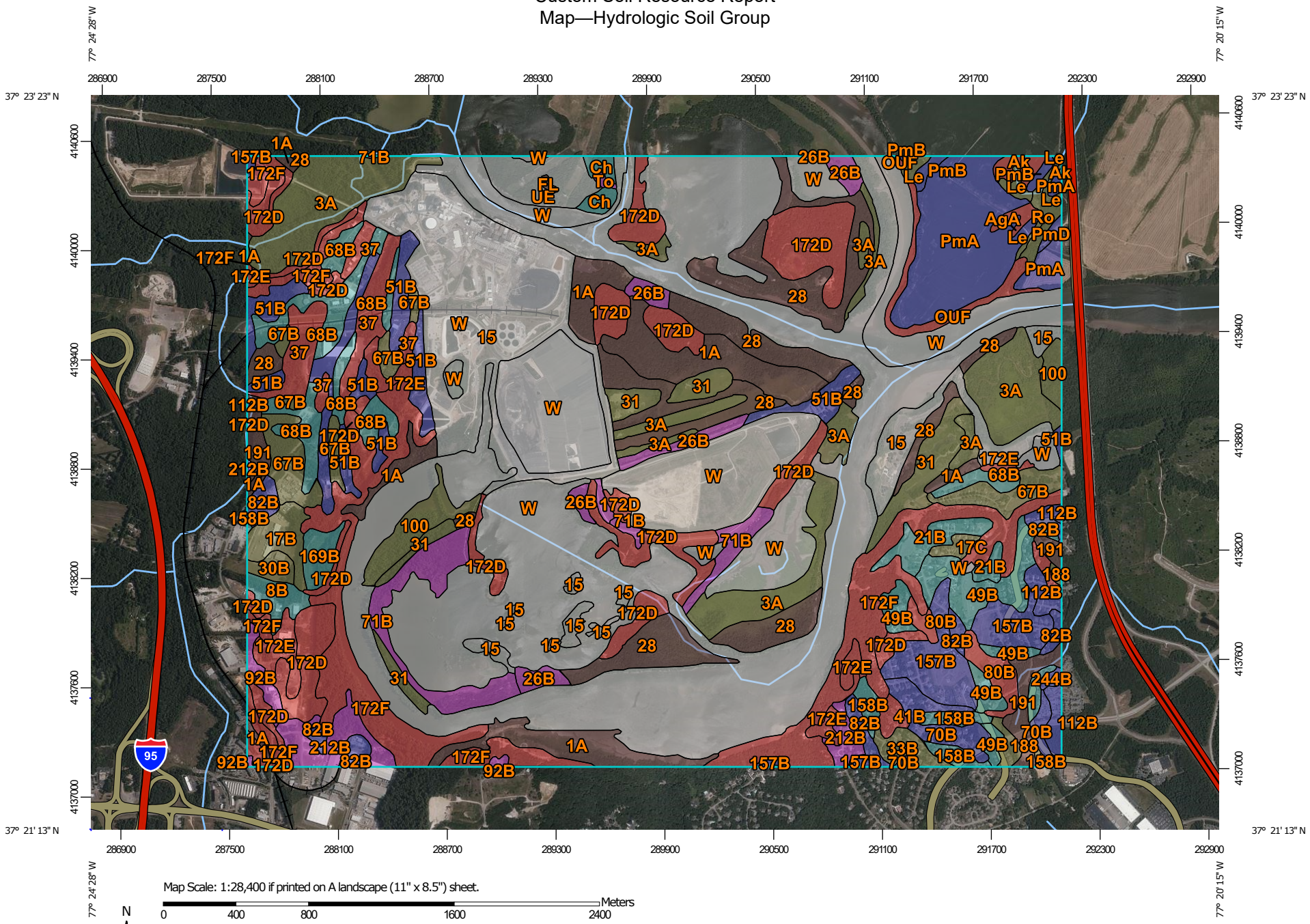
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.


77° 24' 28" W
77° 20' 15" W
37° 23' 23" N
37° 21' 13" N
286900
287500
288100
288700
289300
289900
290500
291100
291700
292300
292900
4140600
4140000
4139400
4138800
4138200
4137600
4137000
95
Map Scale: 1:28,400 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 400 800 1600 2400
Feet
0 1000 2000 4000 6000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Chesterfield County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Soil Survey Area: Henrico County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 1, 2019—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1A	Fluvaquents	B/D	140.1	3.7%
3A	Fluvaquents, ponded	C/D	211.9	5.7%
8B	Tetotum fine sandy loam, ponded	C	14.2	0.4%
15	Made land		298.5	8.0%
17B	Gritney fine sandy loam, 2 to 6 percent slopes	C/D	20.8	0.6%
17C	Gritney fine sandy loam, 6 to 12 percent slopes	C/D	5.3	0.1%
21B	Atlee silt loam, 0 to 4 percent slopes	C	24.1	0.6%
26B	Toccoa fine sandy loam, 0 to 4 percent slopes	A	38.4	1.0%
28	Chewacla loam	B/D	212.6	5.7%
30B	Lenoir silt loam, 0 to 4 percent slopes	C/D	8.0	0.2%
31	Chastain loam	C/D	62.5	1.7%
33B	Coxville loam, 2 to 6 percent slopes	C/D	13.1	0.4%
37	Forestdale silt loam	D	59.4	1.6%
41B	Craven fine sandy loam, 2 to 6 percent slopes	D	6.6	0.2%
49B	Bourne fine sandy loam, 2 to 6 percent slopes	C	67.4	1.8%
51B	Pamunkey loam, 0 to 6 percent slopes	B	89.9	2.4%
67B	Lenoir loam, flooded, 0 to 4 percent slopes	C/D	60.8	1.6%
68B	Dogue loam, variant, 0 to 4 percent slopes	C	79.2	2.1%
70B	Norfolk fine sandy loam, 0 to 6 percent slopes	B	30.5	0.8%
71B	Buncombe loamy fine sand, 0 to 4 percent slopes	A	62.4	1.7%
80B	Colfax fine sandy loam, variant, 0 to 4 percent slopes	D	19.3	0.5%
82B	Kempsville-Bourne complex, 2 to 6 percent slopes	B	35.6	1.0%
92B	Rumford loamy fine sand, 2 to 6 percent slopes	A	10.8	0.3%
100	Hydraquents	C/D	34.5	0.9%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
112B	Orangeburg-Faceville sandy loams, 2 to 6 percent slopes	B	16.2	0.4%
157B	Faceville-Gritney fine sandy loams, 2 to 6 percent slopes	B	66.2	1.8%
158B	Tetotum loam, clayey substratum, 2 to 6 percent slopes	C	20.2	0.5%
169B	Bourne sandy loam, 2 to 6 percent slopes	C	13.2	0.4%
172D	Nevarc-Remlik complex, 6 to 12 percent slopes	D	221.0	5.9%
172E	Nevarc-Remlik complex, 12 to 20 percent slopes	D	43.0	1.2%
172F	Nevarc-Remlik complex, 20 to 35 percent slopes	D	245.8	6.6%
188	Dunbar fine sandy loam, 0 to 4 percent slopes	C/D	7.9	0.2%
191	Myatt loam, 0 to 2 percent slopes, rarely flooded	B/D	28.5	0.8%
212B	Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes	A	38.3	1.0%
244B	Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes	B	2.4	0.1%
W	Water		1,119.1	30.0%
Subtotals for Soil Survey Area			**3,427.5**	**91.8%**
Totals for Area of Interest			**3,735.7**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AgA	Angie loam, 0 to 2 percent slopes	D	4.8	0.1%
Ak	Angie loam, concretionary subsoil variant	D	7.7	0.2%
Ch	Chewacla silt loam	C	9.8	0.3%
FL	Fluvaquents	B/D	1.2	0.0%
Le	Lenoir silt loam	C/D	10.4	0.3%
OUF	Nevarc-Remlik complex, 15 to 50 percent slopes	D	18.5	0.5%
PmA	Pamunkey fine sandy loam, 0 to 2 percent slopes	B	123.0	3.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
PmB	Pamunkey fine sandy loam, 2 to 6 percent slopes	B	6.7	0.2%
PmD	Pamunkey fine sandy loam, 6 to 15 percent slopes	B	2.3	0.1%
Ro	Roanoke silt loam	C/D	9.7	0.3%
To	Toccoa fine sandy loam	A	1.4	0.0%
UE	Udorthents, loamy		33.8	0.9%
W	Water		78.9	2.1%
Subtotals for Soil Survey Area			**308.2**	**8.2%**
Totals for Area of Interest			**3,735.7**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

NOAA Atlas 14, Volume 2, Version 3
Location name: Chester, Virginia, USA*
Latitude: 37.3702°, Longitude: -77.3698°
Elevation: 79.01 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.379** (0.343-0.420)	**0.449** (0.407-0.497)	**0.525** (0.475-0.581)	**0.589** (0.531-0.652)	**0.661** (0.594-0.730)	**0.716** (0.641-0.791)	**0.768** (0.684-0.848)	**0.816** (0.723-0.901)	**0.874** (0.768-0.966)	**0.920** (0.803-1.02)
10-min	**0.606** (0.548-0.672)	**0.718** (0.651-0.795)	**0.841** (0.761-0.931)	**0.942** (0.849-1.04)	**1.05** (0.946-1.16)	**1.14** (1.02-1.26)	**1.22** (1.09-1.35)	**1.29** (1.15-1.43)	**1.38** (1.22-1.53)	**1.45** (1.26-1.60)
15-min	**0.757** (0.684-0.839)	**0.902** (0.818-1.00)	**1.06** (0.962-1.18)	**1.19** (1.07-1.32)	**1.34** (1.20-1.48)	**1.45** (1.29-1.59)	**1.54** (1.37-1.70)	**1.63** (1.45-1.80)	**1.74** (1.53-1.92)	**1.82** (1.59-2.01)
30-min	**1.04** (0.938-1.15)	**1.25** (1.13-1.38)	**1.51** (1.37-1.67)	**1.73** (1.56-1.91)	**1.98** (1.78-2.19)	**2.18** (1.95-2.40)	**2.36** (2.11-2.61)	**2.54** (2.25-2.81)	**2.77** (2.43-3.06)	**2.95** (2.57-3.26)
60-min	**1.29** (1.17-1.44)	**1.56** (1.42-1.73)	**1.94** (1.75-2.15)	**2.25** (2.03-2.49)	**2.64** (2.37-2.91)	**2.95** (2.64-3.25)	**3.26** (2.90-3.60)	**3.57** (3.16-3.93)	**3.97** (3.49-4.39)	**4.30** (3.75-4.76)
2-hr	**1.54** (1.39-1.72)	**1.87** (1.68-2.07)	**2.33** (2.10-2.59)	**2.74** (2.46-3.04)	**3.27** (2.92-3.61)	**3.70** (3.29-4.10)	**4.16** (3.66-4.59)	**4.62** (4.05-5.10)	**5.27** (4.56-5.81)	**5.79** (4.98-6.40)
3-hr	**1.66** (1.49-1.86)	**2.01** (1.81-2.25)	**2.52** (2.26-2.81)	**2.96** (2.65-3.30)	**3.55** (3.15-3.94)	**4.03** (3.56-4.48)	**4.54** (3.98-5.03)	**5.06** (4.41-5.61)	**5.79** (4.99-6.42)	**6.40** (5.46-7.09)
6-hr	**2.01** (1.80-2.27)	**2.42** (2.16-2.73)	**3.03** (2.70-3.41)	**3.58** (3.18-4.02)	**4.32** (3.82-4.84)	**4.96** (4.35-5.54)	**5.63** (4.90-6.29)	**6.35** (5.48-7.08)	**7.38** (6.28-8.21)	**8.25** (6.94-9.18)
12-hr	**2.40** (2.16-2.72)	**2.90** (2.60-3.27)	**3.65** (3.26-4.12)	**4.34** (3.86-4.88)	**5.30** (4.66-5.94)	**6.14** (5.36-6.88)	**7.06** (6.09-7.87)	**8.05** (6.87-8.95)	**9.50** (7.97-10.6)	**10.8** (8.91-12.0)
24-hr	**2.78** (2.54-3.06)	**3.36** (3.08-3.71)	**4.31** (3.93-4.76)	**5.11** (4.65-5.64)	**6.31** (5.69-6.94)	**7.33** (6.57-8.05)	**8.45** (7.52-9.27)	**9.70** (8.55-10.6)	**11.6** (10.0-12.6)	**13.1** (11.3-14.4)
2-day	**3.24** (2.97-3.56)	**3.92** (3.59-4.31)	**5.00** (4.58-5.50)	**5.90** (5.38-6.48)	**7.21** (6.53-7.90)	**8.31** (7.49-9.11)	**9.51** (8.50-10.4)	**10.8** (9.59-11.9)	**12.7** (11.1-14.0)	**14.3** (12.4-15.8)
3-day	**3.42** (3.14-3.76)	**4.15** (3.81-4.55)	**5.28** (4.84-5.79)	**6.22** (5.69-6.81)	**7.59** (6.89-8.30)	**8.74** (7.89-9.56)	**9.98** (8.96-10.9)	**11.3** (10.1-12.4)	**13.3** (11.7-14.6)	**15.0** (13.0-16.5)
4-day	**3.61** (3.32-3.95)	**4.37** (4.02-4.79)	**5.56** (5.11-6.08)	**6.54** (5.99-7.15)	**7.97** (7.26-8.70)	**9.16** (8.30-10.0)	**10.5** (9.41-11.4)	**11.9** (10.6-13.0)	**13.9** (12.3-15.2)	**15.6** (13.6-17.2)
7-day	**4.17** (3.85-4.56)	**5.02** (4.63-5.49)	**6.28** (5.79-6.87)	**7.33** (6.74-8.01)	**8.83** (8.08-9.64)	**10.1** (9.18-11.0)	**11.4** (10.3-12.5)	**12.9** (11.6-14.1)	**15.0** (13.3-16.4)	**16.7** (14.7-18.3)
10-day	**4.76** (4.41-5.17)	**5.70** (5.29-6.20)	**7.06** (6.53-7.66)	**8.15** (7.53-8.85)	**9.71** (8.93-10.5)	**11.0** (10.1-11.9)	**12.3** (11.2-13.4)	**13.8** (12.4-15.0)	**15.8** (14.1-17.2)	**17.4** (15.5-19.0)
20-day	**6.41** (5.98-6.89)	**7.65** (7.14-8.21)	**9.25** (8.61-9.93)	**10.5** (9.78-11.3)	**12.2** (11.3-13.1)	**13.6** (12.6-14.6)	**15.0** (13.8-16.1)	**16.4** (15.0-17.7)	**18.4** (16.7-19.8)	**19.9** (17.9-21.5)
30-day	**7.96** (7.47-8.48)	**9.43** (8.86-10.1)	**11.2** (10.5-11.9)	**12.5** (11.7-13.3)	**14.3** (13.3-15.2)	**15.6** (14.6-16.7)	**17.0** (15.8-18.1)	**18.3** (16.9-19.6)	**20.1** (18.5-21.5)	**21.4** (19.6-22.9)
45-day	**9.99** (9.40-10.6)	**11.8** (11.1-12.5)	**13.8** (13.0-14.7)	**15.3** (14.4-16.3)	**17.3** (16.2-18.3)	**18.8** (17.5-19.9)	**20.2** (18.8-21.4)	**21.6** (20.1-22.9)	**23.3** (21.6-24.9)	**24.6** (22.7-26.3)
60-day	**11.9** (11.2-12.6)	**14.0** (13.2-14.8)	**16.2** (15.3-17.1)	**17.8** (16.8-18.8)	**19.9** (18.7-21.0)	**21.5** (20.2-22.7)	**22.9** (21.5-24.3)	**24.4** (22.8-25.8)	**26.2** (24.4-27.7)	**27.5** (25.5-29.2)

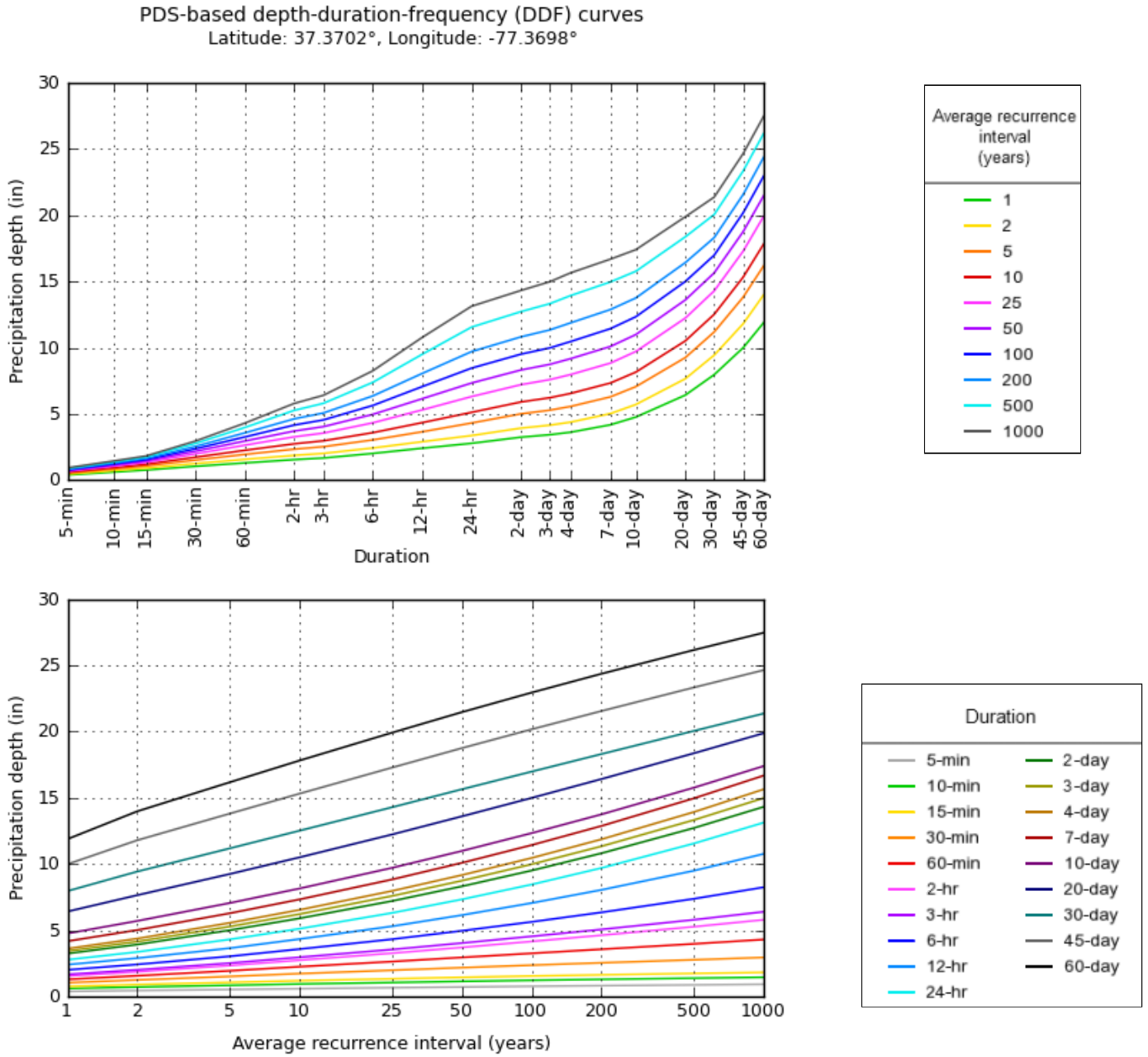
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



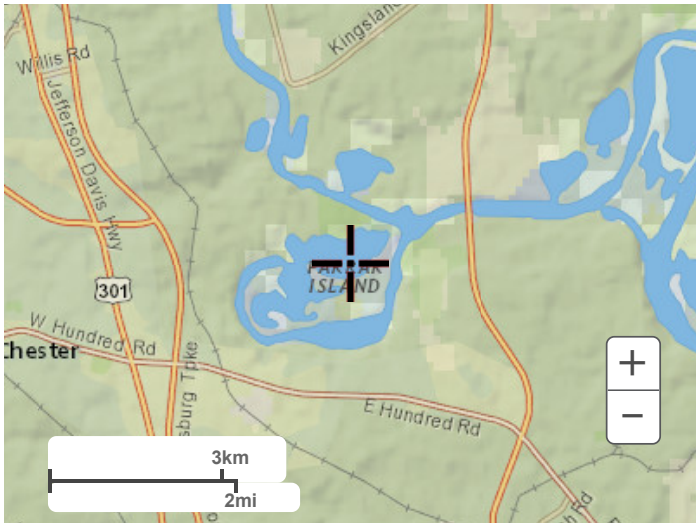
NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Mon Mar 23 16:00:51 2020

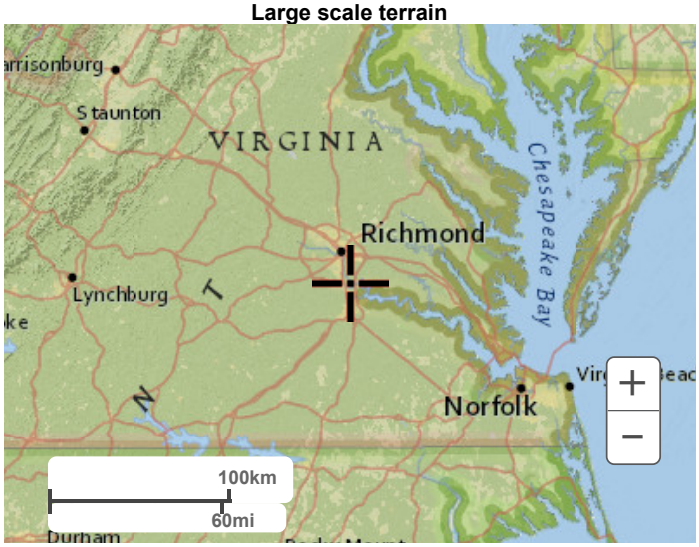
Back to Top

Maps & aerials

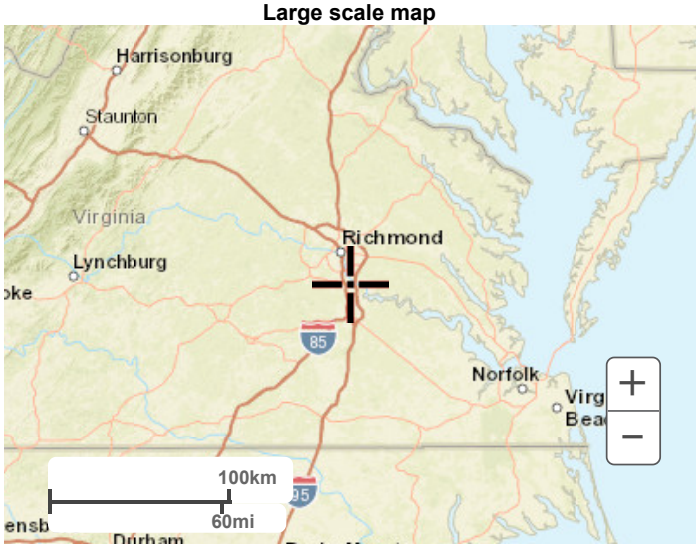
Small scale terrain



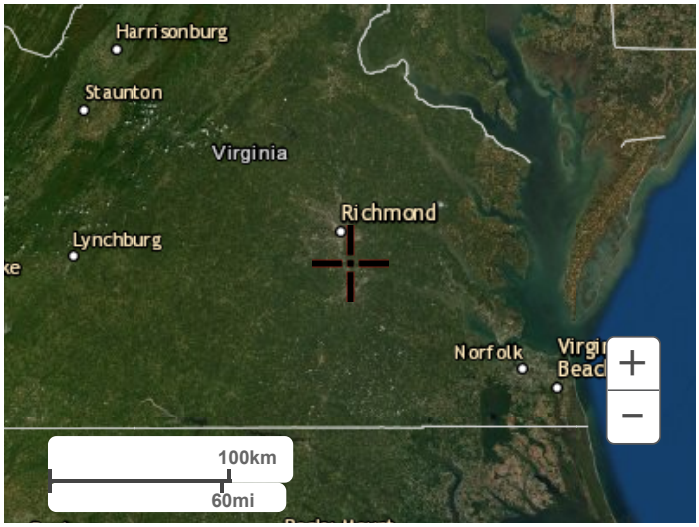
Large scale terrain



Large scale map



Large scale aerial



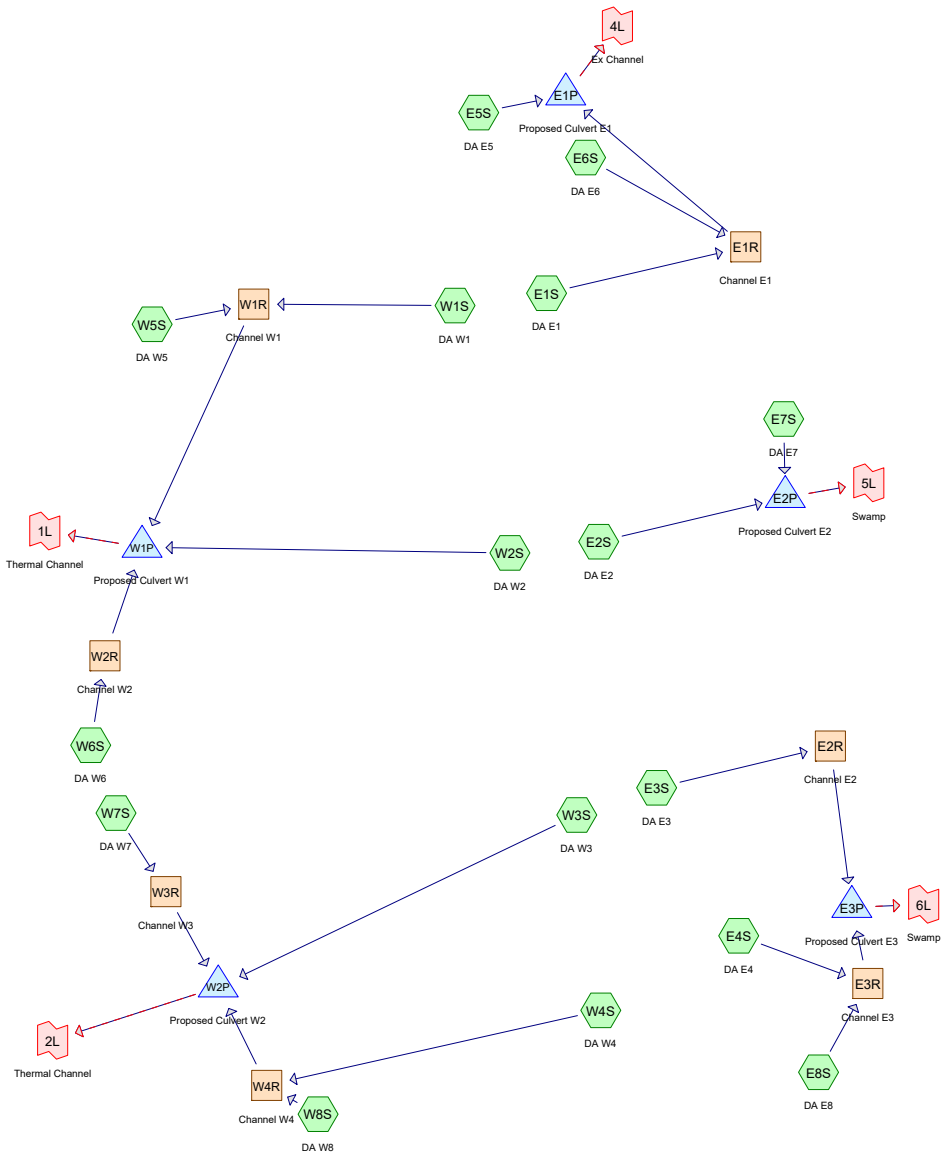
Back to Top

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

Disclaimer

Appendix 2

HydroCAD Inputs and Outputs—Post-Closure Condition



Subcat Reach Pond Link

Routing Diagram for Chesterfield LAP - Proposed 06-05-20
Prepared by AECOM, Printed 6/5/2020
HydroCAD® 10.00-12 s/n 00537 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
107.250	84	50-75% Grass cover, Fair, HSG D (E1S, E2S, E3S, E4S, E5S, E6S, E7S, E8S, W1S, W2S, W3S, W4S, W5S, W6S, W7S, W8S)
107.250	**84**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
107.250	HSG D	E1S, E2S, E3S, E4S, E5S, E6S, E7S, E8S, W1S, W2S, W3S, W4S, W5S, W6S, W7S, W8S
0.000	Other	
107.250		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	107.250	0.000	107.250	50-75% Grass cover, Fair	E1S, E2S, E3S, E4S, E5S, E6S, E7S, E8S, W1S, W2S, W3S, W4S, W5S, W6S, W7S, W8S
0.000	**0.000**	**0.000**	**107.250**	**0.000**	**107.250**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	E1P	9.30	8.70	120.0	0.0050	0.013	36.0	0.0	0.0
2	E2P	4.12	3.60	105.0	0.0050	0.013	18.0	12.0	0.0
3	E3P	5.55	5.00	100.0	0.0055	0.013	18.0	0.0	0.0
4	W1P	6.30	5.20	110.0	0.0100	0.013	48.0	0.0	0.0
5	W2P	6.00	5.00	105.0	0.0095	0.013	48.0	0.0	0.0

Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1S: DA E1 Runoff Area=8.090 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=645' Tc=19.9 min CN=84 Runoff=16.40 cfs 1.225 af

Subcatchment E2S: DA E2 Runoff Area=9.110 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=610' Tc=19.5 min CN=84 Runoff=18.68 cfs 1.380 af

Subcatchment E3S: DA E3 Runoff Area=8.380 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=610' Tc=19.5 min CN=84 Runoff=17.18 cfs 1.269 af

Subcatchment E4S: DA E4 Runoff Area=3.750 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=490' Slope=0.0141 '/' Tc=18.4 min CN=84 Runoff=7.94 cfs 0.568 af

Subcatchment E5S: DA E5 Runoff Area=1.110 ac 0.00% Impervious Runoff Depth=1.82"
Tc=10.0 min CN=84 Runoff=3.10 cfs 0.168 af

Subcatchment E6S: DA E6 Runoff Area=1.480 ac 0.00% Impervious Runoff Depth=1.82"
Tc=10.0 min CN=84 Runoff=4.14 cfs 0.224 af

Subcatchment E7S: DA E7 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=2.10 cfs 0.098 af

Subcatchment E8S: DA E8 Runoff Area=3.510 ac 0.00% Impervious Runoff Depth=1.82"
Tc=10.0 min CN=84 Runoff=9.81 cfs 0.532 af

Subcatchment W1S: DA W1 Runoff Area=9.130 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=1,055' Tc=35.3 min CN=84 Runoff=12.88 cfs 1.383 af

Subcatchment W2S: DA W2 Runoff Area=24.910 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=1,485' Tc=40.3 min CN=84 Runoff=32.05 cfs 3.772 af

Subcatchment W3S: DA W3 Runoff Area=24.990 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=1,470' Tc=40.2 min CN=84 Runoff=32.35 cfs 3.784 af

Subcatchment W4S: DA W4 Runoff Area=2.770 ac 0.00% Impervious Runoff Depth=1.82"
Flow Length=820' Tc=32.8 min CN=84 Runoff=4.12 cfs 0.419 af

Subcatchment W5S: DA W5 Runoff Area=3.650 ac 0.00% Impervious Runoff Depth=1.82"
Tc=10.0 min CN=84 Runoff=10.20 cfs 0.553 af

Subcatchment W6S: DA W6 Runoff Area=1.640 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=5.30 cfs 0.248 af

Subcatchment W7S: DA W7 Runoff Area=1.490 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=4.81 cfs 0.226 af

Subcatchment W8S: DA W8 Runoff Area=2.590 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=8.37 cfs 0.392 af

Reach E1R: Channel E1 Avg. Flow Depth=0.51' Max Vel=4.42 fps Inflow=18.96 cfs 1.449 af
n=0.013 L=1,005.0' S=0.0050 '/' Capacity=635.79 cfs Outflow=18.20 cfs 1.449 af

Reach E2R: Channel E2 Avg. Flow Depth=0.49' Max Vel=4.30 fps Inflow=17.18 cfs 1.269 af
n=0.013 L=805.0' S=0.0050 '/' Capacity=636.03 cfs Outflow=16.66 cfs 1.269 af

Reach E3R: Channel E3 Avg. Flow Depth=0.43' Max Vel=4.79 fps Inflow=16.46 cfs 1.099 af
n=0.013 L=845.0' S=0.0072 '/' Capacity=764.06 cfs Outflow=15.80 cfs 1.099 af

Reach W1R: Channel W1 Avg. Flow Depth=0.38' Max Vel=5.21 fps Inflow=15.81 cfs 1.935 af
n=0.013 L=1,461.5' S=0.0099 '/' Capacity=892.42 cfs Outflow=14.76 cfs 1.935 af

Reach W2R: Channel W2 Avg. Flow Depth=0.27' Max Vel=2.38 fps Inflow=5.30 cfs 0.248 af
n=0.013 L=660.0' S=0.0030 '/' Capacity=489.26 cfs Outflow=4.63 cfs 0.248 af

Reach W3R: Channel W3 Avg. Flow Depth=0.25' Max Vel=2.45 fps Inflow=4.81 cfs 0.226 af
n=0.013 L=640.0' S=0.0035 '/' Capacity=533.52 cfs Outflow=4.26 cfs 0.226 af

Reach W4R: Channel W4 Avg. Flow Depth=0.28' Max Vel=4.15 fps Inflow=9.77 cfs 0.812 af
n=0.013 L=1,355.0' S=0.0087 '/' Capacity=837.12 cfs Outflow=8.38 cfs 0.812 af

Pond E1P: Proposed Culvert E1 Peak Elev=11.19' Storage=5,037 cf Inflow=19.77 cfs 1.617 af
Primary=17.56 cfs 1.617 af Secondary=0.00 cfs 0.000 af Outflow=17.56 cfs 1.617 af

Pond E2P: Proposed Culvert E2 Peak Elev=12.79' Storage=1,491 cf Inflow=19.22 cfs 1.478 af
Primary=18.75 cfs 1.478 af Secondary=0.00 cfs 0.000 af Outflow=18.75 cfs 1.478 af

Pond E3P: Proposed Culvert E3 Peak Elev=12.89' Storage=5,346 cf Inflow=30.92 cfs 2.368 af
Primary=28.09 cfs 2.368 af Secondary=0.00 cfs 0.000 af Outflow=28.09 cfs 2.368 af

Pond W1P: Proposed Culvert W1 Peak Elev=8.76' Storage=26,776 cf Inflow=47.33 cfs 5.956 af
Primary=41.10 cfs 5.948 af Secondary=0.00 cfs 0.000 af Outflow=41.10 cfs 5.948 af

Pond W2P: Proposed Culvert W2 Peak Elev=8.24' Storage=16,329 cf Inflow=38.04 cfs 4.822 af
Primary=34.60 cfs 4.817 af Secondary=0.00 cfs 0.000 af Outflow=34.60 cfs 4.817 af

Link 1L: Thermal Channel Inflow=41.10 cfs 5.948 af
Primary=41.10 cfs 5.948 af

Link 2L: Thermal Channel Inflow=34.60 cfs 4.817 af
Primary=34.60 cfs 4.817 af

Link 4L: Ex Channel Inflow=17.56 cfs 1.617 af
Primary=17.56 cfs 1.617 af

Link 5L: Swamp Inflow=18.75 cfs 1.478 af
Primary=18.75 cfs 1.478 af

Link 6L: Swamp Inflow=28.09 cfs 2.368 af
Primary=28.09 cfs 2.368 af

Total Runoff Area = 107.250 ac Runoff Volume = 16.241 af Average Runoff Depth = 1.82"
100.00% Pervious = 107.250 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E1S: DA E1

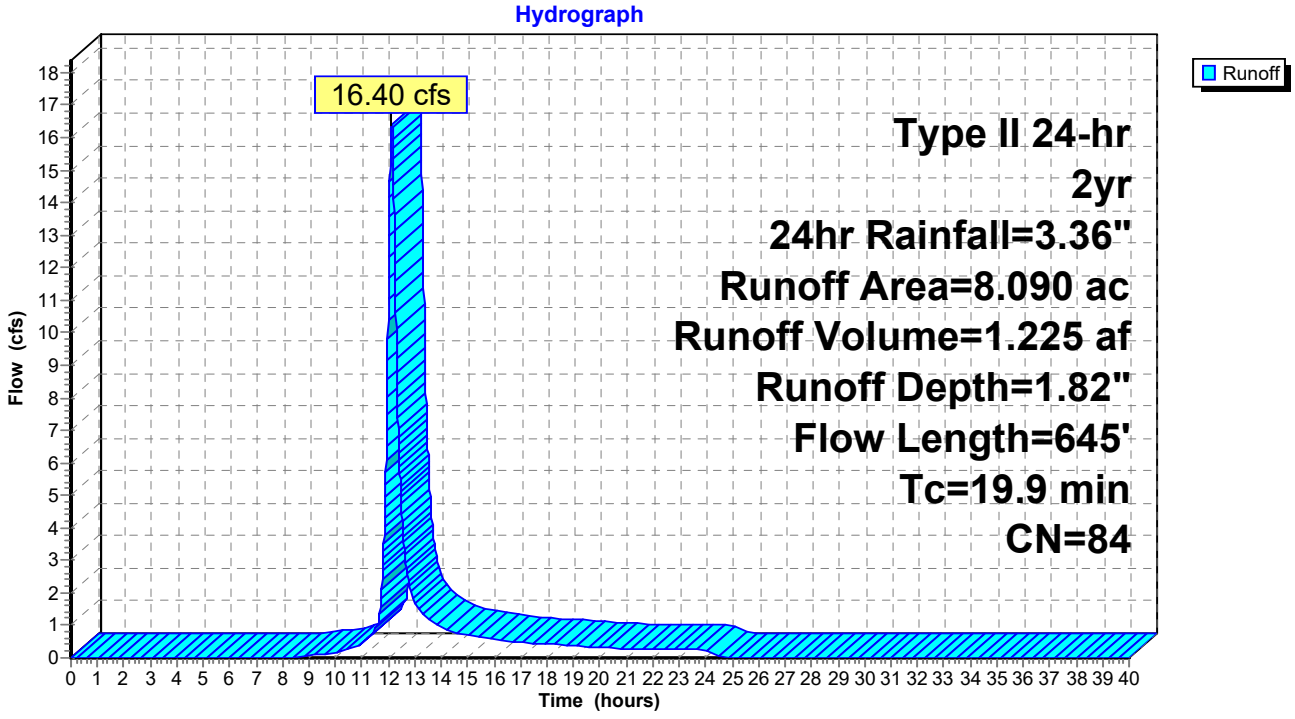
Runoff = 16.40 cfs @ 12.13 hrs, Volume= 1.225 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
8.090	84	50-75% Grass cover, Fair, HSG D
8.090		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.5	150	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.9	645	Total			

Subcatchment E1S: DA E1



Summary for Subcatchment E2S: DA E2

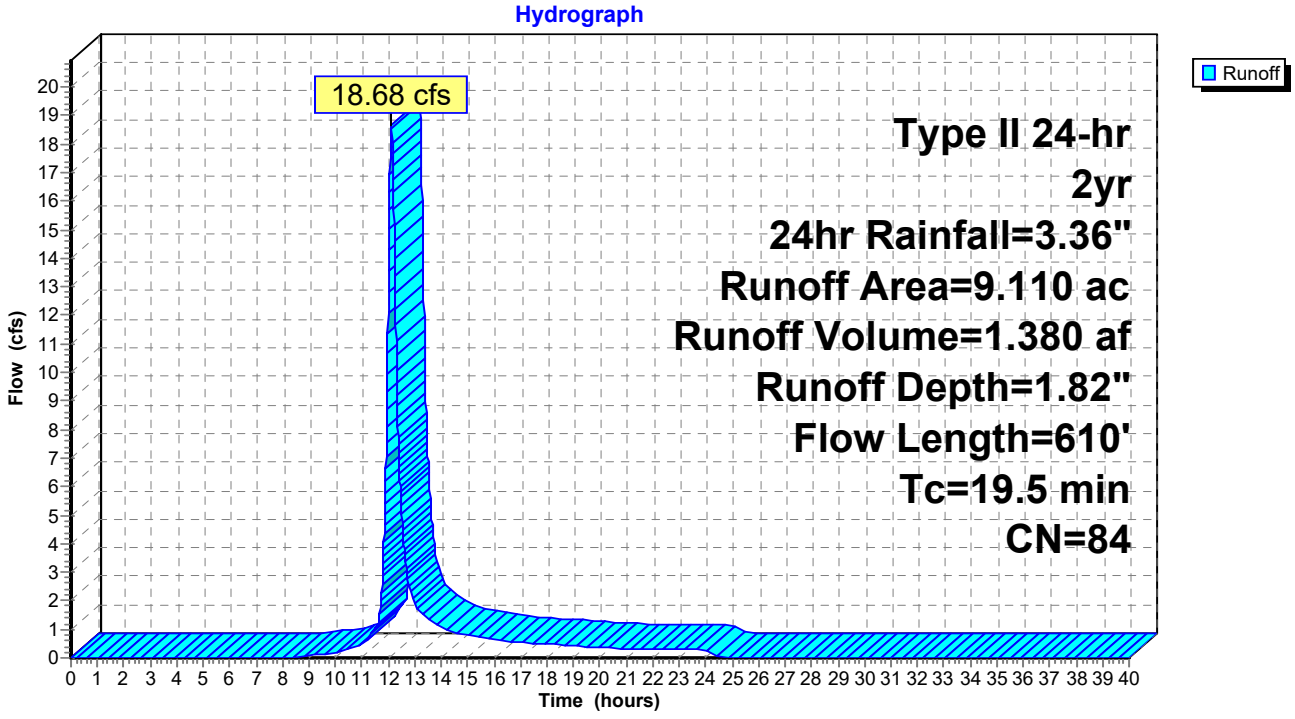
Runoff = 18.68 cfs @ 12.12 hrs, Volume= 1.380 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
9.110	84	50-75% Grass cover, Fair, HSG D
9.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E2S: DA E2



Summary for Subcatchment E3S: DA E3

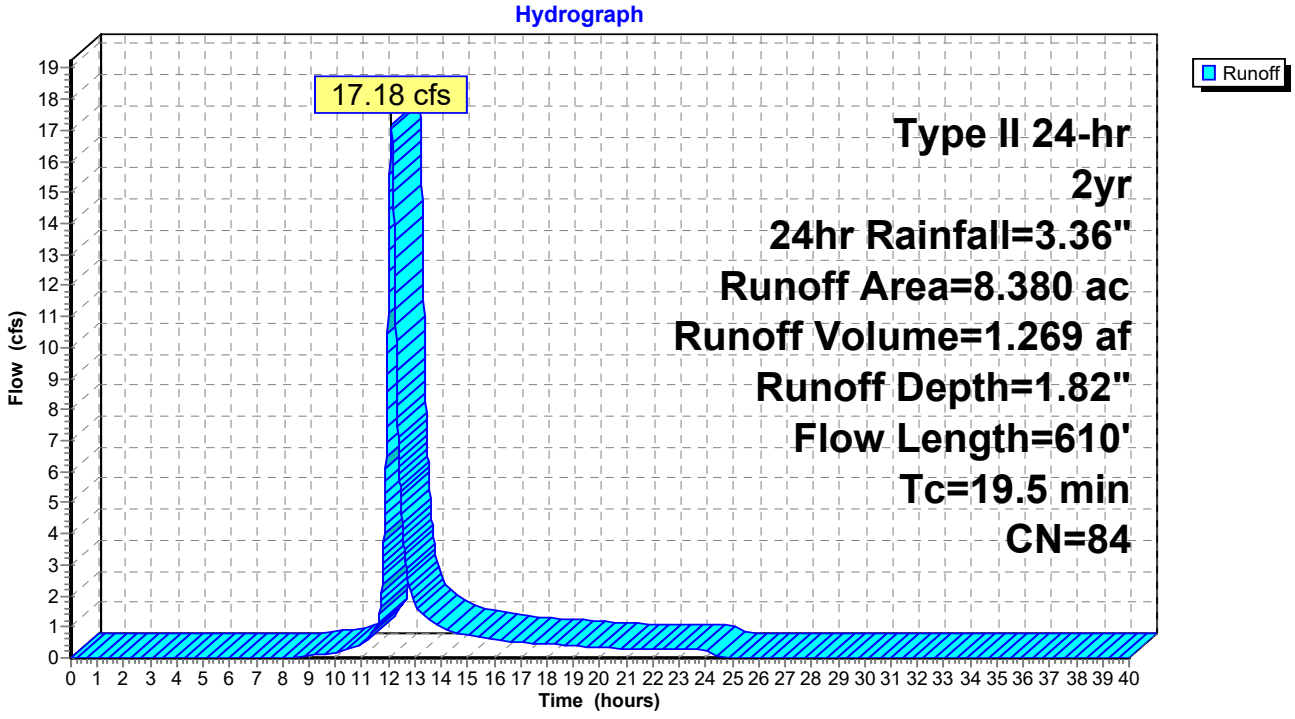
Runoff = 17.18 cfs @ 12.12 hrs, Volume= 1.269 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
8.380	84	50-75% Grass cover, Fair, HSG D
8.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E3S: DA E3



Summary for Subcatchment E4S: DA E4

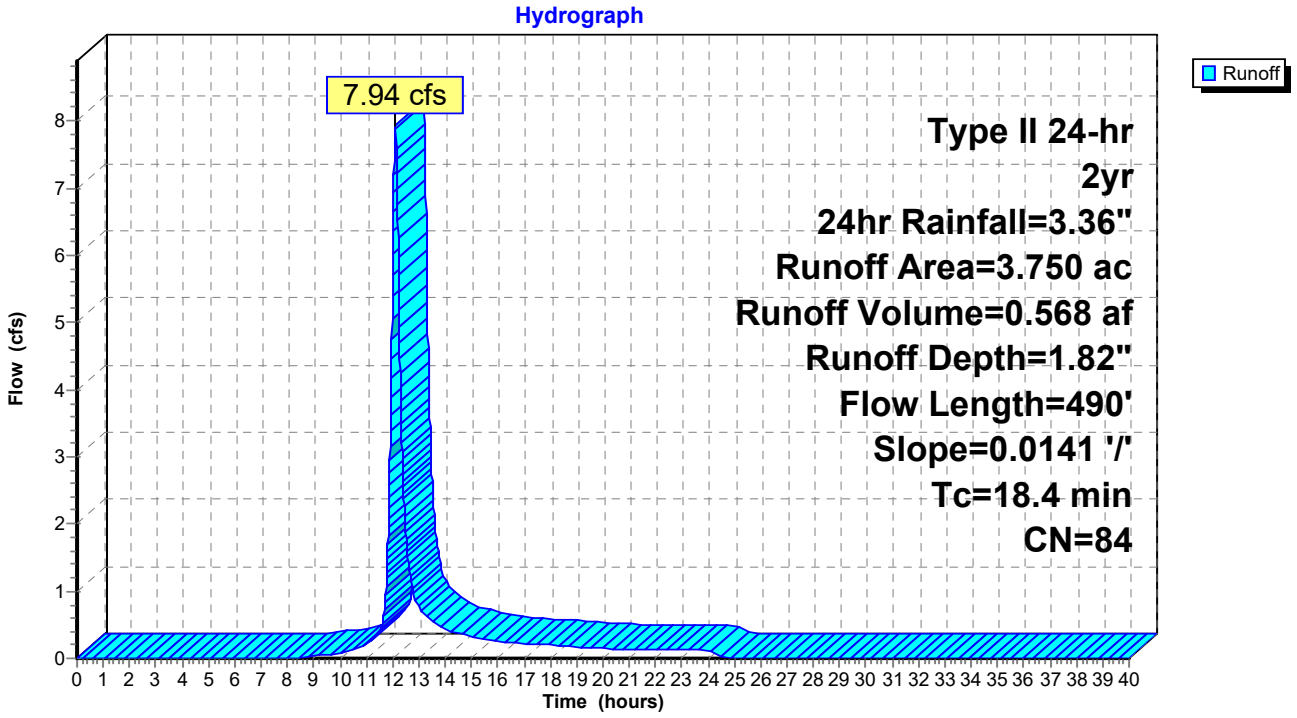
Runoff = 7.94 cfs @ 12.11 hrs, Volume= 0.568 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
3.750	84	50-75% Grass cover, Fair, HSG D
3.750		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	340	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
18.4	490	Total			

Subcatchment E4S: DA E4



Summary for Subcatchment E5S: DA E5

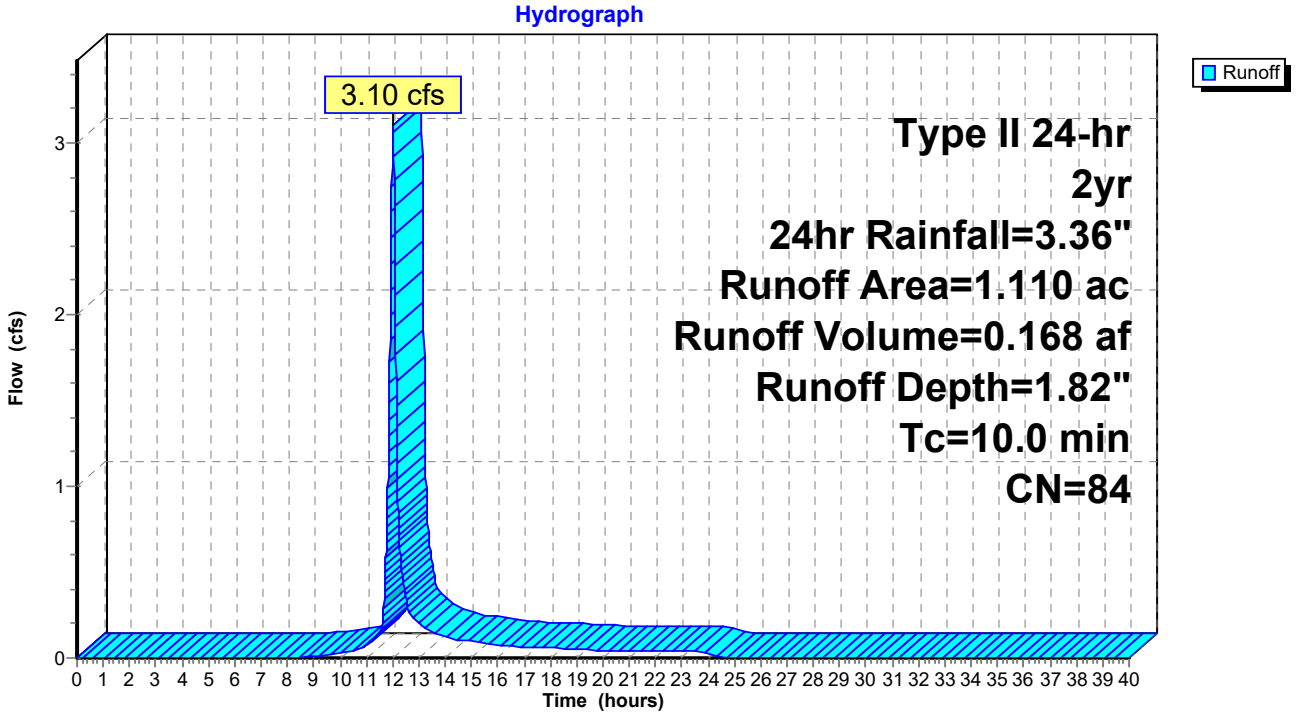
Runoff = 3.10 cfs @ 12.02 hrs, Volume= 0.168 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
1.110	84	50-75% Grass cover, Fair, HSG D
1.110		100.00% Pervious Area

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

Subcatchment E5S: DA E5



Summary for Subcatchment E6S: DA E6

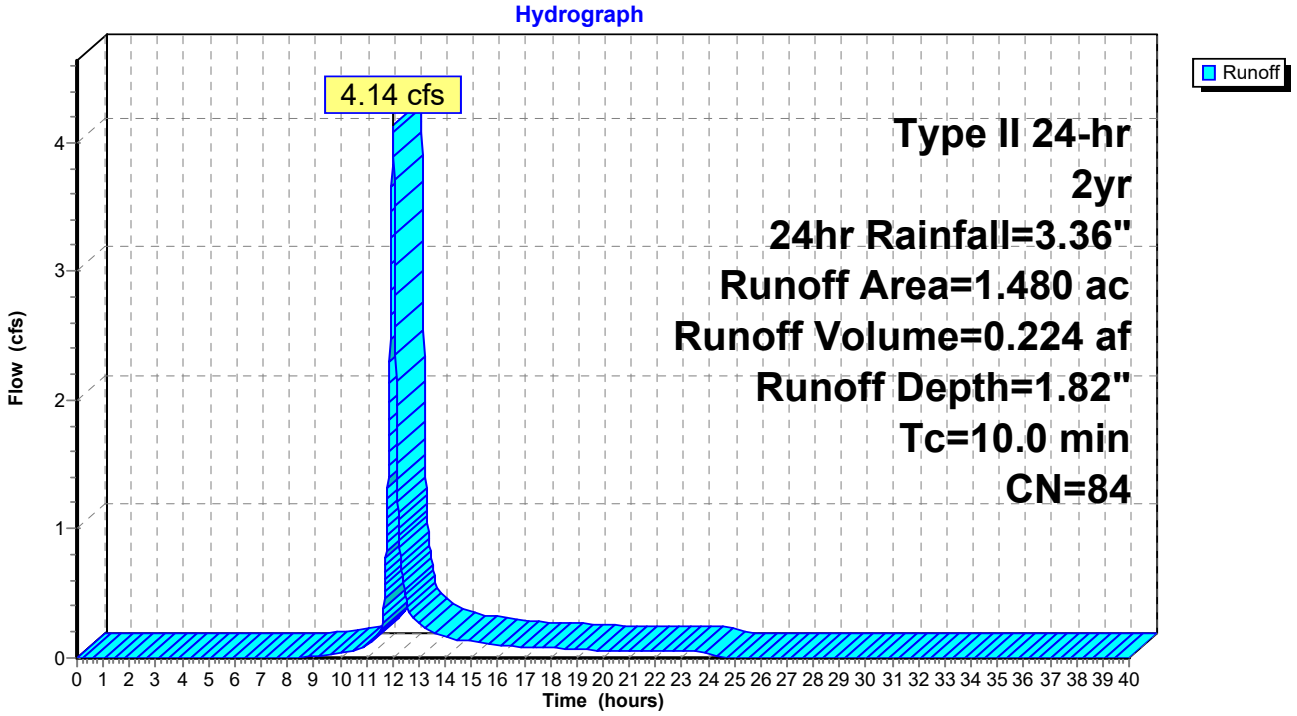
Runoff = 4.14 cfs @ 12.02 hrs, Volume= 0.224 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
1.480	84	50-75% Grass cover, Fair, HSG D
1.480		100.00% Pervious Area

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

Subcatchment E6S: DA E6



Summary for Subcatchment E7S: DA E7

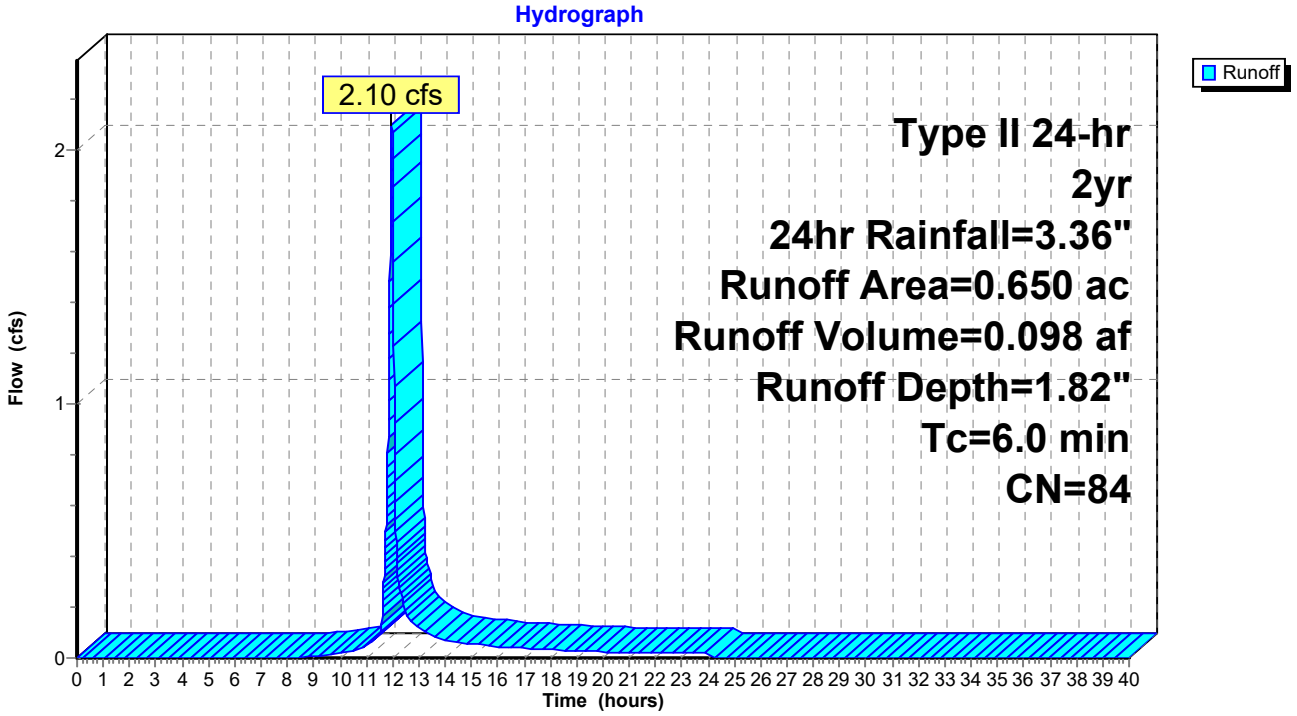
Runoff = 2.10 cfs @ 11.97 hrs, Volume= 0.098 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
0.650	84	50-75% Grass cover, Fair, HSG D
0.650		100.00% Pervious Area

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

Subcatchment E7S: DA E7



Summary for Subcatchment E8S: DA E8

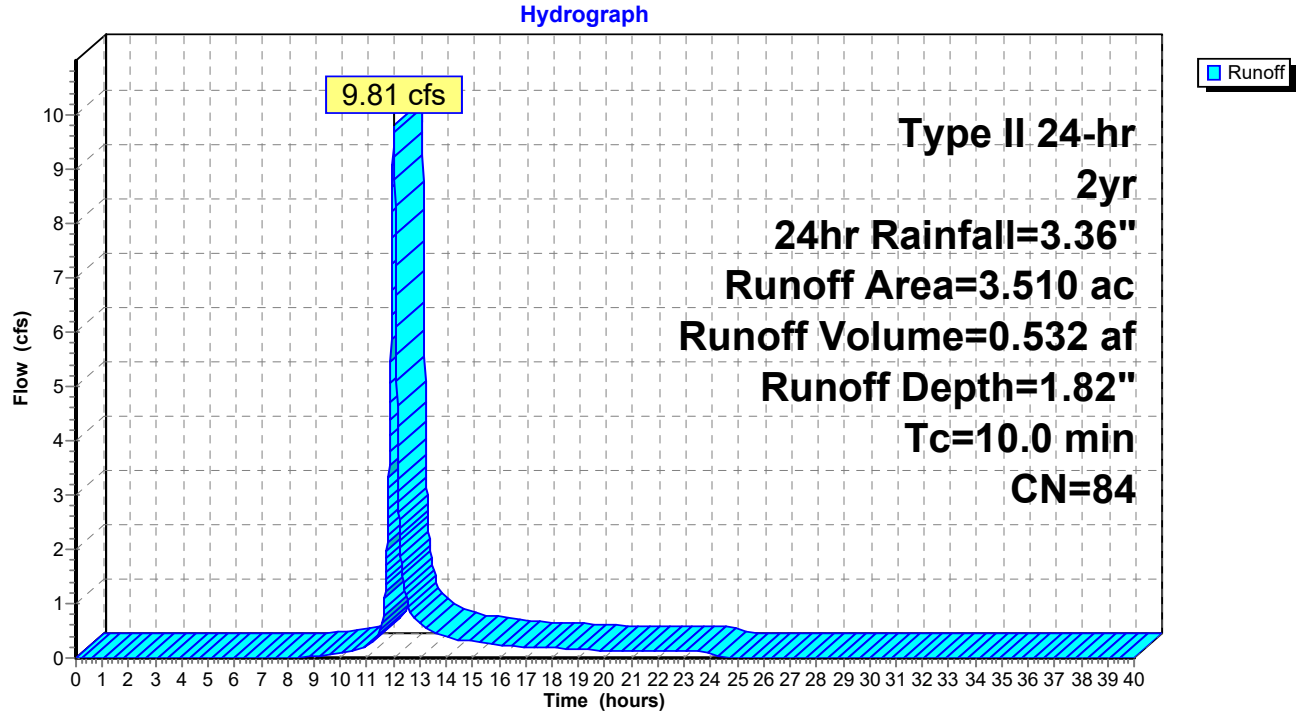
Runoff = 9.81 cfs @ 12.02 hrs, Volume= 0.532 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
3.510	84	50-75% Grass cover, Fair, HSG D
3.510		100.00% Pervious Area

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

Subcatchment E8S: DA E8



Summary for Subcatchment W1S: DA W1

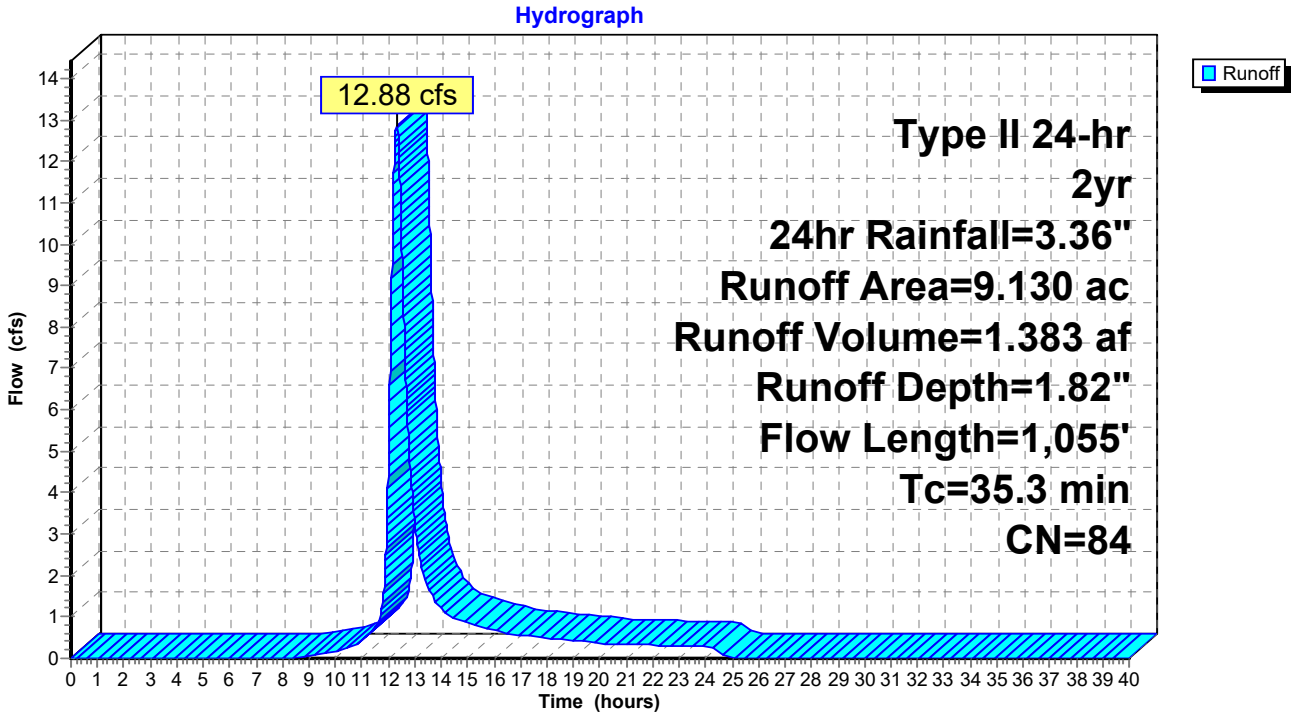
Runoff = 12.88 cfs @ 12.31 hrs, Volume= 1.383 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
9.130	84	50-75% Grass cover, Fair, HSG D
9.130		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.9	565	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
3.4	340	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
35.3	1,055	Total			

Subcatchment W1S: DA W1



Summary for Subcatchment W2S: DA W2

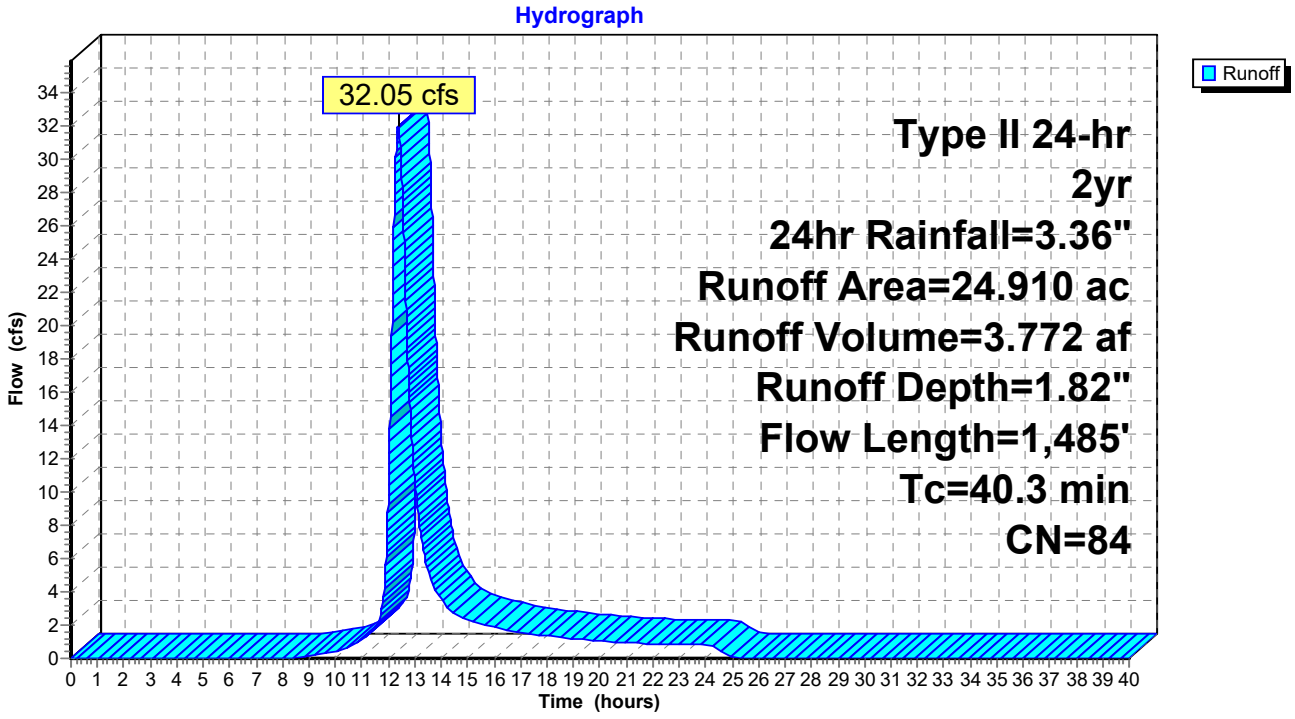
Runoff = 32.05 cfs @ 12.36 hrs, Volume= 3.772 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
24.910	84	50-75% Grass cover, Fair, HSG D
24.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	665	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.9	670	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.3	1,485	Total			

Subcatchment W2S: DA W2



Summary for Subcatchment W3S: DA W3

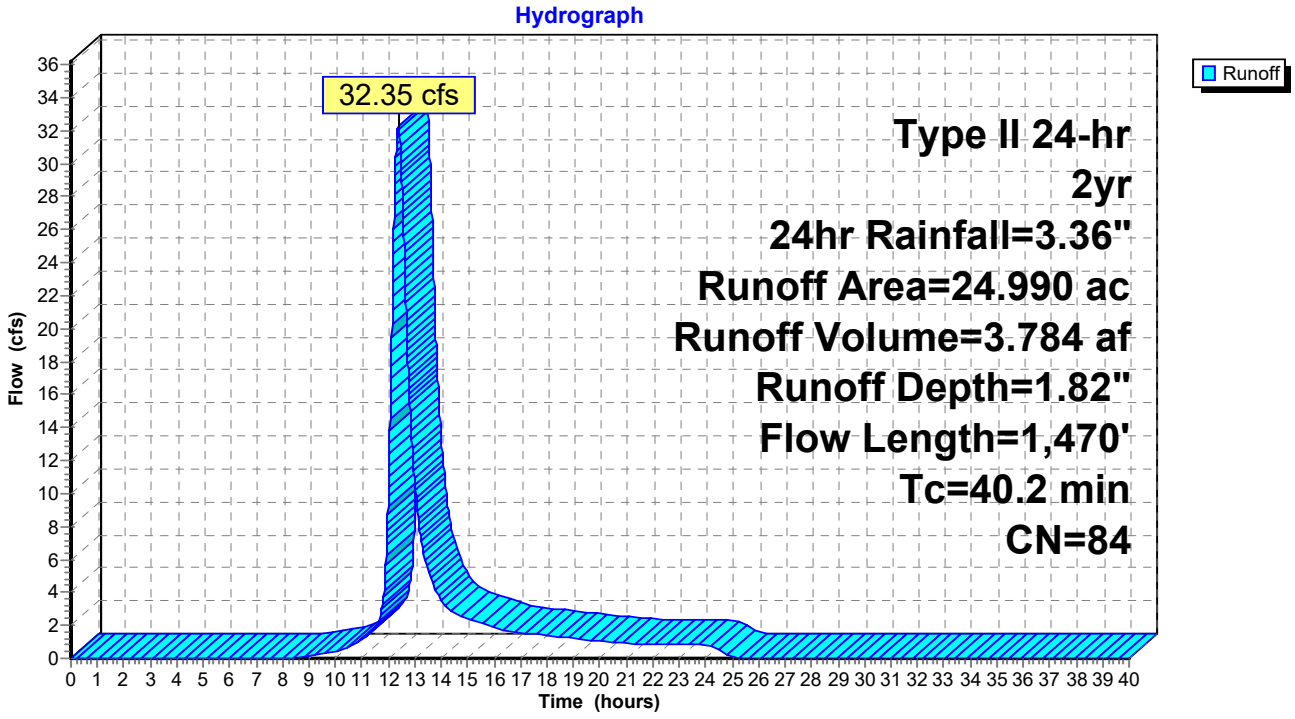
Runoff = 32.35 cfs @ 12.37 hrs, Volume= 3.784 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
24.990	84	50-75% Grass cover, Fair, HSG D
24.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	660	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.8	660	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.2	1,470	Total			

Subcatchment W3S: DA W3



Summary for Subcatchment W4S: DA W4

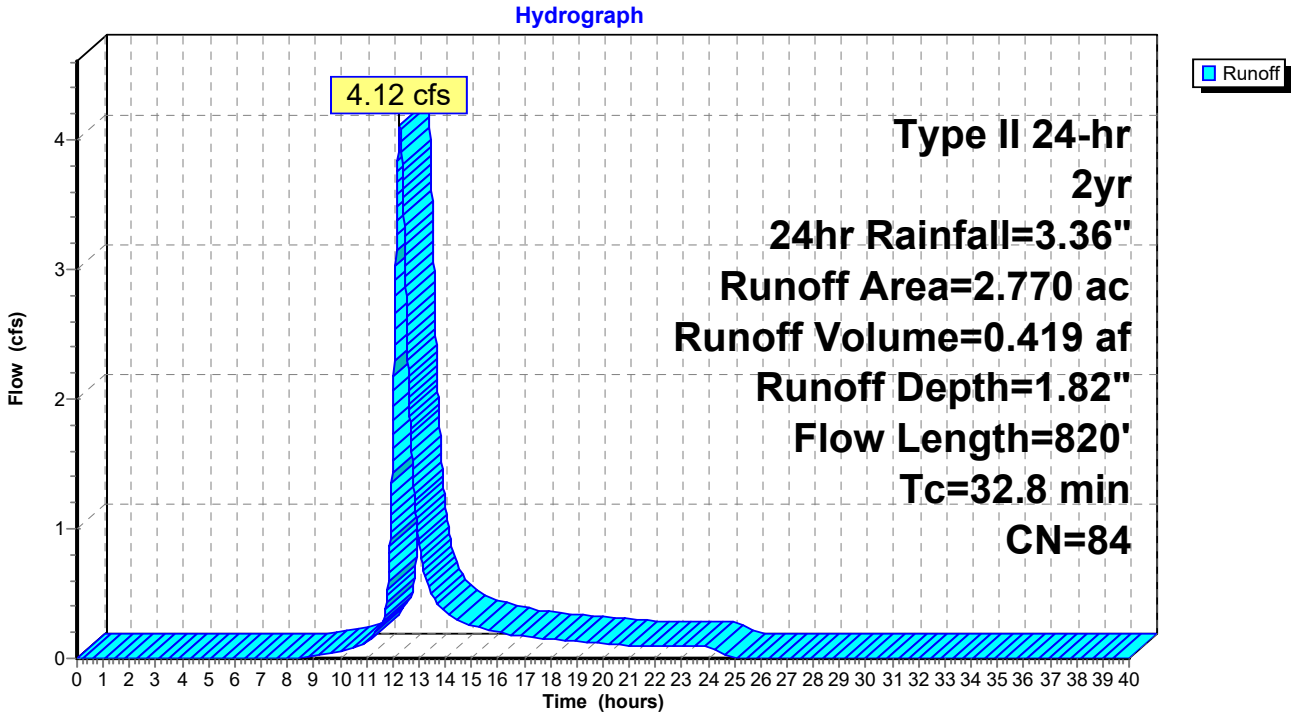
Runoff = 4.12 cfs @ 12.28 hrs, Volume= 0.419 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
2.770	84	50-75% Grass cover, Fair, HSG D
2.770		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.6	550	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
1.2	120	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
32.8	820	Total			

Subcatchment W4S: DA W4



Summary for Subcatchment W5S: DA W5

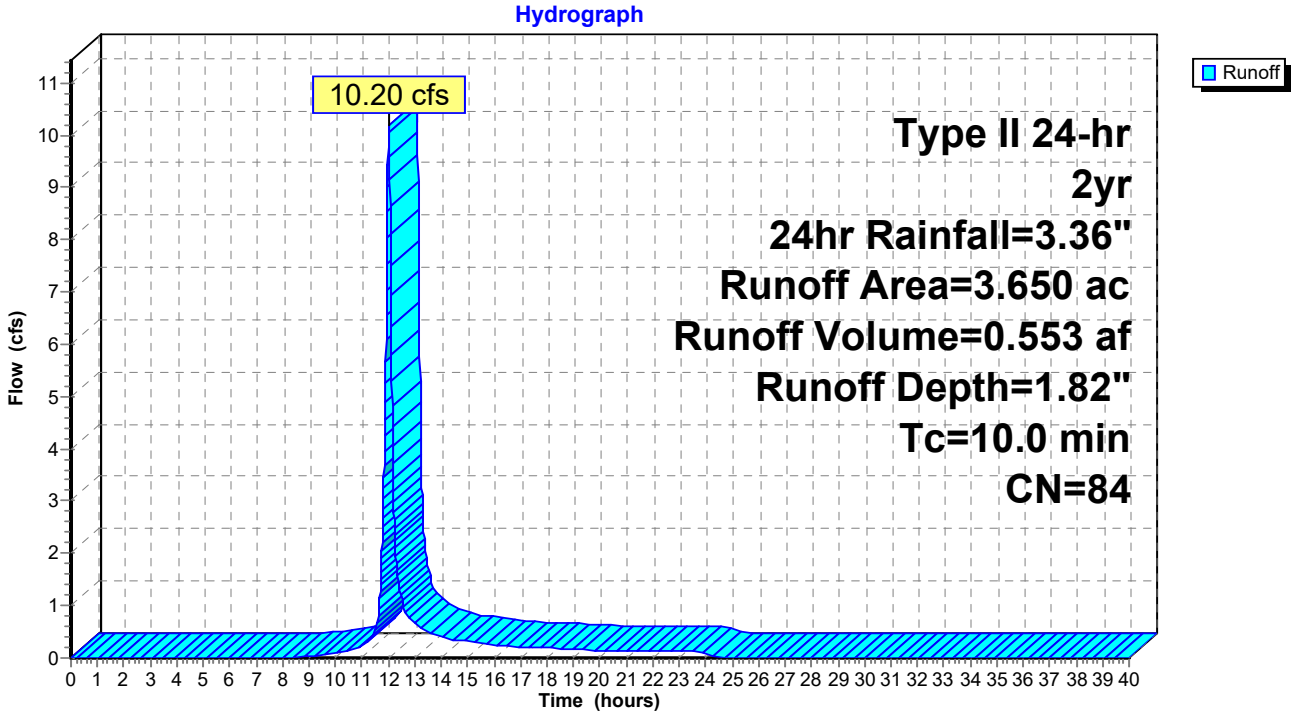
Runoff = 10.20 cfs @ 12.02 hrs, Volume= 0.553 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
3.650	84	50-75% Grass cover, Fair, HSG D
3.650		100.00% Pervious Area

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

Subcatchment W5S: DA W5



Summary for Subcatchment W6S: DA W6

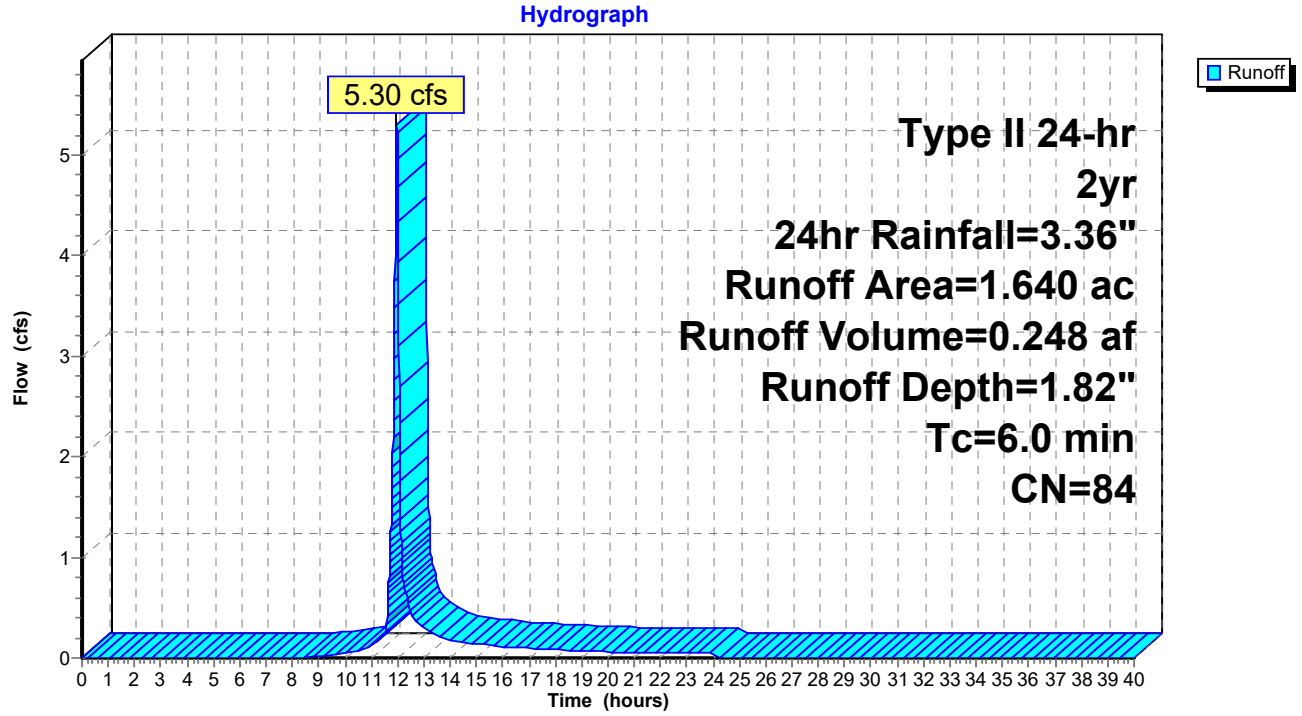
Runoff = 5.30 cfs @ 11.97 hrs, Volume= 0.248 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
1.640	84	50-75% Grass cover, Fair, HSG D
1.640		100.00% Pervious Area

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

Subcatchment W6S: DA W6



Summary for Subcatchment W7S: DA W7

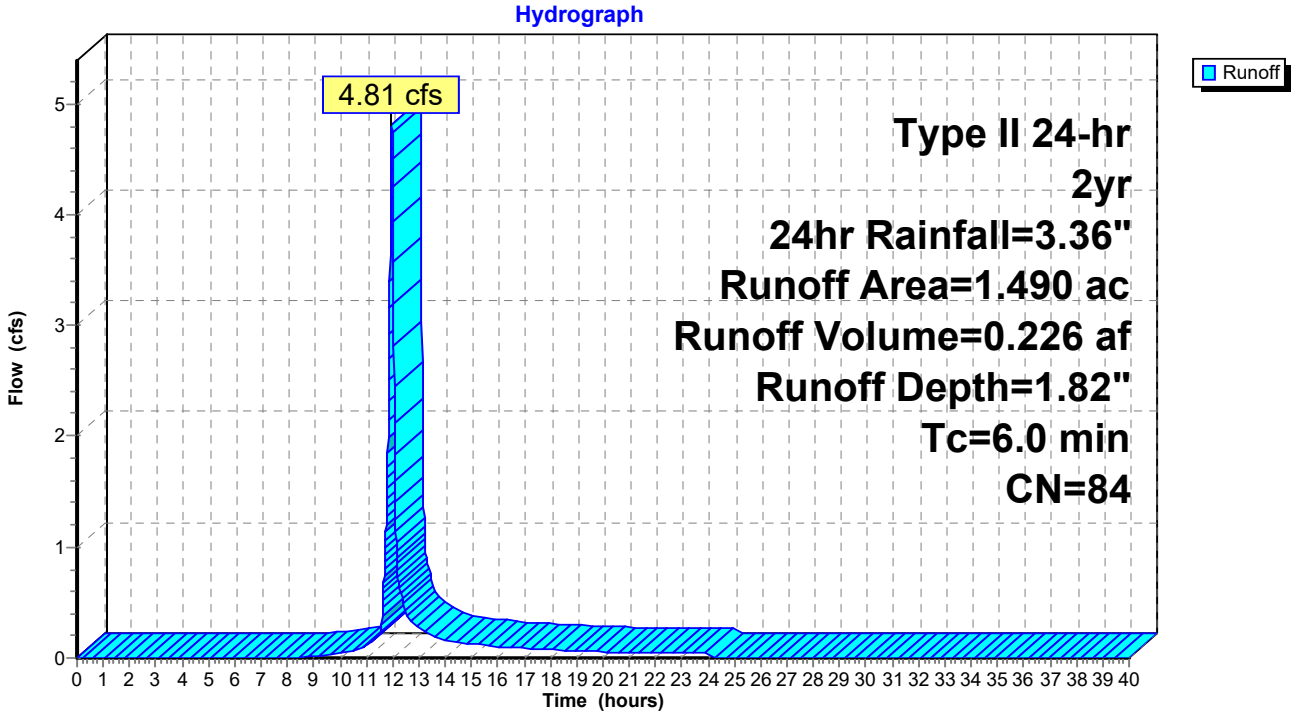
Runoff = 4.81 cfs @ 11.97 hrs, Volume= 0.226 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
1.490	84	50-75% Grass cover, Fair, HSG D
1.490		100.00% Pervious Area

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

Subcatchment W7S: DA W7



Summary for Subcatchment W8S: DA W8

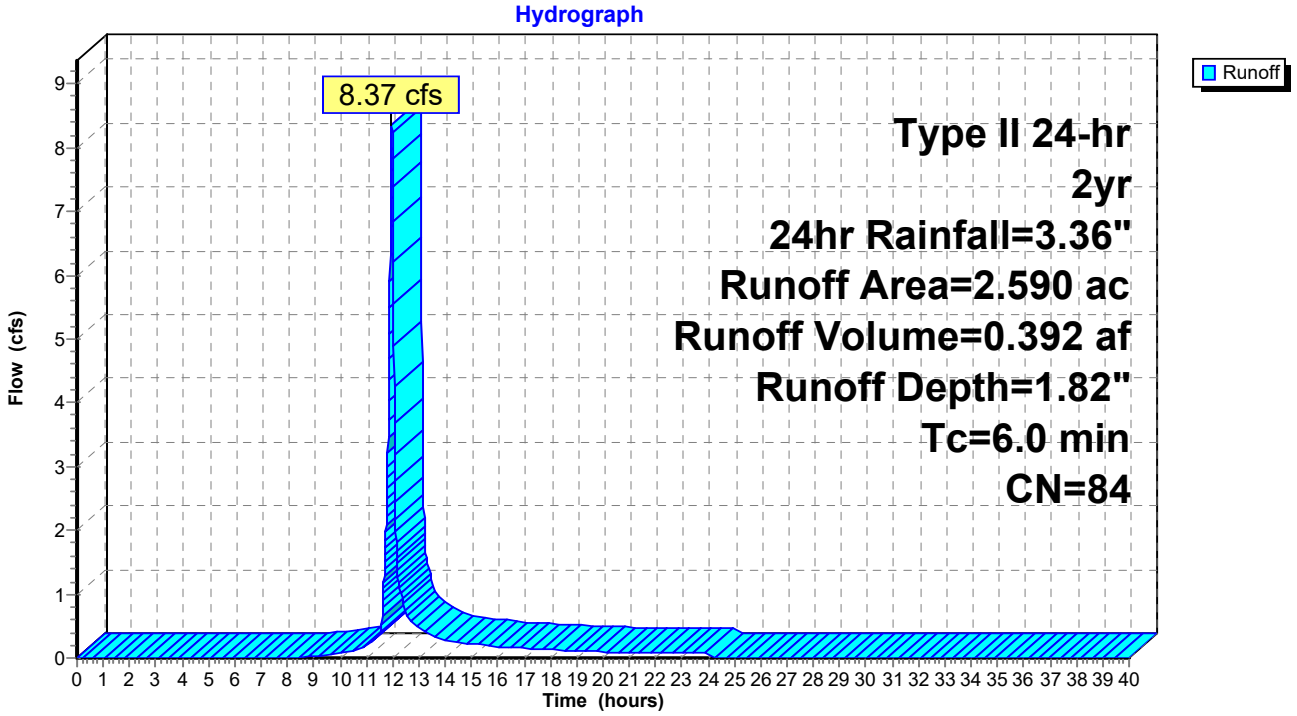
Runoff = 8.37 cfs @ 11.97 hrs, Volume= 0.392 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 2yr, 24hr Rainfall=3.36"

Area (ac)	CN	Description
2.590	84	50-75% Grass cover, Fair, HSG D
2.590		100.00% Pervious Area

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

Subcatchment W8S: DA W8



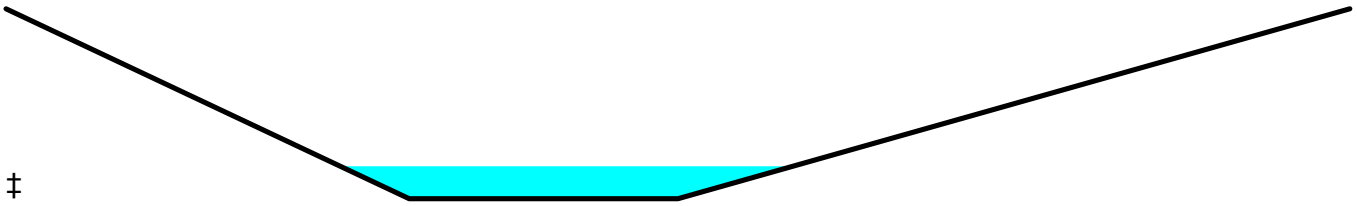
Summary for Reach E1R: Channel E1

Inflow Area = 9.570 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 18.96 cfs @ 12.10 hrs, Volume= 1.449 af
Outflow = 18.20 cfs @ 12.14 hrs, Volume= 1.449 af, Atten= 4%, Lag= 2.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 4.42 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 13.0 min

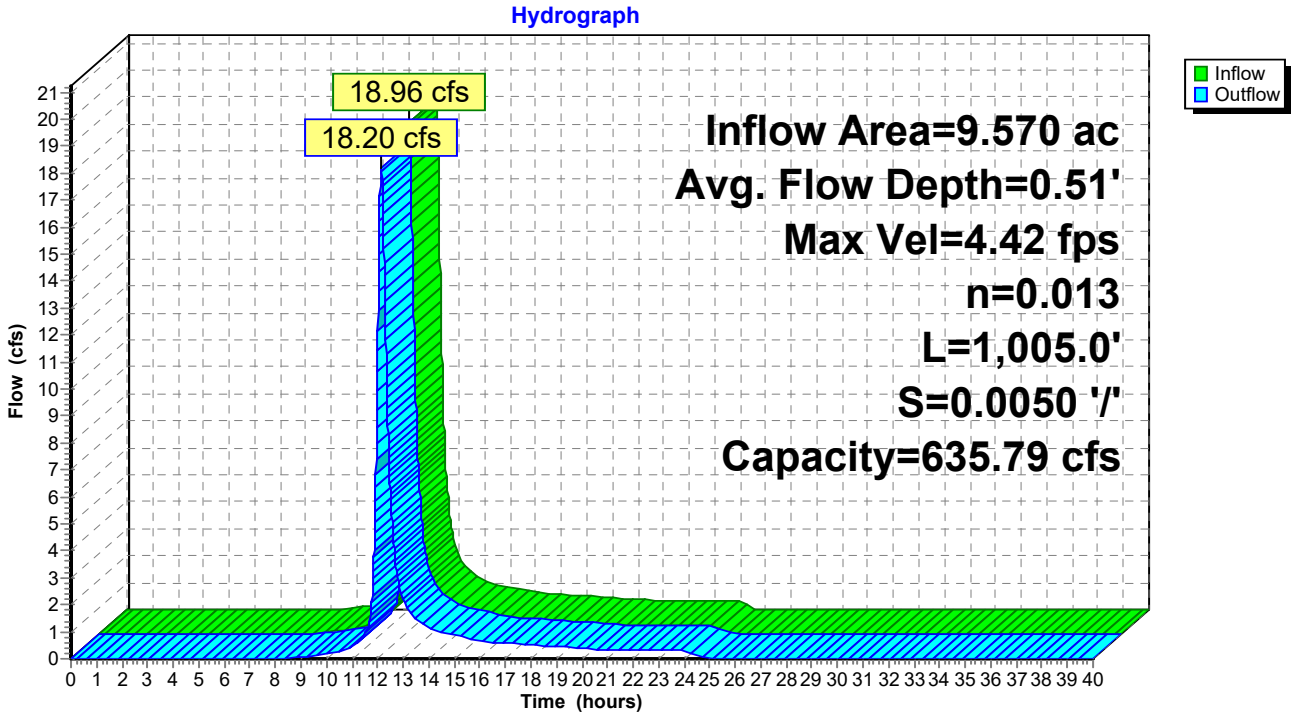
Peak Storage= 4,143 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.51'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 635.79 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,005.0' Slope= 0.0050 '/'
Inlet Invert= 14.32', Outlet Invert= 9.28'



‡

Reach E1R: Channel E1



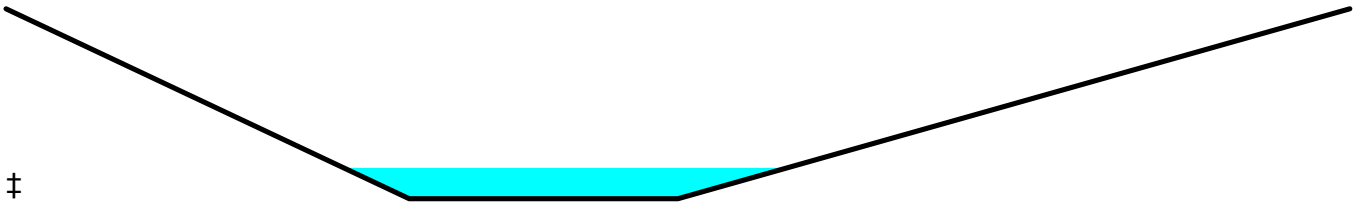
Summary for Reach E2R: Channel E2

Inflow Area = 8.380 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 17.18 cfs @ 12.12 hrs, Volume= 1.269 af
Outflow = 16.66 cfs @ 12.16 hrs, Volume= 1.269 af, Atten= 3%, Lag= 2.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 4.30 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 10.7 min

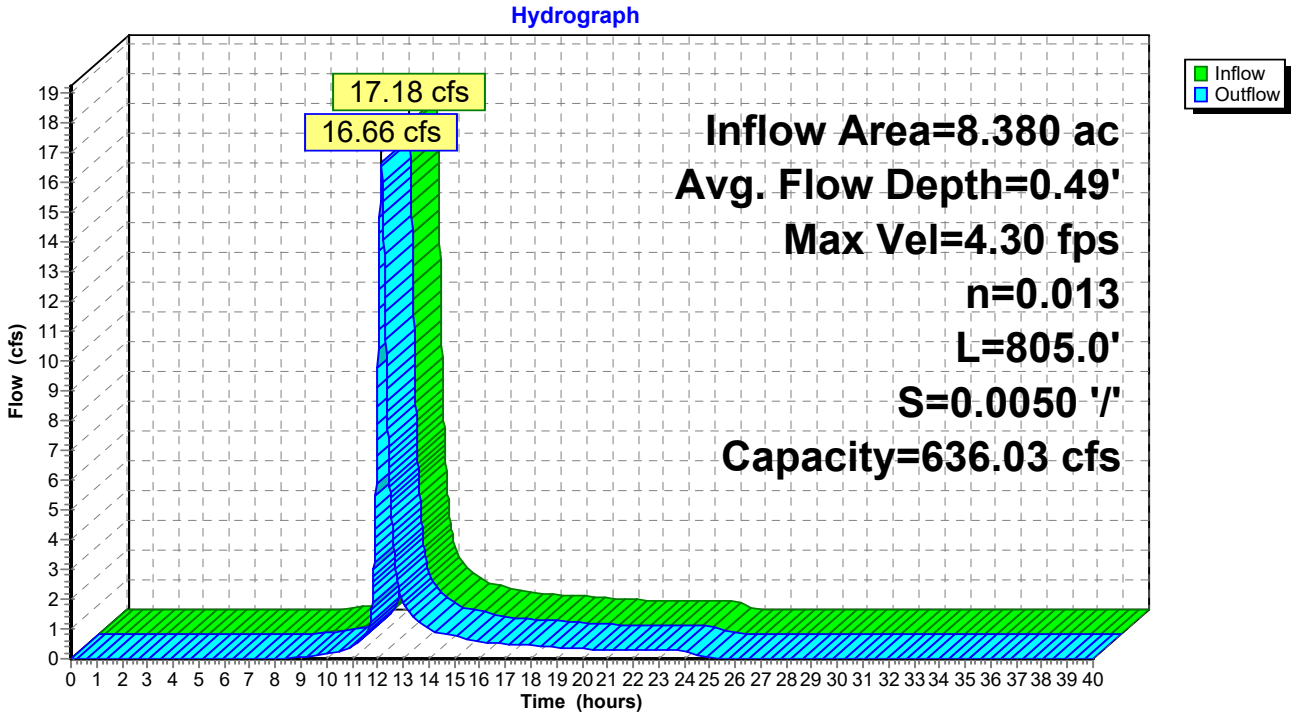
Peak Storage= 3,120 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 636.03 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 805.0' Slope= 0.0050 '/'
Inlet Invert= 15.27', Outlet Invert= 11.23'



‡

Reach E2R: Channel E2



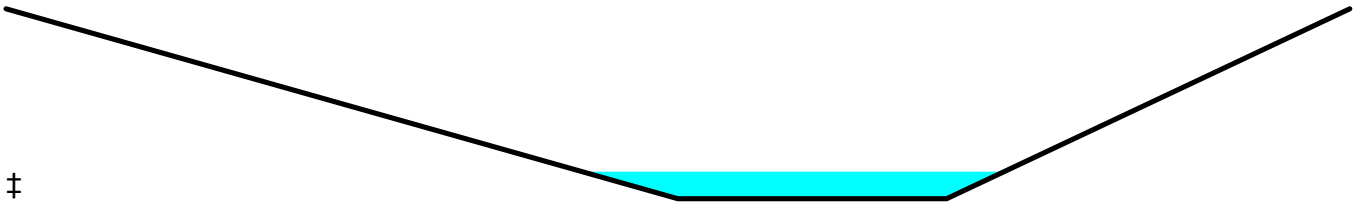
Summary for Reach E3R: Channel E3

Inflow Area = 7.260 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 16.46 cfs @ 12.04 hrs, Volume= 1.099 af
Outflow = 15.80 cfs @ 12.07 hrs, Volume= 1.099 af, Atten= 4%, Lag= 2.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 4.79 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 10.3 min

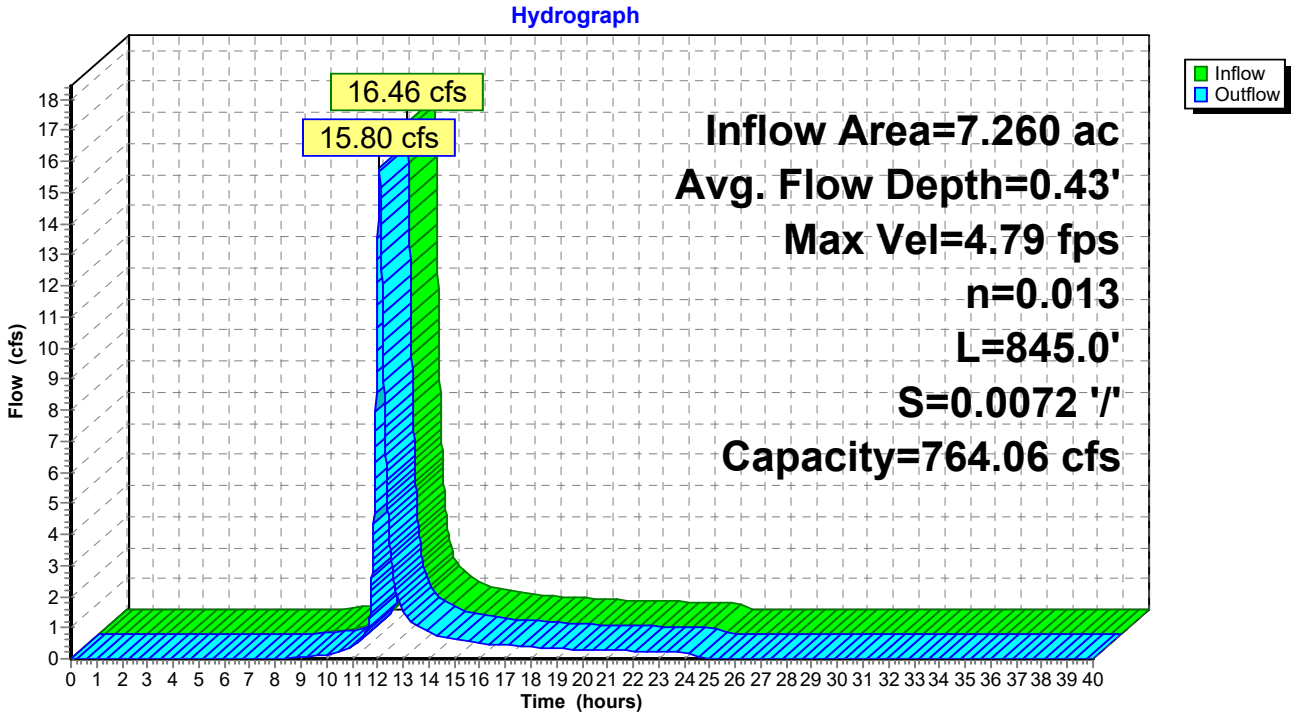
Peak Storage= 2,784 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 764.06 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 845.0' Slope= 0.0072 '/'
Inlet Invert= 17.35', Outlet Invert= 11.23'



‡

Reach E3R: Channel E3



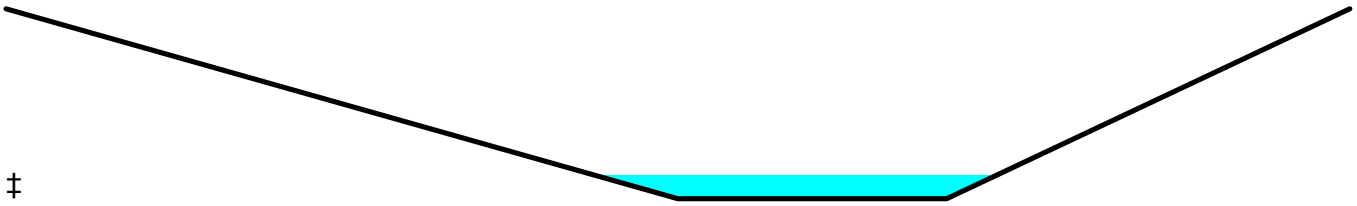
Summary for Reach W1R: Channel W1

Inflow Area = 12.780 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 15.81 cfs @ 12.05 hrs, Volume= 1.935 af
Outflow = 14.76 cfs @ 12.11 hrs, Volume= 1.935 af, Atten= 7%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.21 fps, Min. Travel Time= 4.7 min
Avg. Velocity = 1.78 fps, Avg. Travel Time= 13.7 min

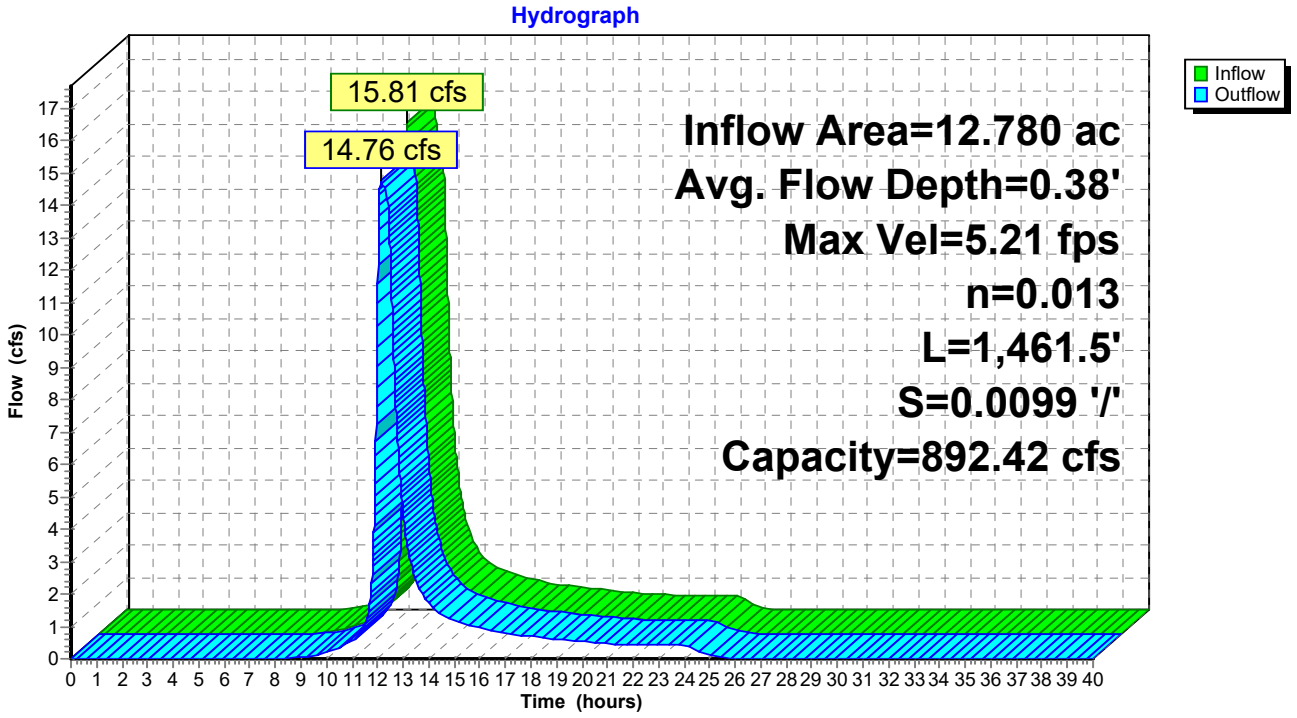
Peak Storage= 4,137 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 892.42 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 1,461.5' Slope= 0.0099 '/'
Inlet Invert= 20.31', Outlet Invert= 5.87'



‡

Reach W1R: Channel W1



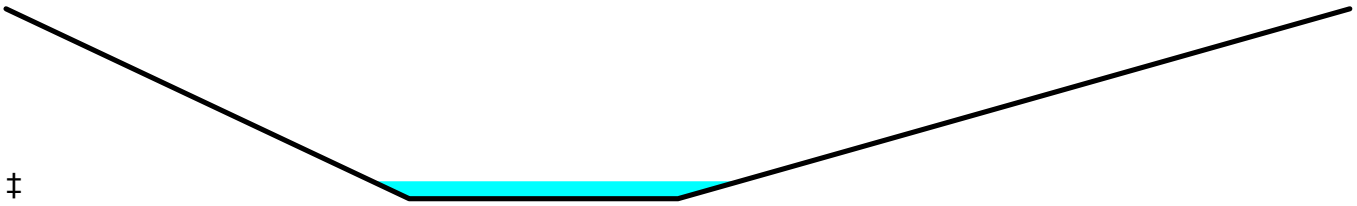
Summary for Reach W2R: Channel W2

Inflow Area = 1.640 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 5.30 cfs @ 11.97 hrs, Volume= 0.248 af
Outflow = 4.63 cfs @ 12.01 hrs, Volume= 0.248 af, Atten= 13%, Lag= 2.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 2.38 fps, Min. Travel Time= 4.6 min
Avg. Velocity = 0.68 fps, Avg. Travel Time= 16.3 min

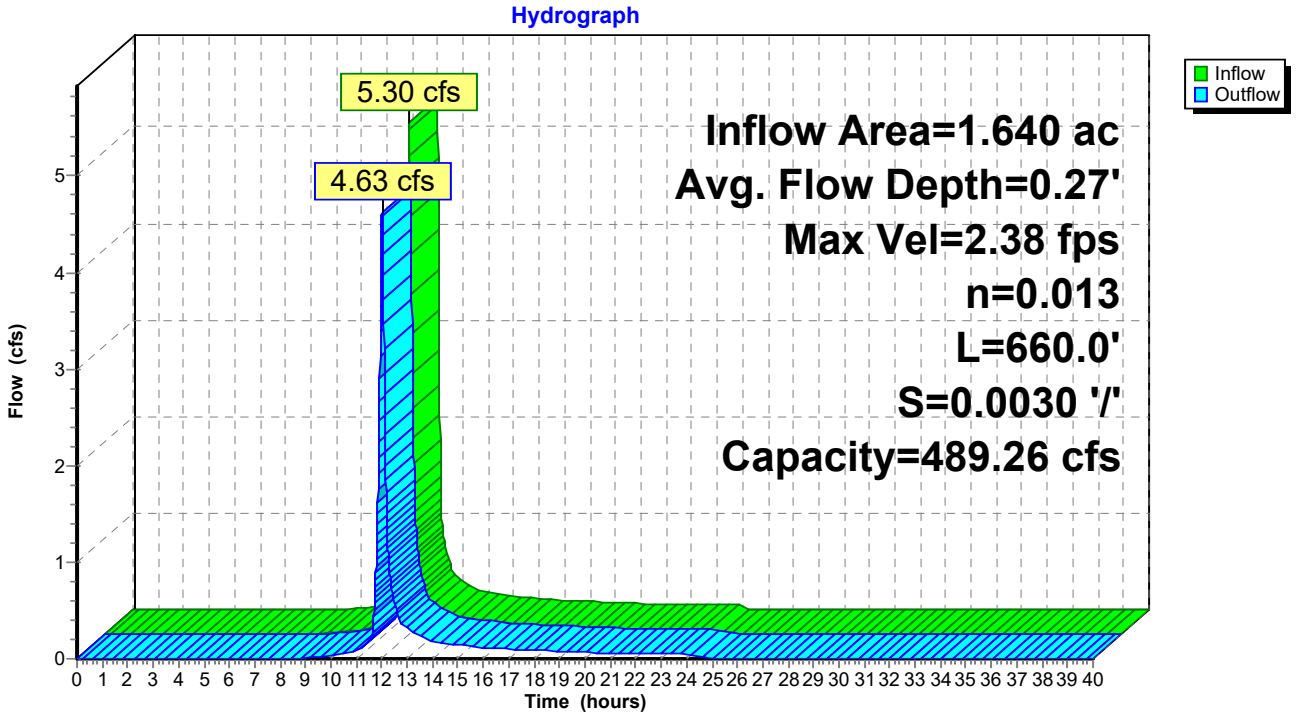
Peak Storage= 1,285 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 489.26 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 660.0' Slope= 0.0030 '/'
Inlet Invert= 7.83', Outlet Invert= 5.87'



‡

Reach W2R: Channel W2



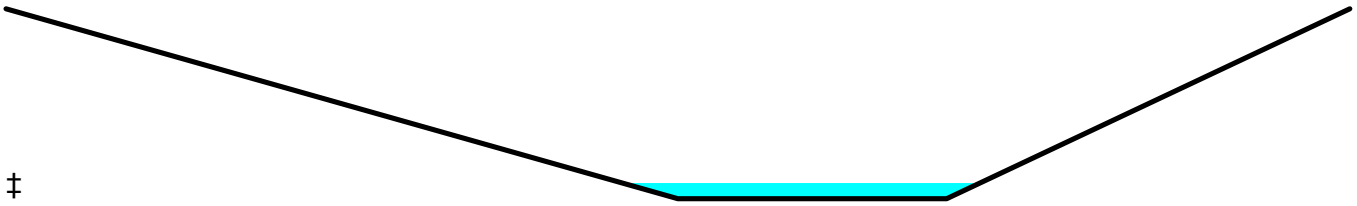
Summary for Reach W3R: Channel W3

Inflow Area = 1.490 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 4.81 cfs @ 11.97 hrs, Volume= 0.226 af
Outflow = 4.26 cfs @ 12.01 hrs, Volume= 0.226 af, Atten= 12%, Lag= 2.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 2.45 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 14.8 min

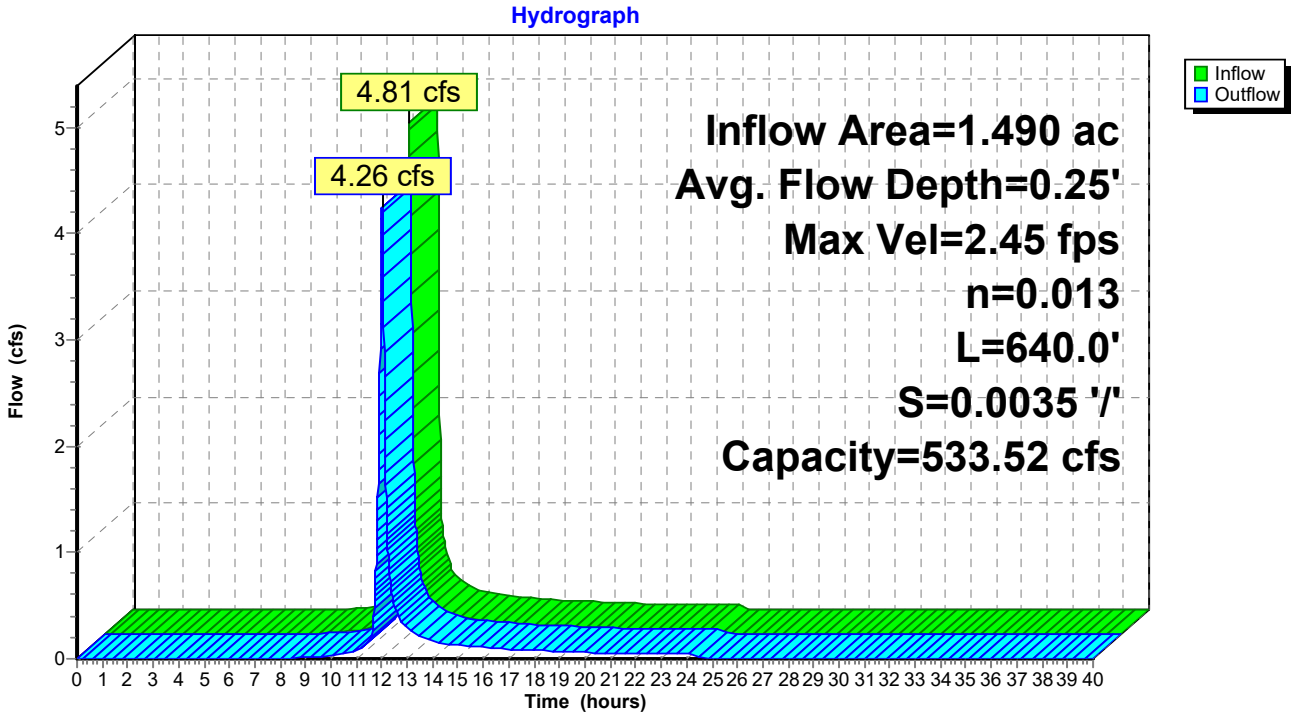
Peak Storage= 1,113 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 533.52 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 640.0' Slope= 0.0035 '/'
Inlet Invert= 7.83', Outlet Invert= 5.57'



‡

Reach W3R: Channel W3



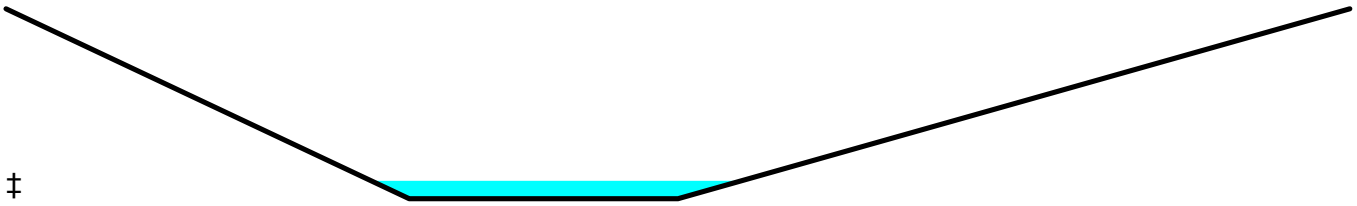
Summary for Reach W4R: Channel W4

Inflow Area = 5.360 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 9.77 cfs @ 11.98 hrs, Volume= 0.812 af
Outflow = 8.38 cfs @ 12.03 hrs, Volume= 0.812 af, Atten= 14%, Lag= 2.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 4.15 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 1.32 fps, Avg. Travel Time= 17.1 min

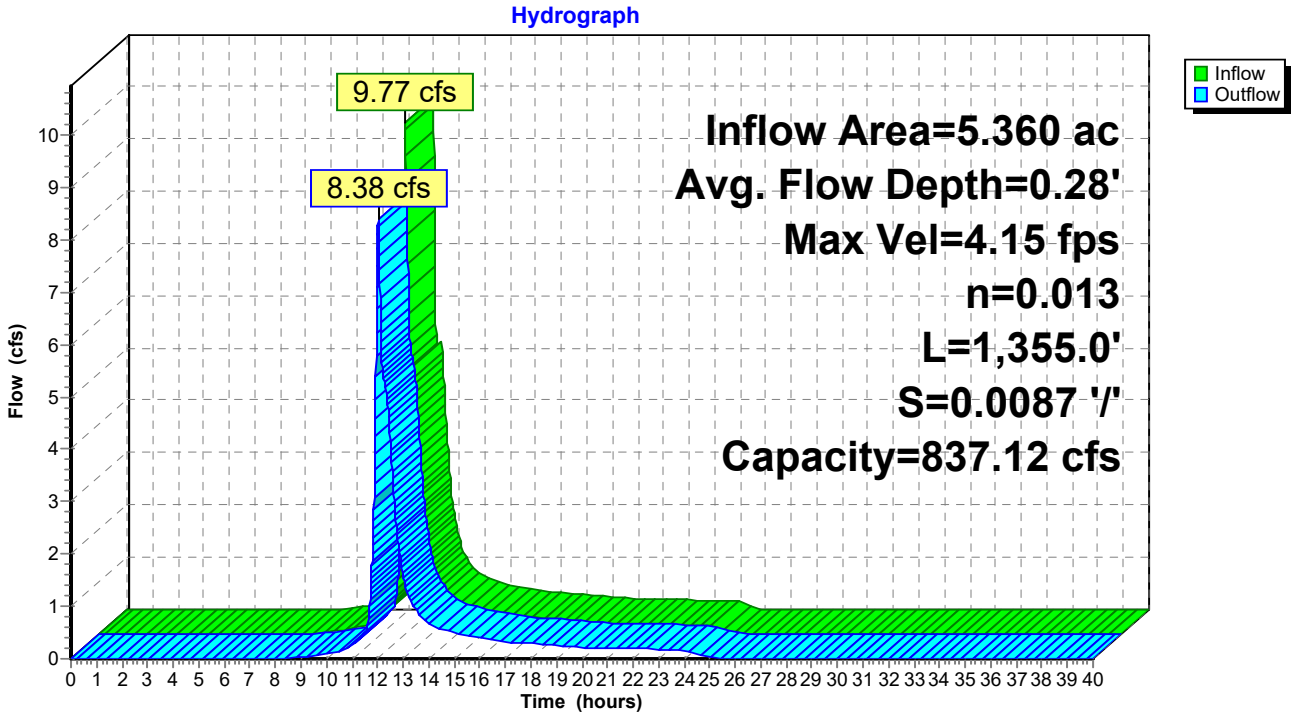
Peak Storage= 2,738 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 837.12 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,355.0' Slope= 0.0087 '/'
Inlet Invert= 17.35', Outlet Invert= 5.57'



‡

Reach W4R: Channel W4



Summary for Pond E1P: Proposed Culvert E1

[62] Hint: Exceeded Reach E1R OUTLET depth by 1.43' @ 12.25 hrs

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 19.77 cfs @ 12.12 hrs, Volume= 1.617 af
Outflow = 17.56 cfs @ 12.21 hrs, Volume= 1.617 af, Atten= 11%, Lag= 5.6 min
Primary = 17.56 cfs @ 12.21 hrs, Volume= 1.617 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 11.19' @ 12.21 hrs Surf.Area= 6,446 sf Storage= 5,037 cf

Plug-Flow detention time= 3.2 min calculated for 1.617 af (100% of inflow)
Center-of-Mass det. time= 3.1 min (845.2 - 842.1)

Volume	Invert	Avail.Storage	Storage Description
#1	9.20'	138,439 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

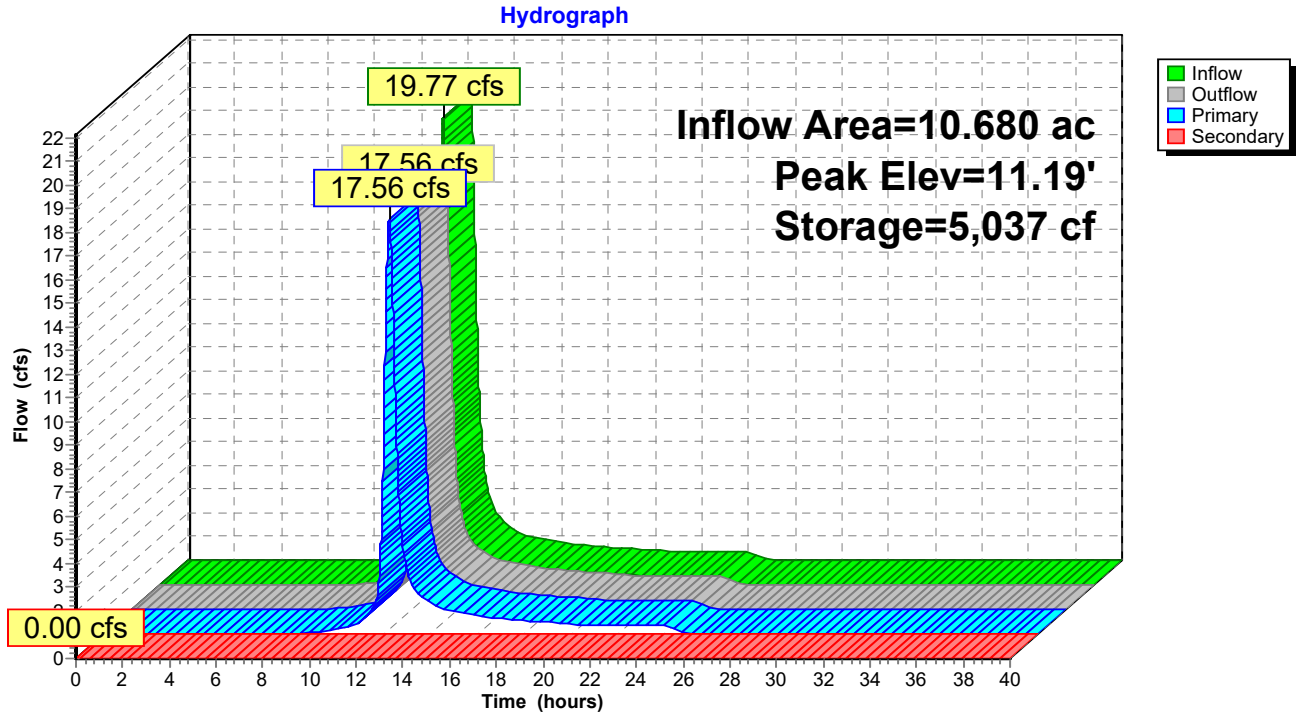
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
9.20	0	0.0	0	0	0
10.00	1,725	385.0	460	460	11,796
11.00	5,530	845.0	3,448	3,908	56,826
12.00	11,180	1,305.0	8,191	12,099	135,535
13.00	18,810	1,770.0	14,831	26,929	249,331
14.00	28,645	2,245.0	23,556	50,485	401,109
15.00	49,400	2,488.0	38,554	89,039	492,663
16.00	49,400	2,488.0	49,400	138,439	495,151

Device	Routing	Invert	Outlet Devices
#1	Primary	9.30'	**36.0" Round 36" Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.30' / 8.70' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=17.55 cfs @ 12.21 hrs HW=11.19' TW=6.00' (Dynamic Tailwater)
↑—**1=36" Culvert** (Barrel Controls 17.55 cfs @ 5.35 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.20' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Proposed Culvert E1



Summary for Pond E2P: Proposed Culvert E2

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 19.22 cfs @ 12.11 hrs, Volume= 1.478 af
Outflow = 18.75 cfs @ 12.15 hrs, Volume= 1.478 af, Atten= 2%, Lag= 2.1 min
Primary = 18.75 cfs @ 12.15 hrs, Volume= 1.478 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 12.79' @ 12.15 hrs Surf.Area= 2,936 sf Storage= 1,491 cf

Plug-Flow detention time= 0.5 min calculated for 1.478 af (100% of inflow)
Center-of-Mass det. time= 0.5 min (836.4 - 835.9)

Volume	Invert	Avail.Storage	Storage Description
#1	11.50'	56,085 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

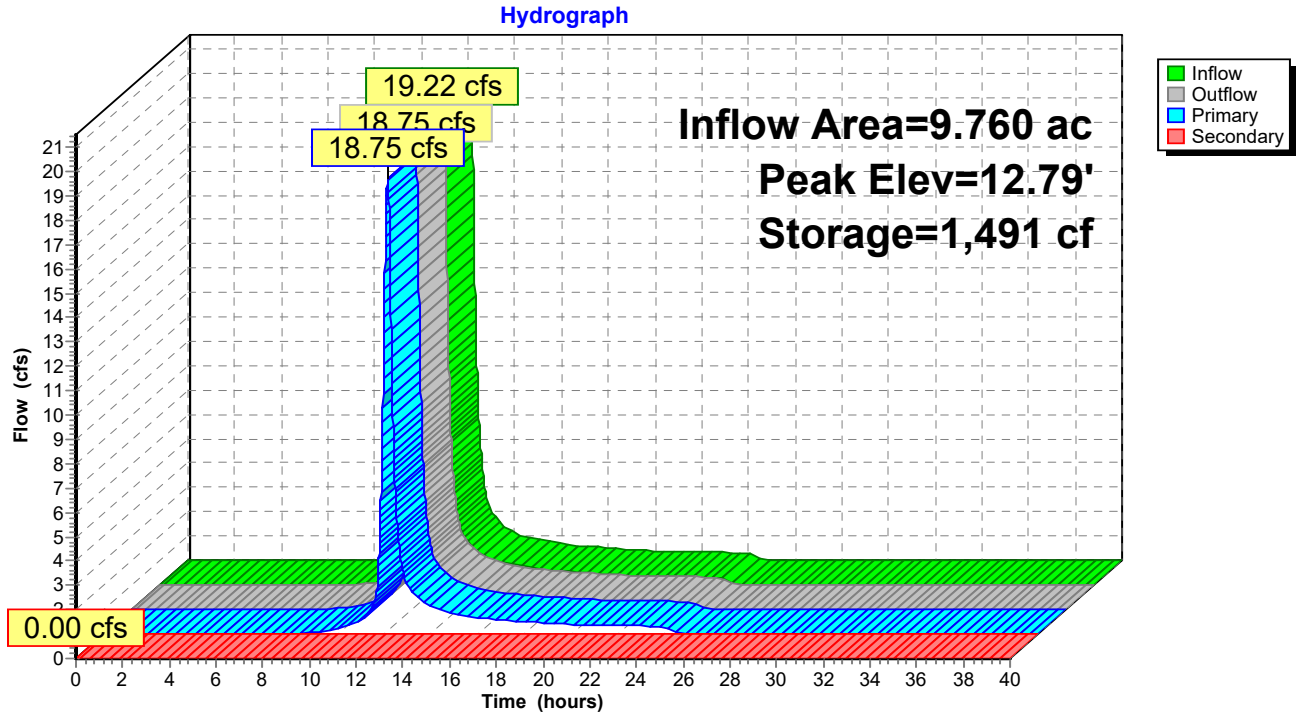
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.50	0	0.0	0	0	0
12.00	765	210.0	128	128	3,510
13.00	3,765	650.0	2,076	2,203	33,625
14.00	8,530	1,095.0	5,987	8,191	95,425
15.00	20,110	1,435.0	13,912	22,103	163,889
16.00	50,095	1,580.0	33,982	56,085	198,711

Device	Routing	Invert	Outlet Devices
#1	Primary	4.12'	**18.0" W x 12.0" H, R=12.0" Elliptical (3) 18x12" Culverts X 3.00** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.12' / 3.60' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.17 sf
#2	Device 1	11.50'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=18.74 cfs @ 12.15 hrs HW=12.79' TW=6.00' (Dynamic Tailwater)
↑—**1=(3) 18x12" Culverts** (Passes 18.74 cfs of 36.18 cfs potential flow)
↑—**2=Orifice/Grate** (Orifice Controls 18.74 cfs @ 3.64 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.50' TW=6.00' (Dynamic Tailwater)
↑—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E2P: Proposed Culvert E2



Summary for Pond E3P: Proposed Culvert E3

[62] Hint: Exceeded Reach E2R OUTLET depth by 1.18' @ 12.20 hrs
[62] Hint: Exceeded Reach E3R OUTLET depth by 1.30' @ 12.21 hrs

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 30.92 cfs @ 12.11 hrs, Volume= 2.368 af
Outflow = 28.09 cfs @ 12.19 hrs, Volume= 2.368 af, Atten= 9%, Lag= 4.3 min
Primary = 28.09 cfs @ 12.19 hrs, Volume= 2.368 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 12.89' @ 12.19 hrs Surf.Area= 8,062 sf Storage= 5,346 cf

Plug-Flow detention time= 1.3 min calculated for 2.368 af (100% of inflow)
Center-of-Mass det. time= 1.3 min (842.5 - 841.2)

Volume	Invert	Avail.Storage	Storage Description
#1	11.20'	87,995 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

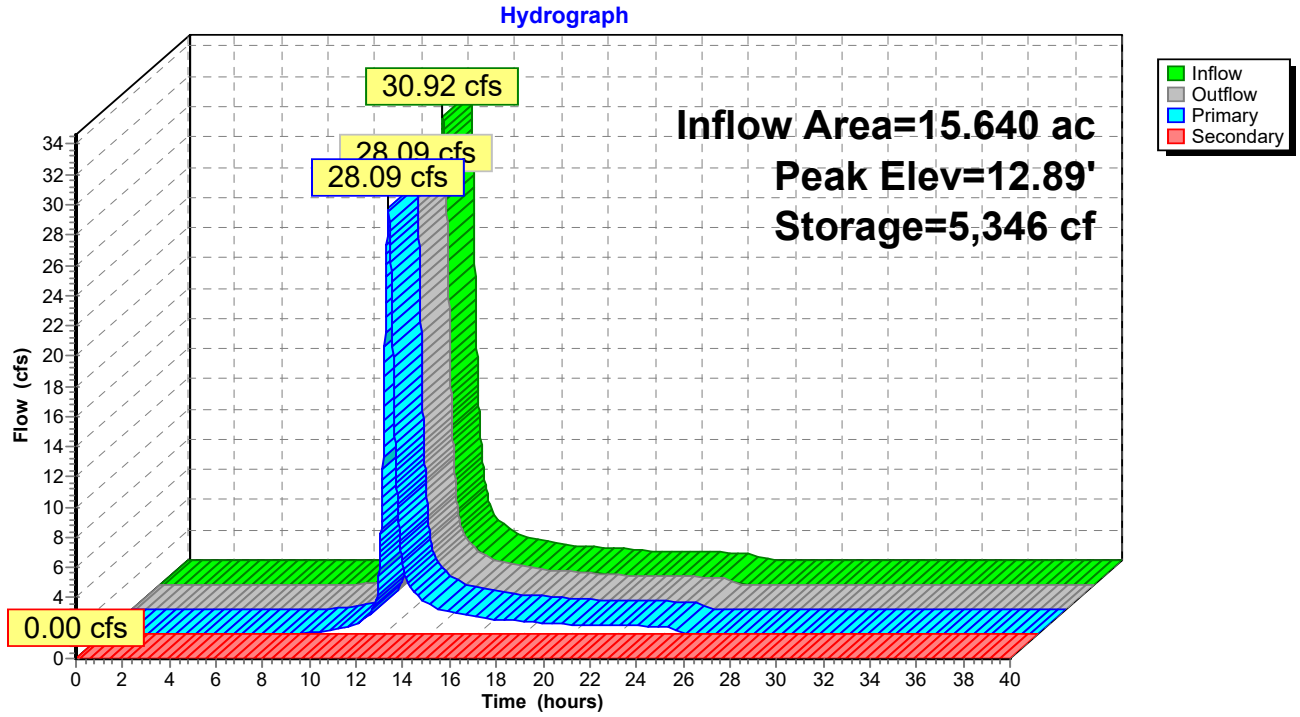
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.20	0	0.0	0	0	0
12.00	2,790	625.0	744	744	31,086
13.00	8,945	1,350.0	5,577	6,321	145,035
14.00	17,465	1,985.0	12,970	19,291	313,567
15.00	30,060	2,655.0	23,479	42,770	560,968
16.00	62,330	3,050.0	45,225	87,995	740,317

Device	Routing	Invert	Outlet Devices
#1	Primary	5.55'	**18.0" Round (3) 18" Culverts X 3.00** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.55' / 5.00' S= 0.0055 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	11.20'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=28.08 cfs @ 12.19 hrs HW=12.88' TW=6.00' (Dynamic Tailwater)
└**1=(3) 18" Culverts** (Passes 28.08 cfs of 58.92 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 28.08 cfs @ 4.17 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' TW=6.00' (Dynamic Tailwater)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E3P: Proposed Culvert E3



Summary for Pond W1P: Proposed Culvert W1

[62] Hint: Exceeded Reach W1R OUTLET depth by 2.56' @ 12.55 hrs
[63] Warning: Exceeded Reach W2R INLET depth by 0.85' @ 12.53 hrs

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 47.33 cfs @ 12.36 hrs, Volume= 5.956 af
Outflow = 41.10 cfs @ 12.52 hrs, Volume= 5.948 af, Atten= 13%, Lag= 9.6 min
Primary = 41.10 cfs @ 12.52 hrs, Volume= 5.948 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 8.76' @ 12.52 hrs Surf.Area= 22,164 sf Storage= 26,776 cf

Plug-Flow detention time= 12.0 min calculated for 5.948 af (100% of inflow)
Center-of-Mass det. time= 11.1 min (865.4 - 854.3)

Volume	Invert	Avail.Storage	Storage Description
#1	5.80'	501,374 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

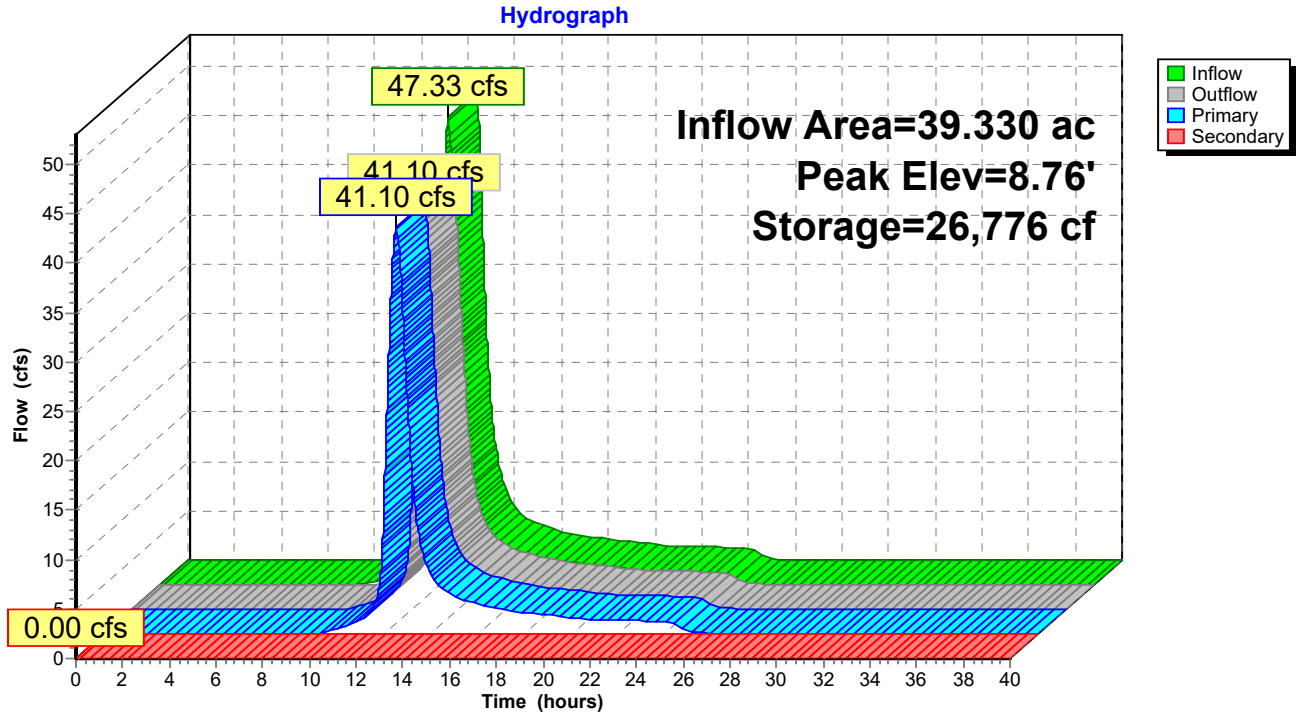
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.80	0	0.0	0	0	0
6.00	475	155.0	32	32	1,912
7.00	5,935	1,130.0	2,696	2,728	101,615
8.00	14,975	2,015.0	10,112	12,840	323,110
9.00	24,795	2,340.0	19,680	32,520	435,763
10.00	41,685	2,720.0	32,876	65,397	588,796
11.00	101,320	3,145.0	69,331	134,728	787,174
12.00	183,080	3,370.0	140,199	274,927	903,870
13.00	272,785	3,650.0	226,447	501,374	1,060,327

Device	Routing	Invert	Outlet Devices
#1	Primary	6.30'	**48.0" Round 48" Culvert** L= 110.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.30' / 5.20' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.25'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=41.10 cfs @ 12.52 hrs HW=8.76' TW=6.00' (Dynamic Tailwater)
1=48" Culvert (Barrel Controls 41.10 cfs @ 7.28 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.80' TW=6.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond W1P: Proposed Culvert W1



Summary for Pond W2P: Proposed Culvert W2

[63] Warning: Exceeded Reach W3R INLET depth by 0.34' @ 12.50 hrs
[62] Hint: Exceeded Reach W4R OUTLET depth by 2.48' @ 12.51 hrs

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 38.04 cfs @ 12.37 hrs, Volume= 4.822 af
Outflow = 34.60 cfs @ 12.49 hrs, Volume= 4.817 af, Atten= 9%, Lag= 7.2 min
Primary = 34.60 cfs @ 12.49 hrs, Volume= 4.817 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 8.24' @ 12.49 hrs Surf.Area= 15,096 sf Storage= 16,329 cf

Plug-Flow detention time= 9.6 min calculated for 4.817 af (100% of inflow)
Center-of-Mass det. time= 9.0 min (862.7 - 853.7)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	454,263 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

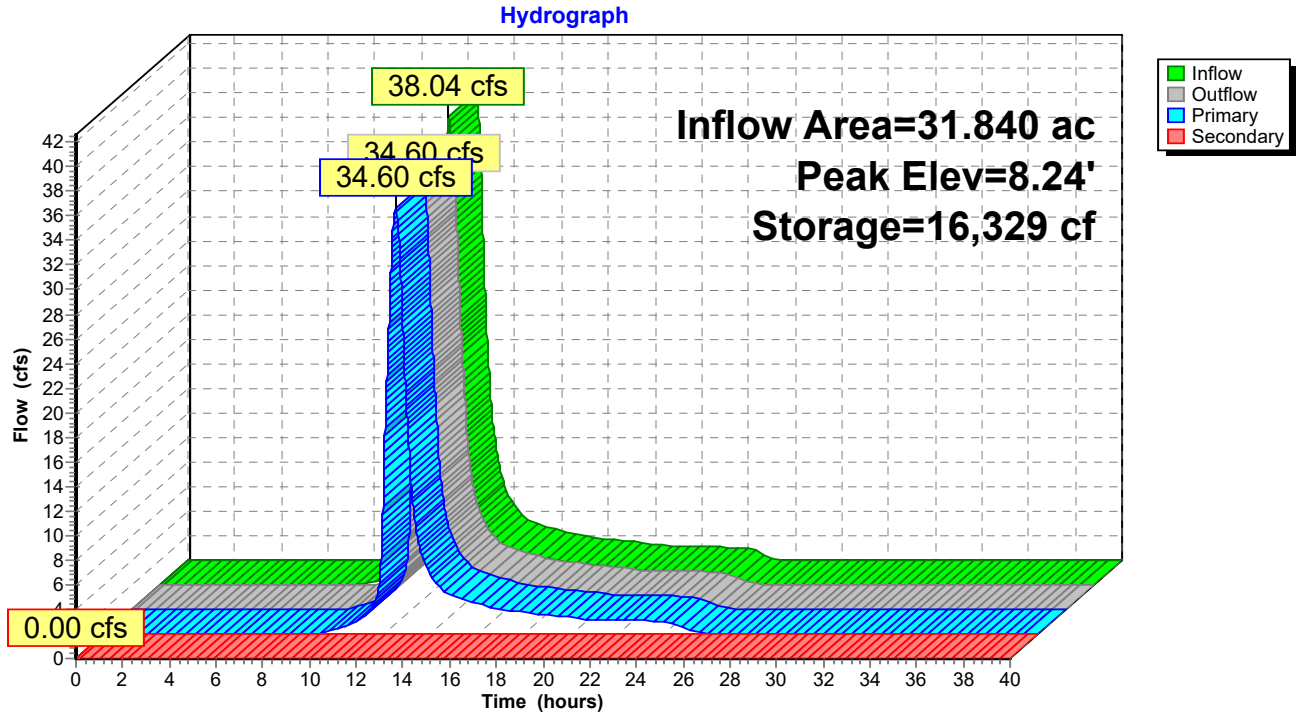
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	0	0.0	0	0	0
6.00	1,200	320.0	160	160	8,149
7.00	6,000	1,030.0	3,294	3,454	84,427
8.00	13,375	1,650.0	9,444	12,899	216,660
9.00	21,190	1,805.0	17,133	30,032	259,310
10.00	38,310	2,000.0	29,331	59,363	318,386
11.00	86,665	2,220.0	60,865	120,228	392,295
12.00	166,100	2,600.0	124,248	244,476	538,069
13.00	256,750	3,035.0	209,787	454,263	733,152

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**48.0" Round 48" Culvert** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0095 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=34.60 cfs @ 12.49 hrs HW=8.24' TW=6.00' (Dynamic Tailwater)
↑—**1=48" Culvert** (Barrel Controls 34.60 cfs @ 6.90 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.60' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W2P: Proposed Culvert W2



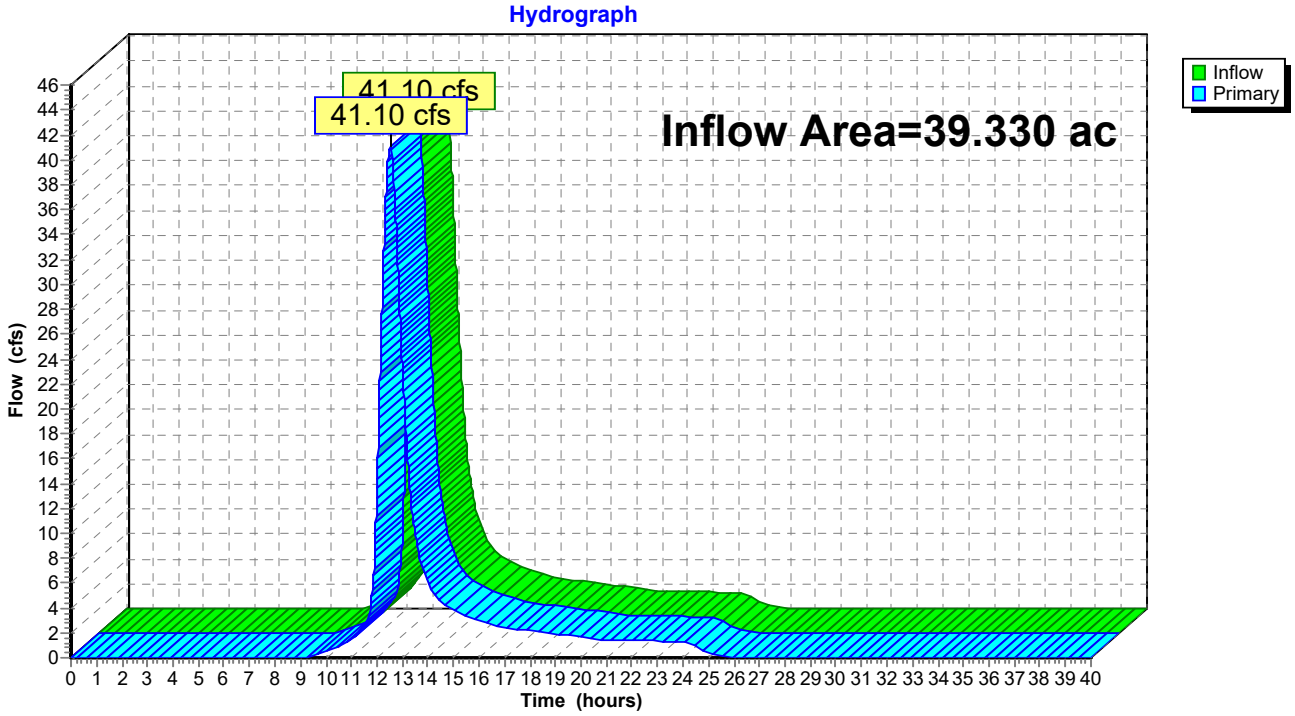
Summary for Link 1L: Thermal Channel

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 1.81" for 2yr, 24hr event
Inflow = 41.10 cfs @ 12.52 hrs, Volume= 5.948 af
Primary = 41.10 cfs @ 12.52 hrs, Volume= 5.948 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 1L: Thermal Channel



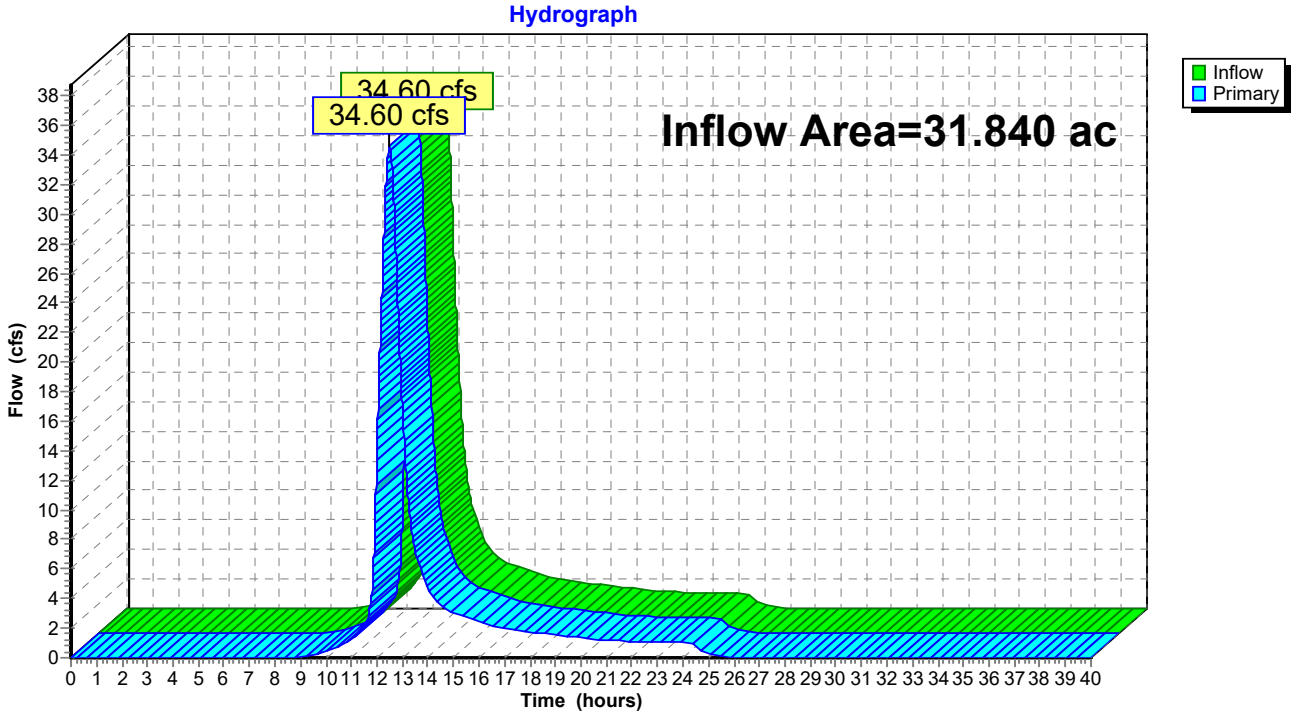
Summary for Link 2L: Thermal Channel

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 34.60 cfs @ 12.49 hrs, Volume= 4.817 af
Primary = 34.60 cfs @ 12.49 hrs, Volume= 4.817 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 2L: Thermal Channel



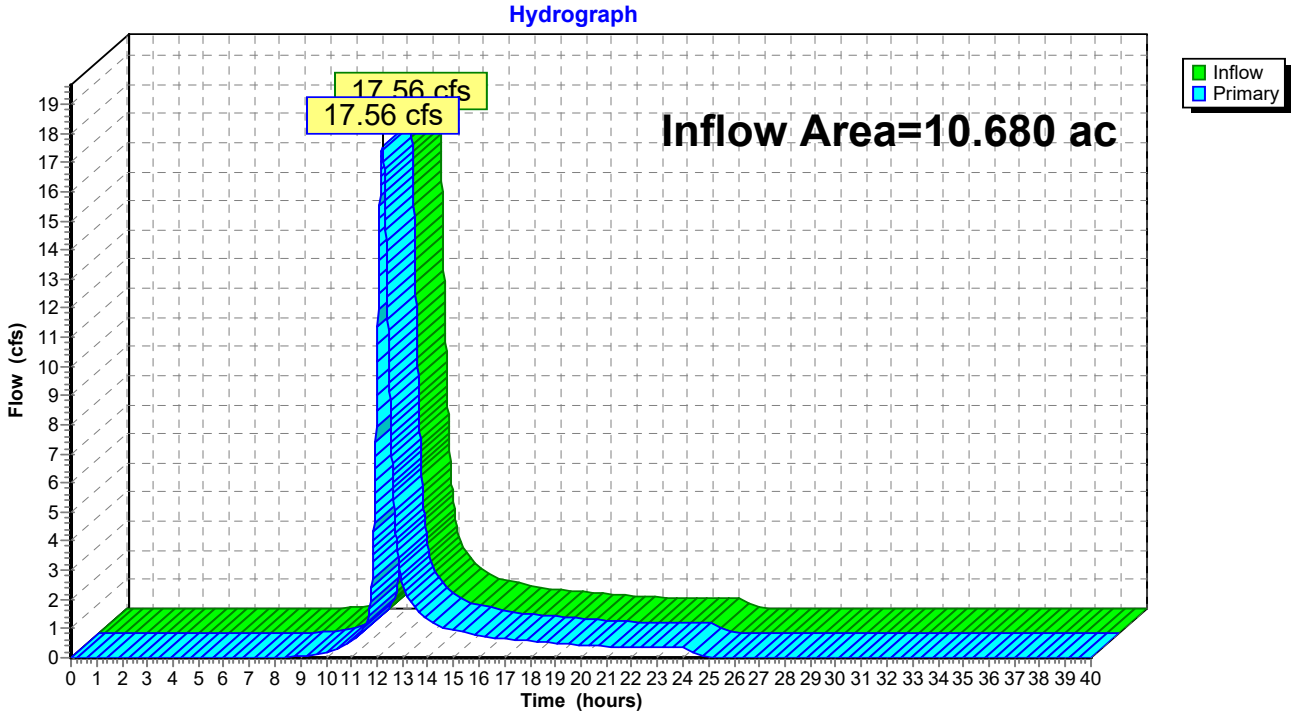
Summary for Link 4L: Ex Channel

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 17.56 cfs @ 12.21 hrs, Volume= 1.617 af
Primary = 17.56 cfs @ 12.21 hrs, Volume= 1.617 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 4L: Ex Channel



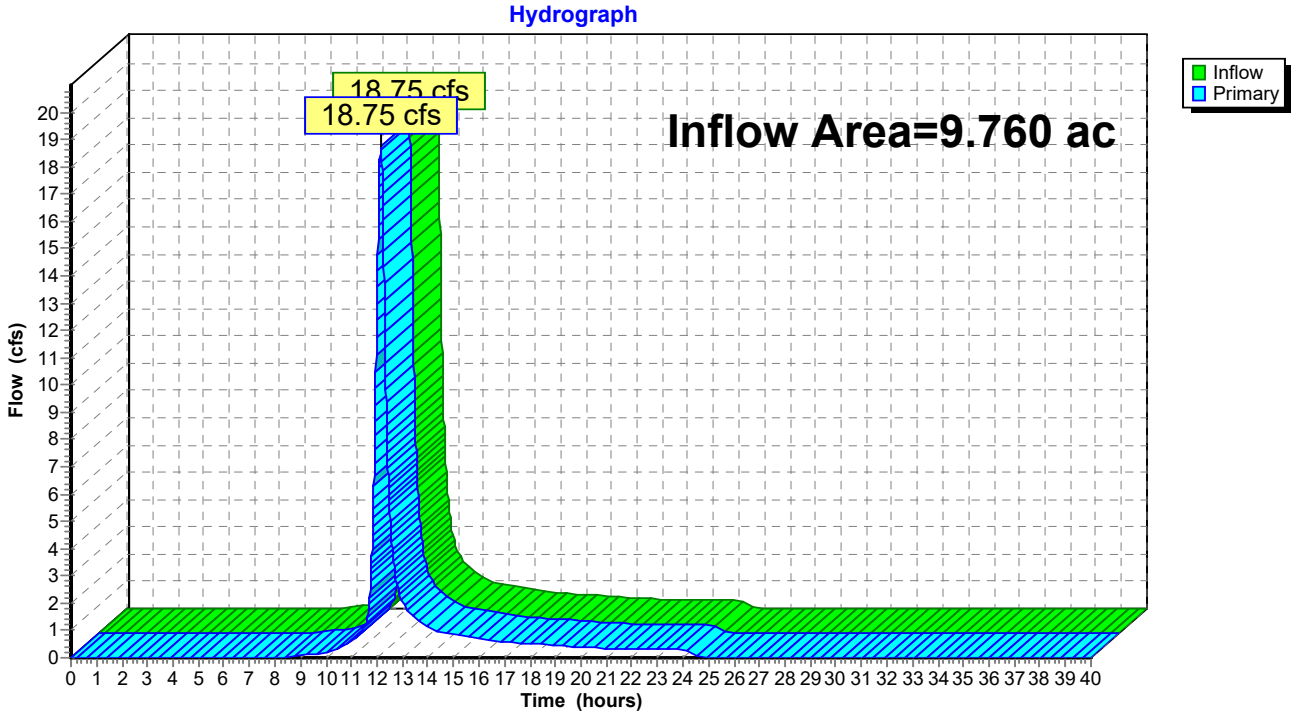
Summary for Link 5L: Swamp

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 18.75 cfs @ 12.15 hrs, Volume= 1.478 af
Primary = 18.75 cfs @ 12.15 hrs, Volume= 1.478 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 5L: Swamp



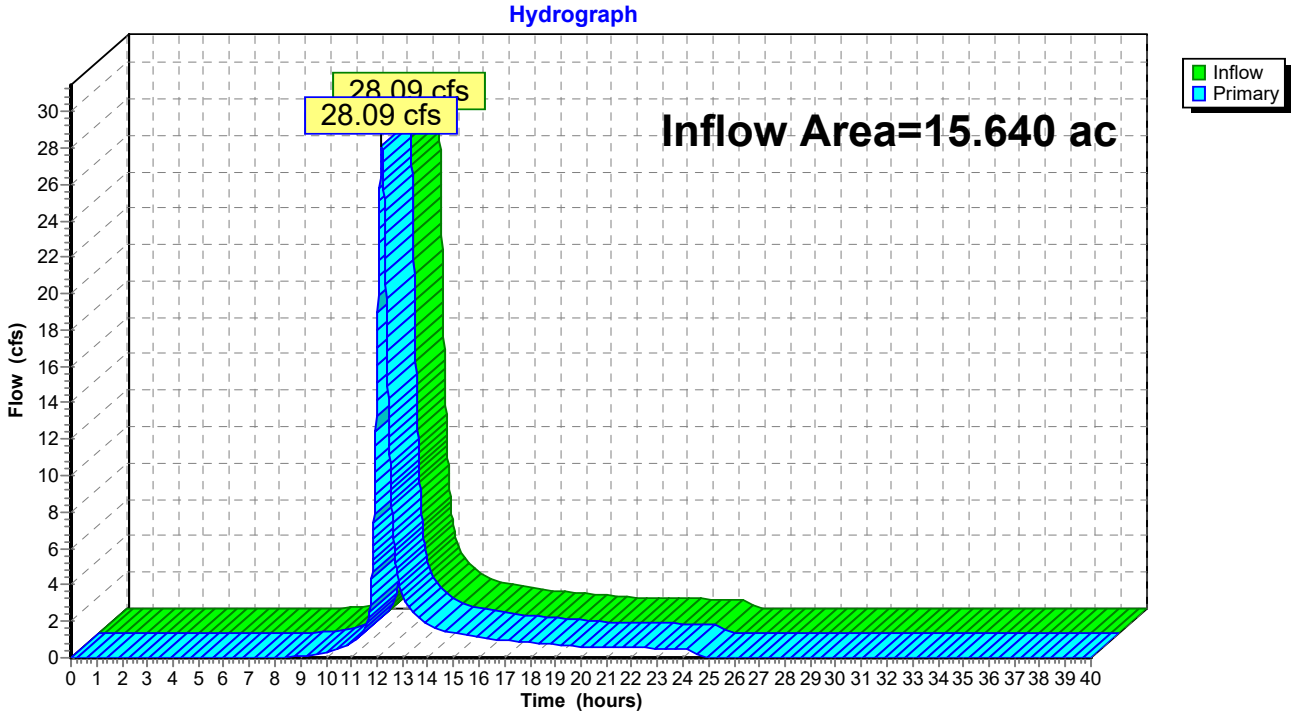
Summary for Link 6L: Swamp

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 28.09 cfs @ 12.19 hrs, Volume= 2.368 af
Primary = 28.09 cfs @ 12.19 hrs, Volume= 2.368 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 6L: Swamp



Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1S: DA E1 Runoff Area=8.090 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=645' Tc=19.9 min CN=84 Runoff=30.23 cfs 2.273 af

Subcatchment E2S: DA E2 Runoff Area=9.110 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=610' Tc=19.5 min CN=84 Runoff=34.47 cfs 2.559 af

Subcatchment E3S: DA E3 Runoff Area=8.380 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=610' Tc=19.5 min CN=84 Runoff=31.71 cfs 2.354 af

Subcatchment E4S: DA E4 Runoff Area=3.750 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=490' Slope=0.0141 '/' Tc=18.4 min CN=84 Runoff=14.61 cfs 1.053 af

Subcatchment E5S: DA E5 Runoff Area=1.110 ac 0.00% Impervious Runoff Depth=3.37"
Tc=10.0 min CN=84 Runoff=5.65 cfs 0.312 af

Subcatchment E6S: DA E6 Runoff Area=1.480 ac 0.00% Impervious Runoff Depth=3.37"
Tc=10.0 min CN=84 Runoff=7.54 cfs 0.416 af

Subcatchment E7S: DA E7 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=3.80 cfs 0.183 af

Subcatchment E8S: DA E8 Runoff Area=3.510 ac 0.00% Impervious Runoff Depth=3.37"
Tc=10.0 min CN=84 Runoff=17.88 cfs 0.986 af

Subcatchment W1S: DA W1 Runoff Area=9.130 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=1,055' Tc=35.3 min CN=84 Runoff=23.92 cfs 2.565 af

Subcatchment W2S: DA W2 Runoff Area=24.910 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=1,485' Tc=40.3 min CN=84 Runoff=59.64 cfs 6.998 af

Subcatchment W3S: DA W3 Runoff Area=24.990 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=1,470' Tc=40.2 min CN=84 Runoff=60.12 cfs 7.021 af

Subcatchment W4S: DA W4 Runoff Area=2.770 ac 0.00% Impervious Runoff Depth=3.37"
Flow Length=820' Tc=32.8 min CN=84 Runoff=7.64 cfs 0.778 af

Subcatchment W5S: DA W5 Runoff Area=3.650 ac 0.00% Impervious Runoff Depth=3.37"
Tc=10.0 min CN=84 Runoff=18.59 cfs 1.025 af

Subcatchment W6S: DA W6 Runoff Area=1.640 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=9.58 cfs 0.461 af

Subcatchment W7S: DA W7 Runoff Area=1.490 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=8.71 cfs 0.419 af

Subcatchment W8S: DA W8 Runoff Area=2.590 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=15.14 cfs 0.728 af

Reach E1R: Channel E1 Avg. Flow Depth=0.72' Max Vel=5.33 fps Inflow=34.99 cfs 2.689 af
n=0.013 L=1,005.0' S=0.0050 '/' Capacity=635.79 cfs Outflow=33.97 cfs 2.689 af

Reach E2R: Channel E2 Avg. Flow Depth=0.68' Max Vel=5.19 fps Inflow=31.71 cfs 2.354 af
n=0.013 L=805.0' S=0.0050 '/' Capacity=636.03 cfs Outflow=30.96 cfs 2.354 af

Reach E3R: Channel E3 Avg. Flow Depth=0.60' Max Vel=5.81 fps Inflow=30.24 cfs 2.040 af
n=0.013 L=845.0' S=0.0072 '/' Capacity=764.06 cfs Outflow=29.37 cfs 2.040 af

Reach W1R: Channel W1 Avg. Flow Depth=0.54' Max Vel=6.39 fps Inflow=29.63 cfs 3.590 af
n=0.013 L=1,461.5' S=0.0099 '/' Capacity=892.42 cfs Outflow=28.22 cfs 3.590 af

Reach W2R: Channel W2 Avg. Flow Depth=0.39' Max Vel=2.92 fps Inflow=9.58 cfs 0.461 af
n=0.013 L=660.0' S=0.0030 '/' Capacity=489.26 cfs Outflow=8.70 cfs 0.461 af

Reach W3R: Channel W3 Avg. Flow Depth=0.36' Max Vel=3.02 fps Inflow=8.71 cfs 0.419 af
n=0.013 L=640.0' S=0.0035 '/' Capacity=533.52 cfs Outflow=7.98 cfs 0.419 af

Reach W4R: Channel W4 Avg. Flow Depth=0.41' Max Vel=5.13 fps Inflow=17.95 cfs 1.506 af
n=0.013 L=1,355.0' S=0.0087 '/' Capacity=837.12 cfs Outflow=16.09 cfs 1.506 af

Pond E1P: Proposed Culvert E1 Peak Elev=11.98' Storage=11,921 cf Inflow=37.14 cfs 3.000 af
Primary=30.70 cfs 3.000 af Secondary=0.00 cfs 0.000 af Outflow=30.70 cfs 3.000 af

Pond E2P: Proposed Culvert E2 Peak Elev=13.41' Storage=4,073 cf Inflow=35.41 cfs 2.742 af
Primary=33.82 cfs 2.742 af Secondary=0.00 cfs 0.000 af Outflow=33.82 cfs 2.742 af

Pond E3P: Proposed Culvert E3 Peak Elev=13.73' Storage=14,944 cf Inflow=57.59 cfs 4.394 af
Primary=46.73 cfs 4.394 af Secondary=0.00 cfs 0.000 af Outflow=46.73 cfs 4.394 af

Pond W1P: Proposed Culvert W1 Peak Elev=9.82' Storage=58,206 cf Inflow=87.65 cfs 11.049 af
Primary=71.22 cfs 11.042 af Secondary=0.00 cfs 0.000 af Outflow=71.22 cfs 11.042 af

Pond W2P: Proposed Culvert W2 Peak Elev=9.23' Storage=35,319 cf Inflow=70.34 cfs 8.945 af
Primary=61.54 cfs 8.941 af Secondary=0.00 cfs 0.000 af Outflow=61.54 cfs 8.941 af

Link 1L: Thermal Channel Inflow=71.22 cfs 11.042 af
Primary=71.22 cfs 11.042 af

Link 2L: Thermal Channel Inflow=61.54 cfs 8.941 af
Primary=61.54 cfs 8.941 af

Link 4L: Ex Channel Inflow=30.70 cfs 3.000 af
Primary=30.70 cfs 3.000 af

Link 5L: Swamp Inflow=33.82 cfs 2.742 af
Primary=33.82 cfs 2.742 af

Link 6L: Swamp Inflow=46.73 cfs 4.394 af
Primary=46.73 cfs 4.394 af

Total Runoff Area = 107.250 ac Runoff Volume = 30.130 af Average Runoff Depth = 3.37"
100.00% Pervious = 107.250 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E1S: DA E1

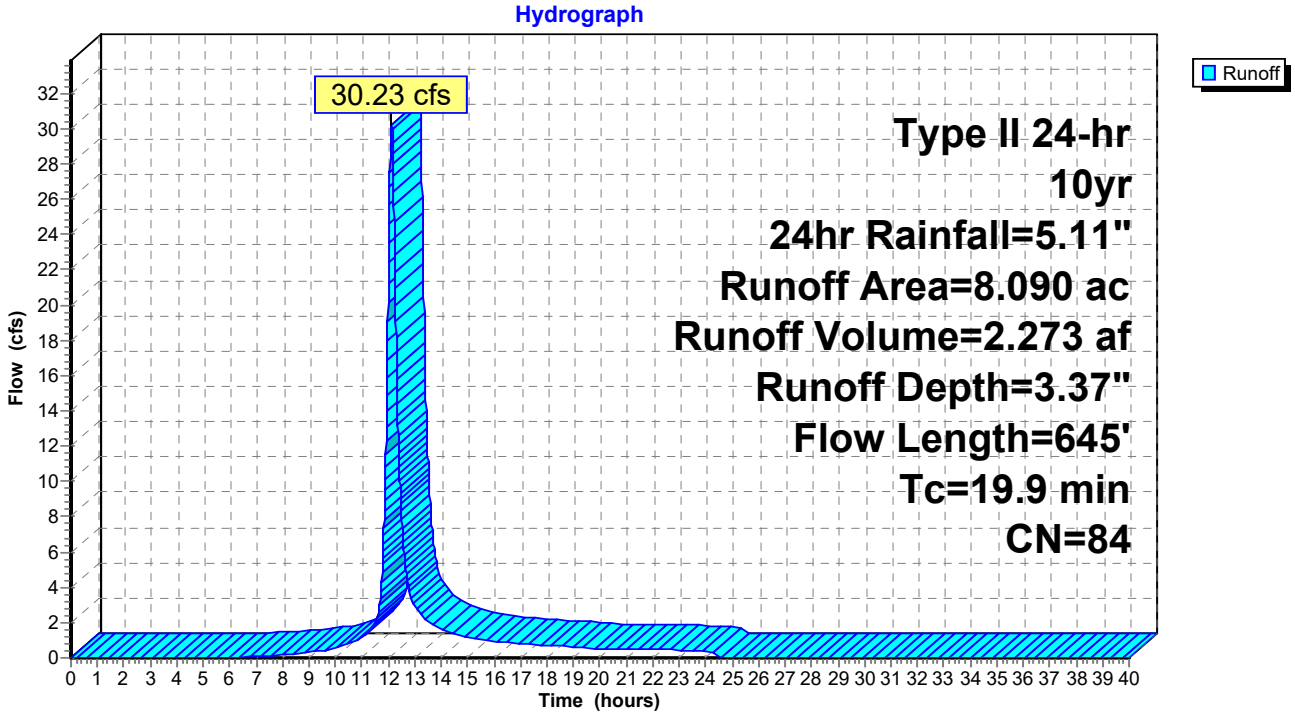
Runoff = 30.23 cfs @ 12.12 hrs, Volume= 2.273 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
8.090	84	50-75% Grass cover, Fair, HSG D
8.090		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.5	150	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.9	645	Total			

Subcatchment E1S: DA E1



Summary for Subcatchment E2S: DA E2

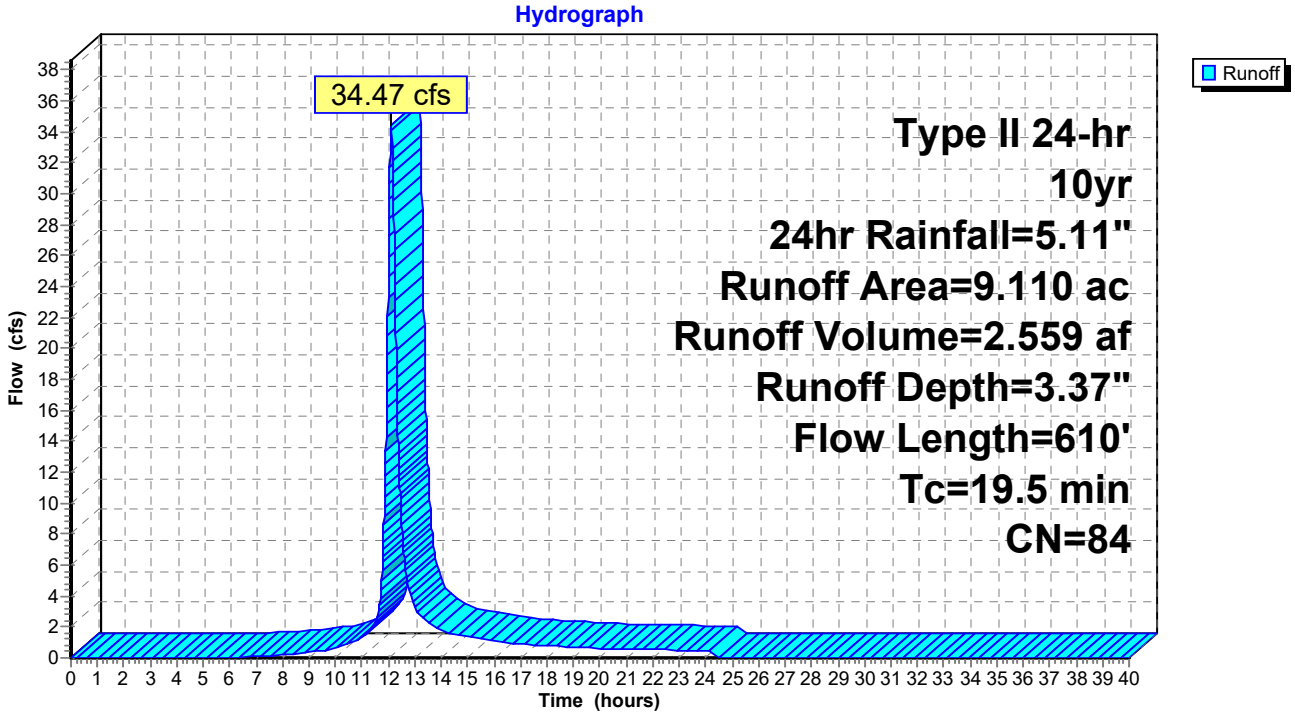
Runoff = 34.47 cfs @ 12.11 hrs, Volume= 2.559 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
9.110	84	50-75% Grass cover, Fair, HSG D
9.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E2S: DA E2



Summary for Subcatchment E3S: DA E3

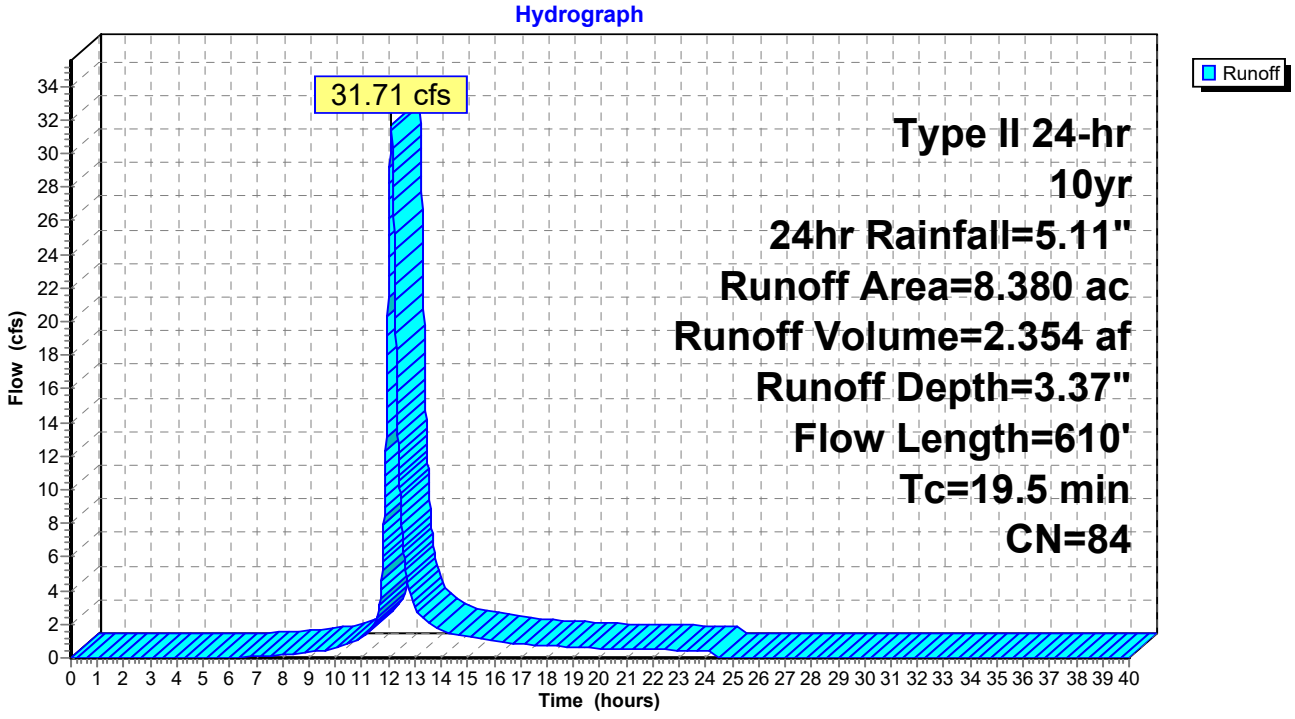
Runoff = 31.71 cfs @ 12.11 hrs, Volume= 2.354 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
8.380	84	50-75% Grass cover, Fair, HSG D
8.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E3S: DA E3



Summary for Subcatchment E4S: DA E4

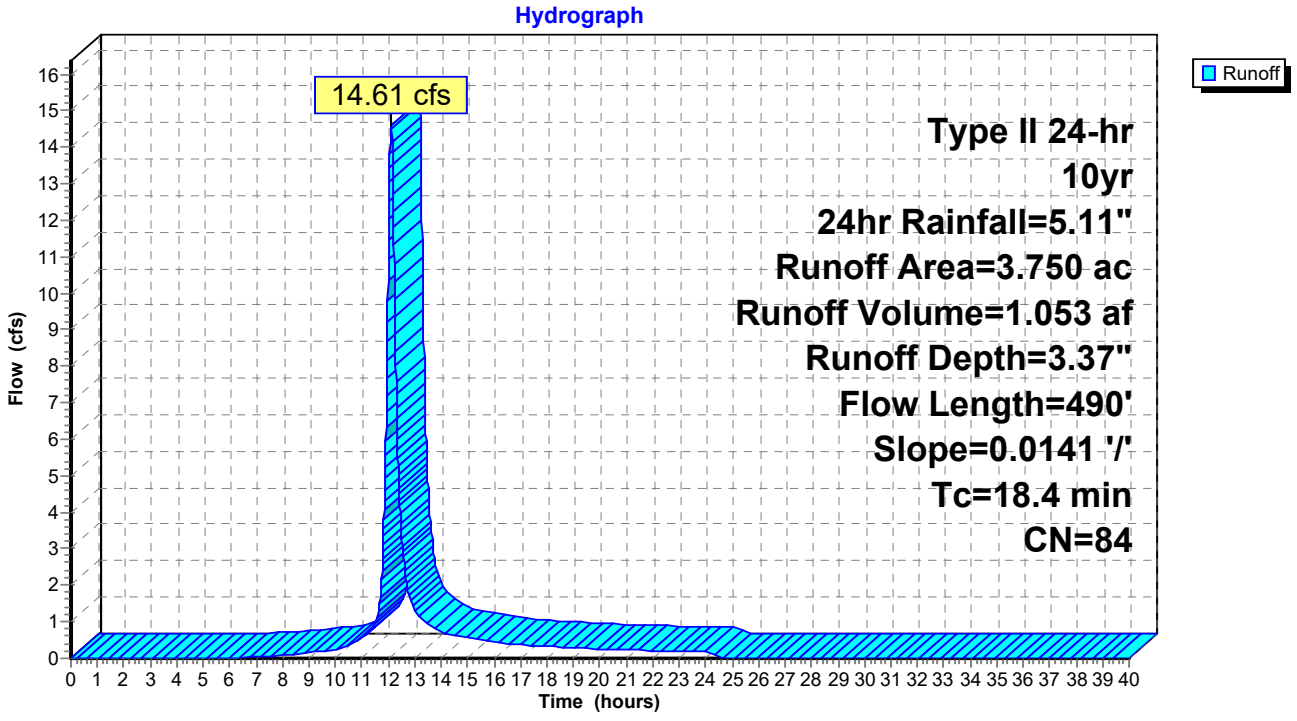
Runoff = 14.61 cfs @ 12.10 hrs, Volume= 1.053 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
3.750	84	50-75% Grass cover, Fair, HSG D
3.750		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	340	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
18.4	490	Total			

Subcatchment E4S: DA E4



Summary for Subcatchment E5S: DA E5

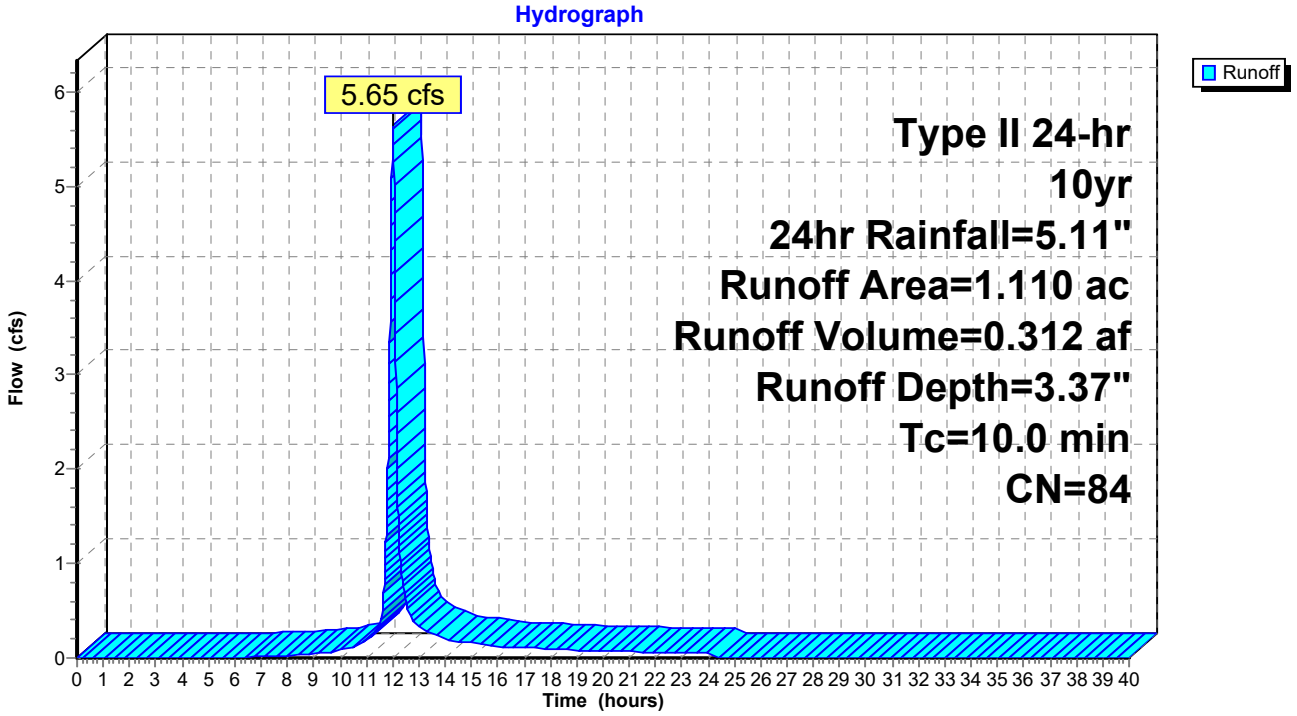
Runoff = 5.65 cfs @ 12.01 hrs, Volume= 0.312 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
1.110	84	50-75% Grass cover, Fair, HSG D
1.110		100.00% Pervious Area

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

Subcatchment E5S: DA E5



Summary for Subcatchment E6S: DA E6

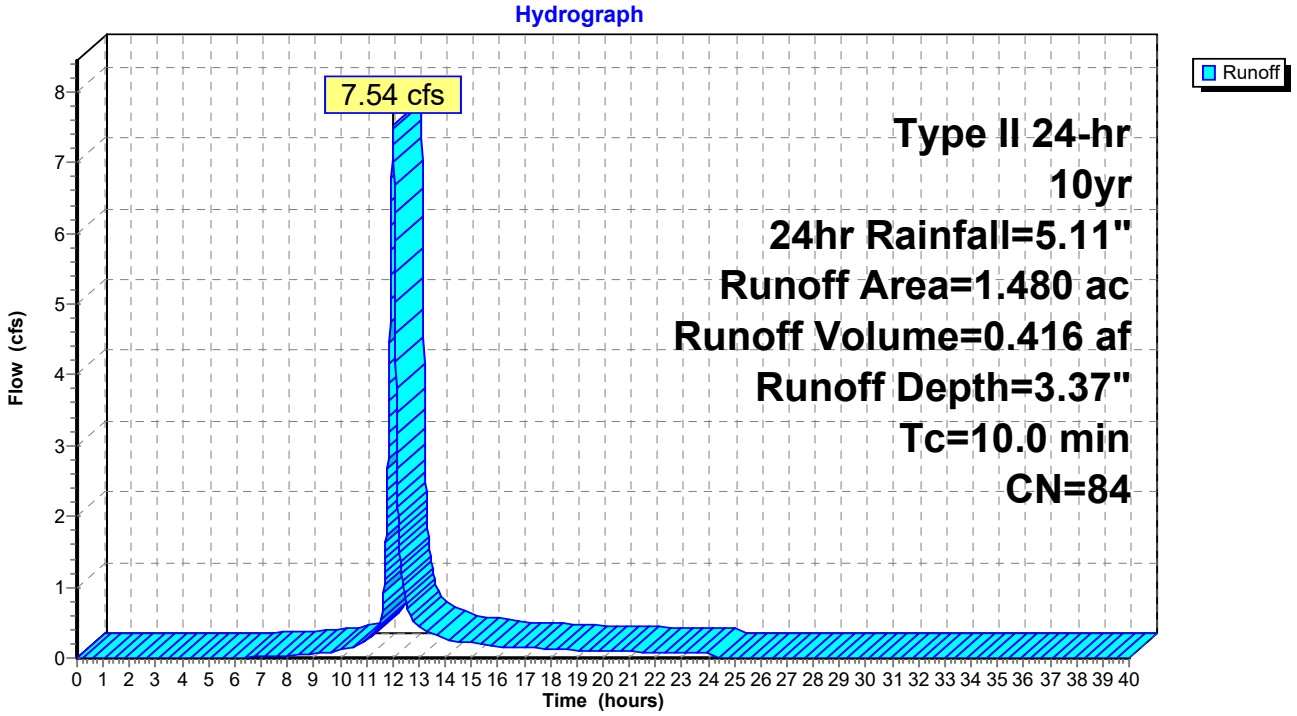
Runoff = 7.54 cfs @ 12.01 hrs, Volume= 0.416 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
1.480	84	50-75% Grass cover, Fair, HSG D
1.480		100.00% Pervious Area

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

Subcatchment E6S: DA E6



Summary for Subcatchment E7S: DA E7

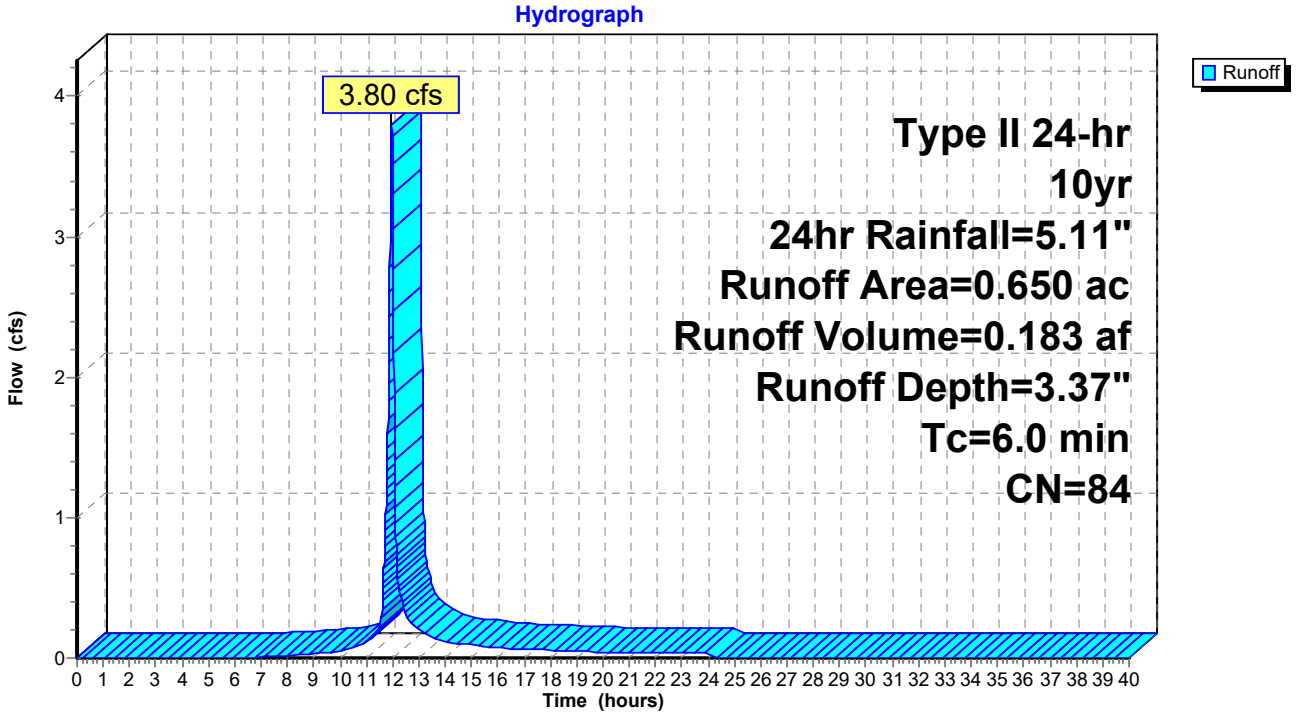
Runoff = 3.80 cfs @ 11.97 hrs, Volume= 0.183 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
0.650	84	50-75% Grass cover, Fair, HSG D
0.650		100.00% Pervious Area

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

Subcatchment E7S: DA E7



Summary for Subcatchment E8S: DA E8

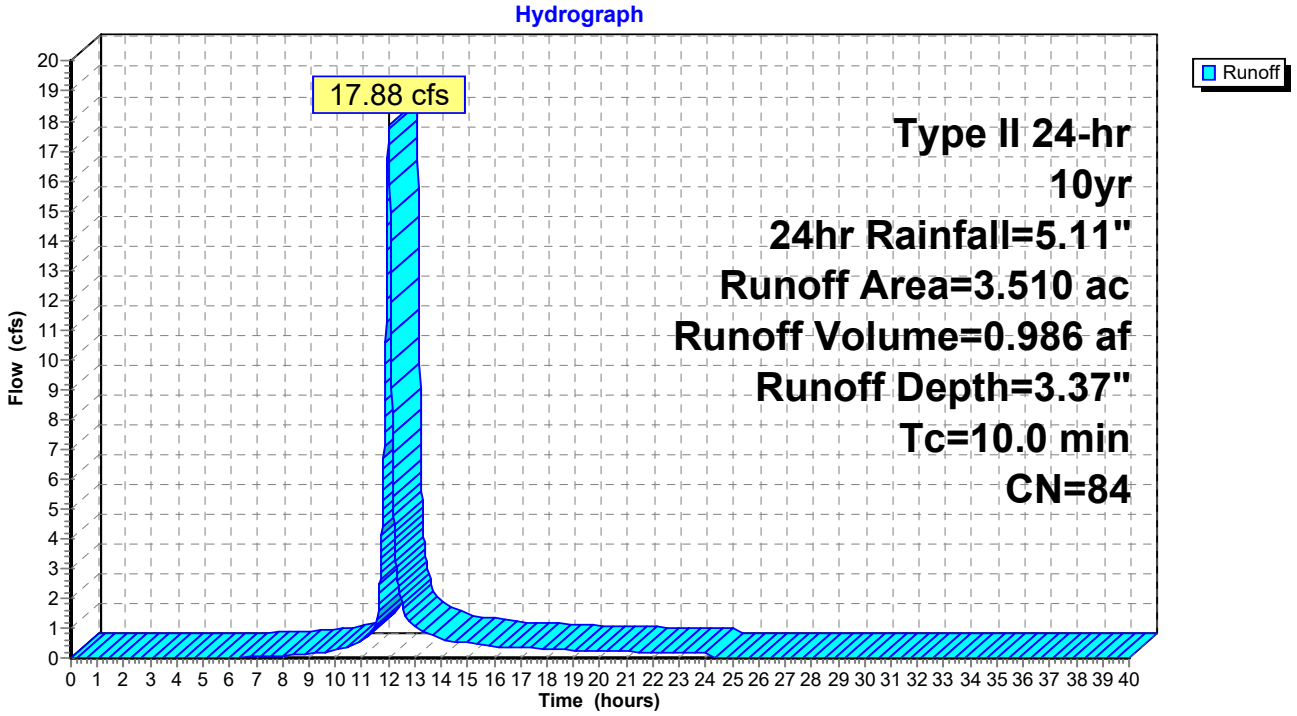
Runoff = 17.88 cfs @ 12.01 hrs, Volume= 0.986 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
3.510	84	50-75% Grass cover, Fair, HSG D
3.510		100.00% Pervious Area

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

Subcatchment E8S: DA E8



Summary for Subcatchment W1S: DA W1

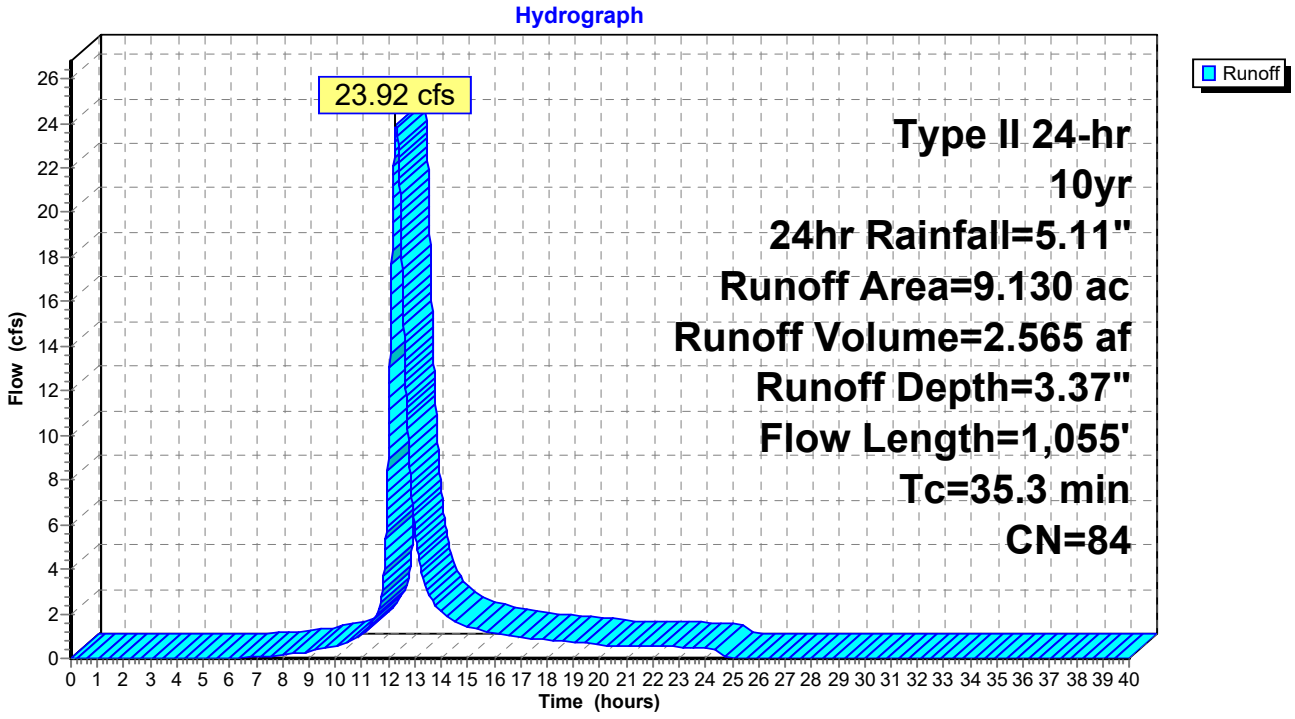
Runoff = 23.92 cfs @ 12.28 hrs, Volume= 2.565 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
9.130	84	50-75% Grass cover, Fair, HSG D
9.130		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.9	565	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
3.4	340	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
35.3	1,055	Total			

Subcatchment W1S: DA W1



Summary for Subcatchment W2S: DA W2

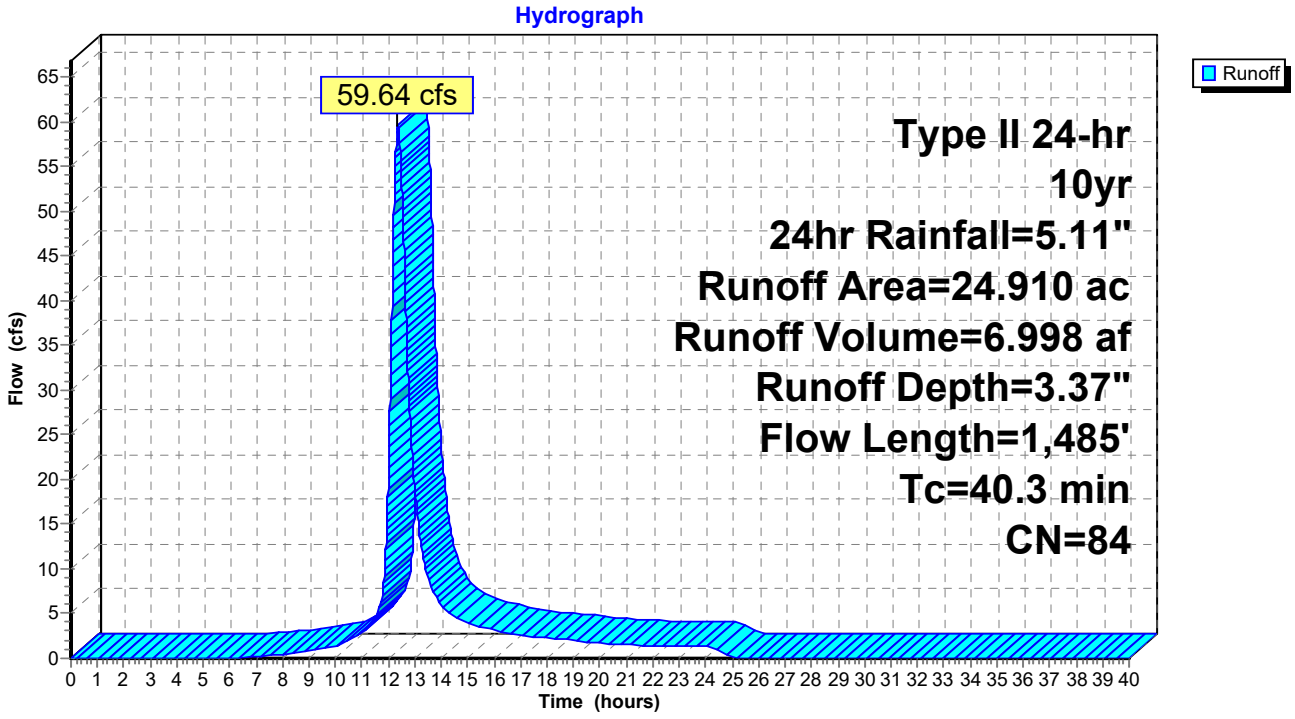
Runoff = 59.64 cfs @ 12.36 hrs, Volume= 6.998 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
24.910	84	50-75% Grass cover, Fair, HSG D
24.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	665	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.9	670	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.3	1,485	Total			

Subcatchment W2S: DA W2



Summary for Subcatchment W3S: DA W3

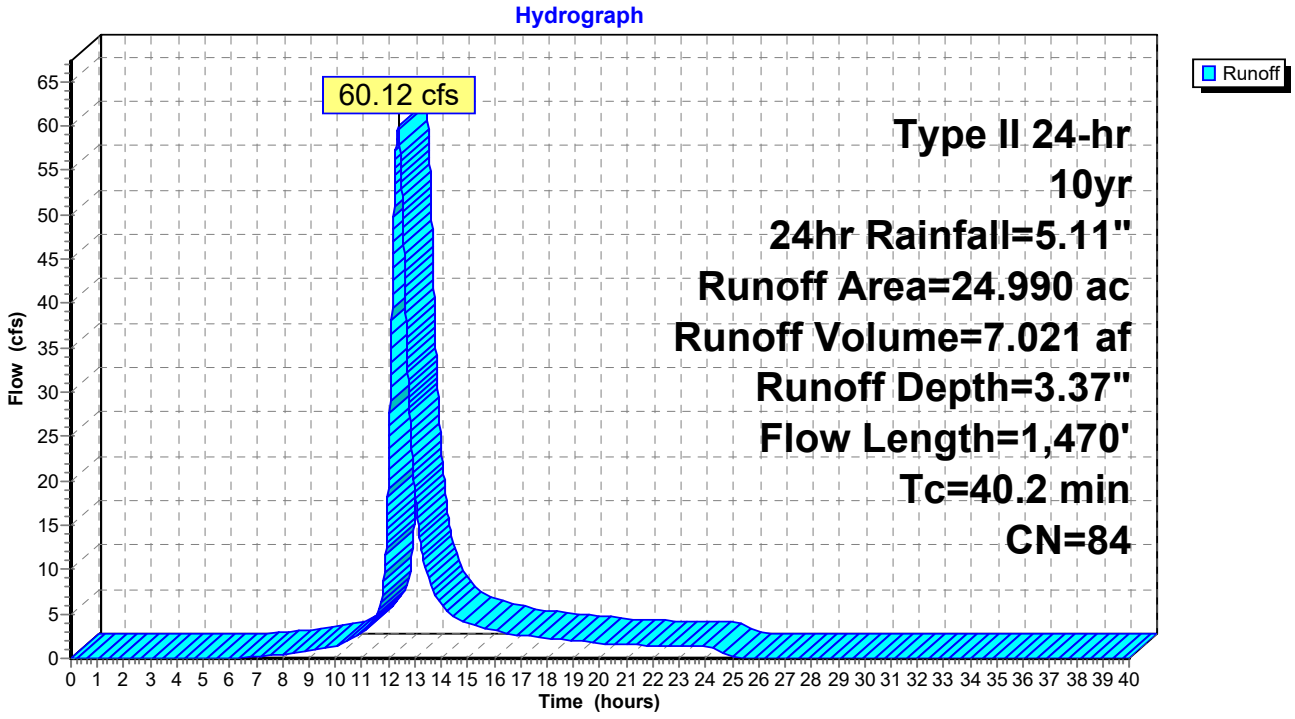
Runoff = 60.12 cfs @ 12.37 hrs, Volume= 7.021 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
24.990	84	50-75% Grass cover, Fair, HSG D
24.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	660	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.8	660	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.2	1,470	Total			

Subcatchment W3S: DA W3



Summary for Subcatchment W4S: DA W4

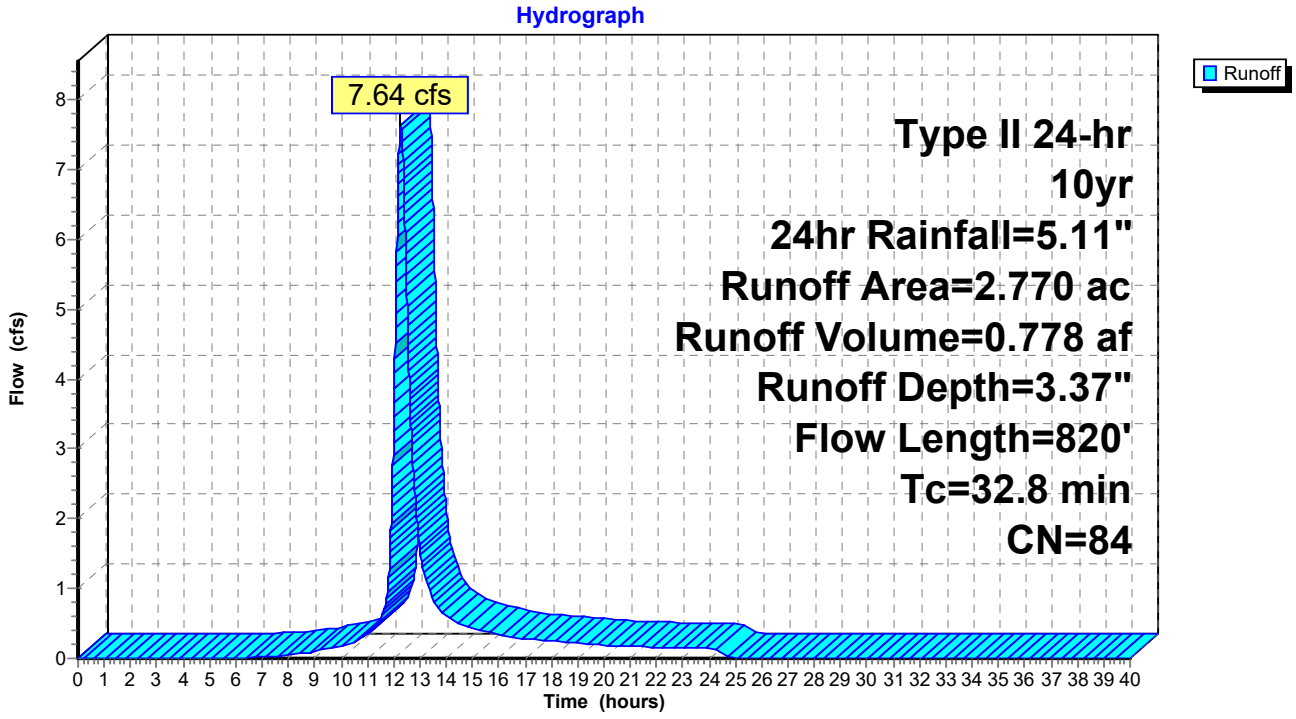
Runoff = 7.64 cfs @ 12.28 hrs, Volume= 0.778 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
2.770	84	50-75% Grass cover, Fair, HSG D
2.770		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.6	550	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
1.2	120	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
32.8	820	Total			

Subcatchment W4S: DA W4



Summary for Subcatchment W5S: DA W5

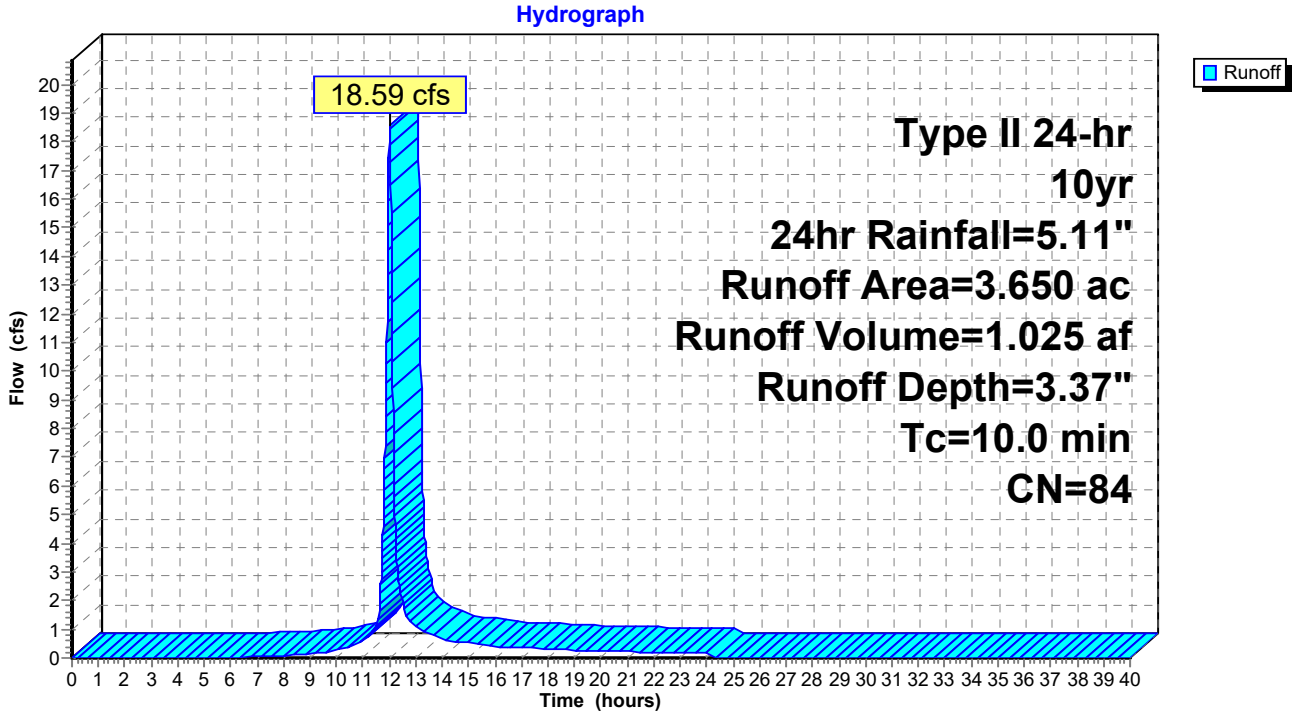
Runoff = 18.59 cfs @ 12.01 hrs, Volume= 1.025 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
3.650	84	50-75% Grass cover, Fair, HSG D
3.650		100.00% Pervious Area

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

Subcatchment W5S: DA W5



Summary for Subcatchment W6S: DA W6

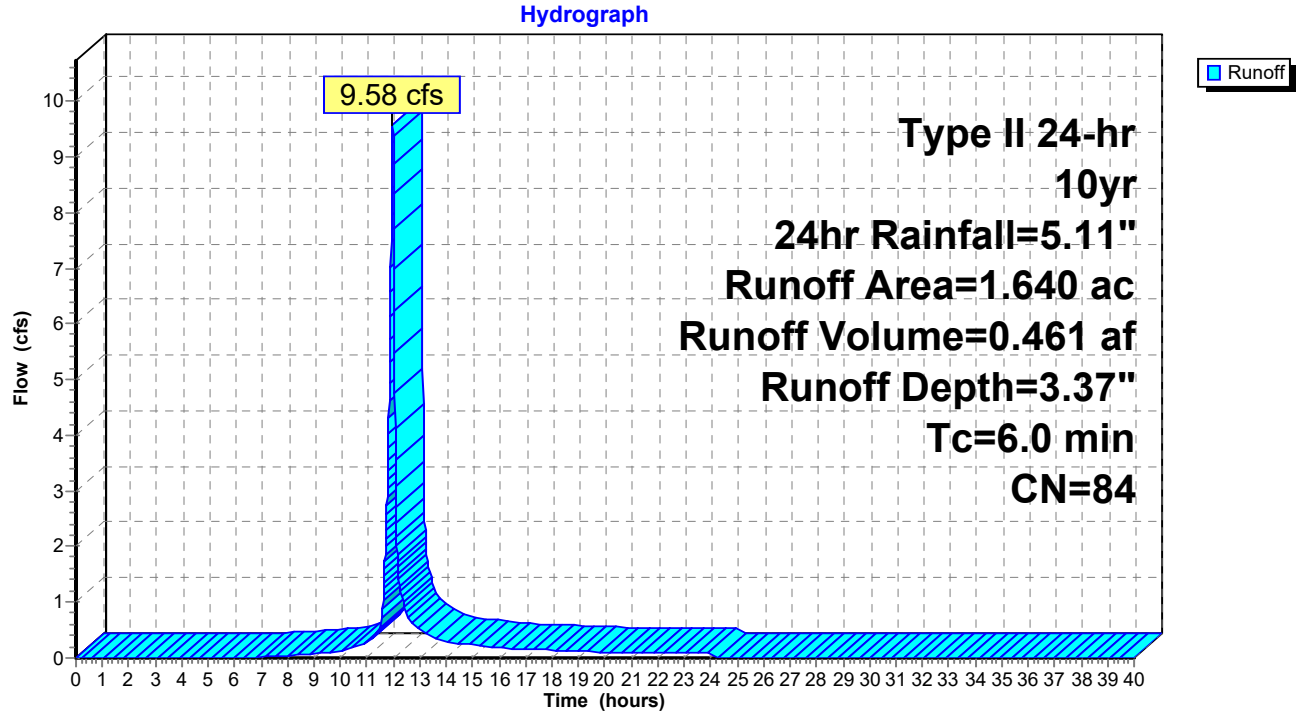
Runoff = 9.58 cfs @ 11.97 hrs, Volume= 0.461 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
1.640	84	50-75% Grass cover, Fair, HSG D
1.640		100.00% Pervious Area

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

Subcatchment W6S: DA W6



Summary for Subcatchment W7S: DA W7

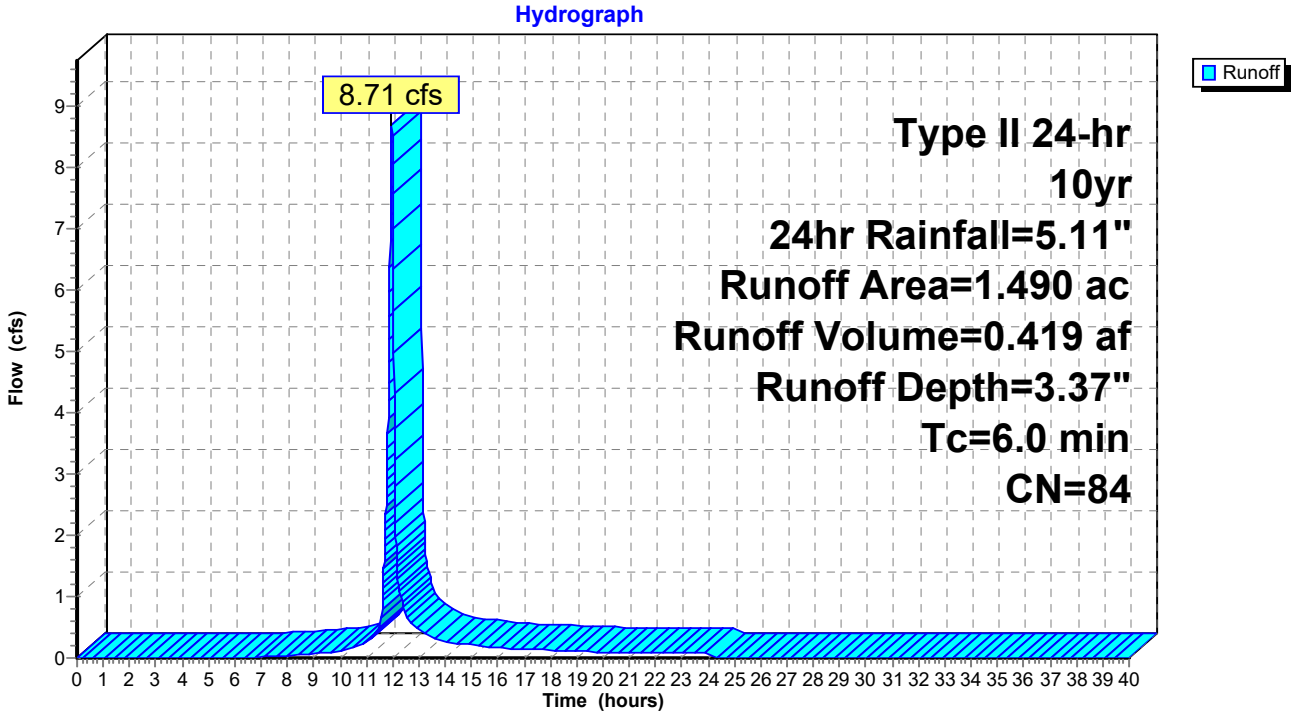
Runoff = 8.71 cfs @ 11.97 hrs, Volume= 0.419 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
1.490	84	50-75% Grass cover, Fair, HSG D
1.490		100.00% Pervious Area

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

Subcatchment W7S: DA W7



Summary for Subcatchment W8S: DA W8

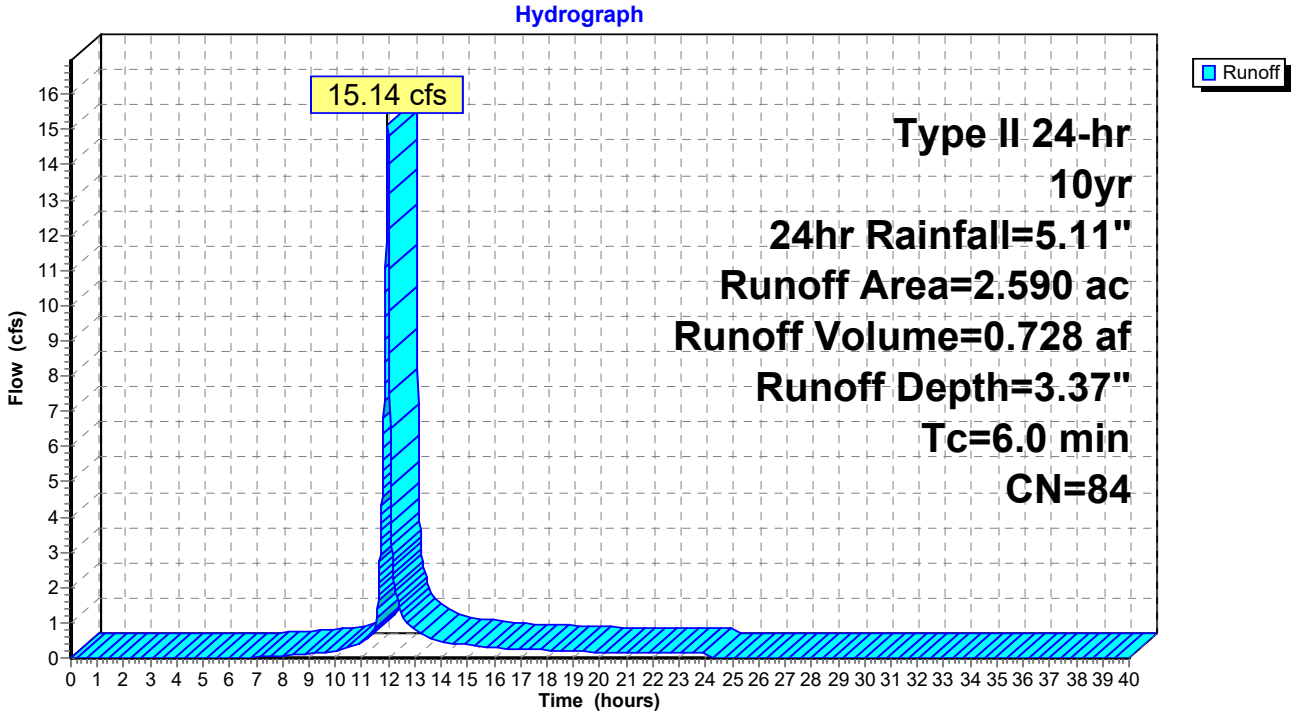
Runoff = 15.14 cfs @ 11.97 hrs, Volume= 0.728 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 10yr, 24hr Rainfall=5.11"

Area (ac)	CN	Description
2.590	84	50-75% Grass cover, Fair, HSG D
2.590		100.00% Pervious Area

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

Subcatchment W8S: DA W8



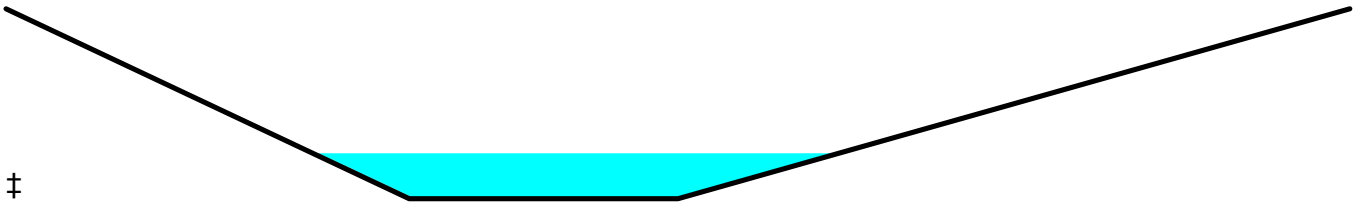
Summary for Reach E1R: Channel E1

Inflow Area = 9.570 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 34.99 cfs @ 12.09 hrs, Volume= 2.689 af
Outflow = 33.97 cfs @ 12.13 hrs, Volume= 2.689 af, Atten= 3%, Lag= 2.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.33 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 11.2 min

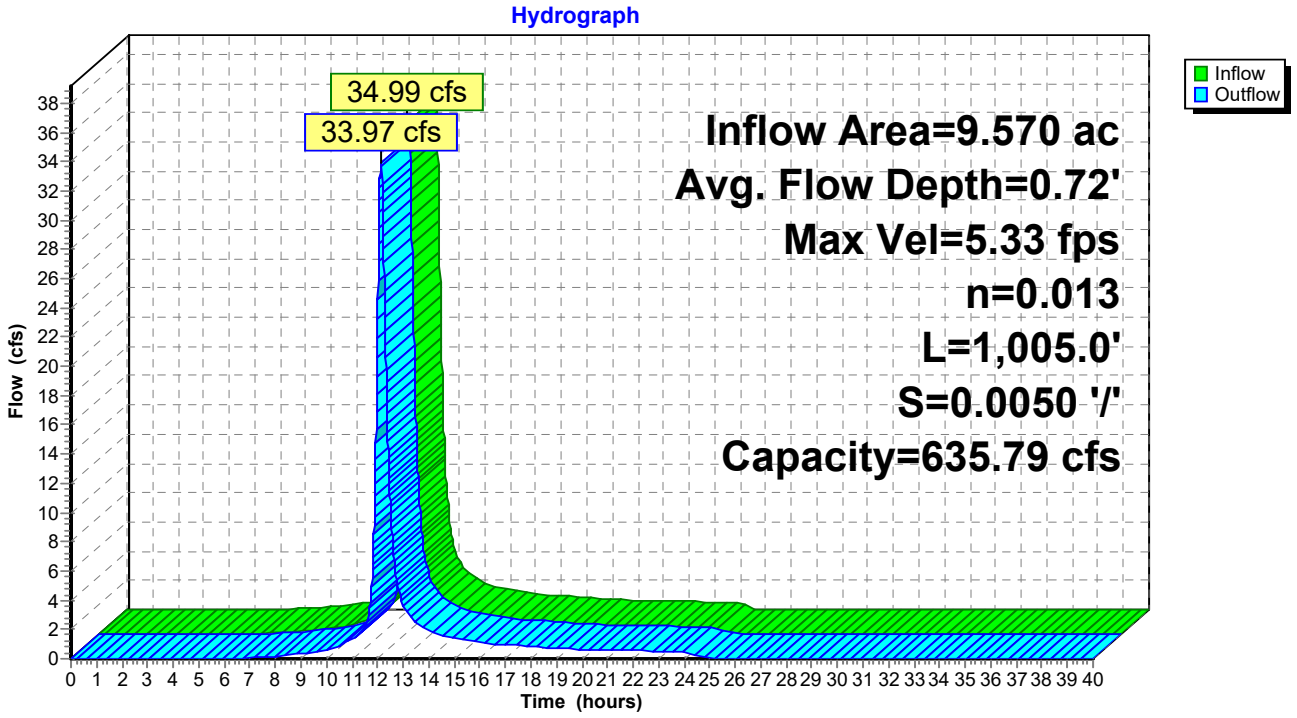
Peak Storage= 6,407 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 635.79 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,005.0' Slope= 0.0050 '/'
Inlet Invert= 14.32', Outlet Invert= 9.28'



‡

Reach E1R: Channel E1



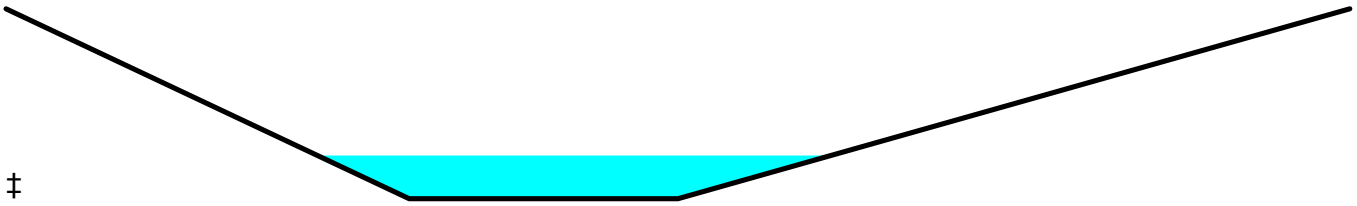
Summary for Reach E2R: Channel E2

Inflow Area = 8.380 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 31.71 cfs @ 12.11 hrs, Volume= 2.354 af
Outflow = 30.96 cfs @ 12.15 hrs, Volume= 2.354 af, Atten= 2%, Lag= 2.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.19 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.45 fps, Avg. Travel Time= 9.3 min

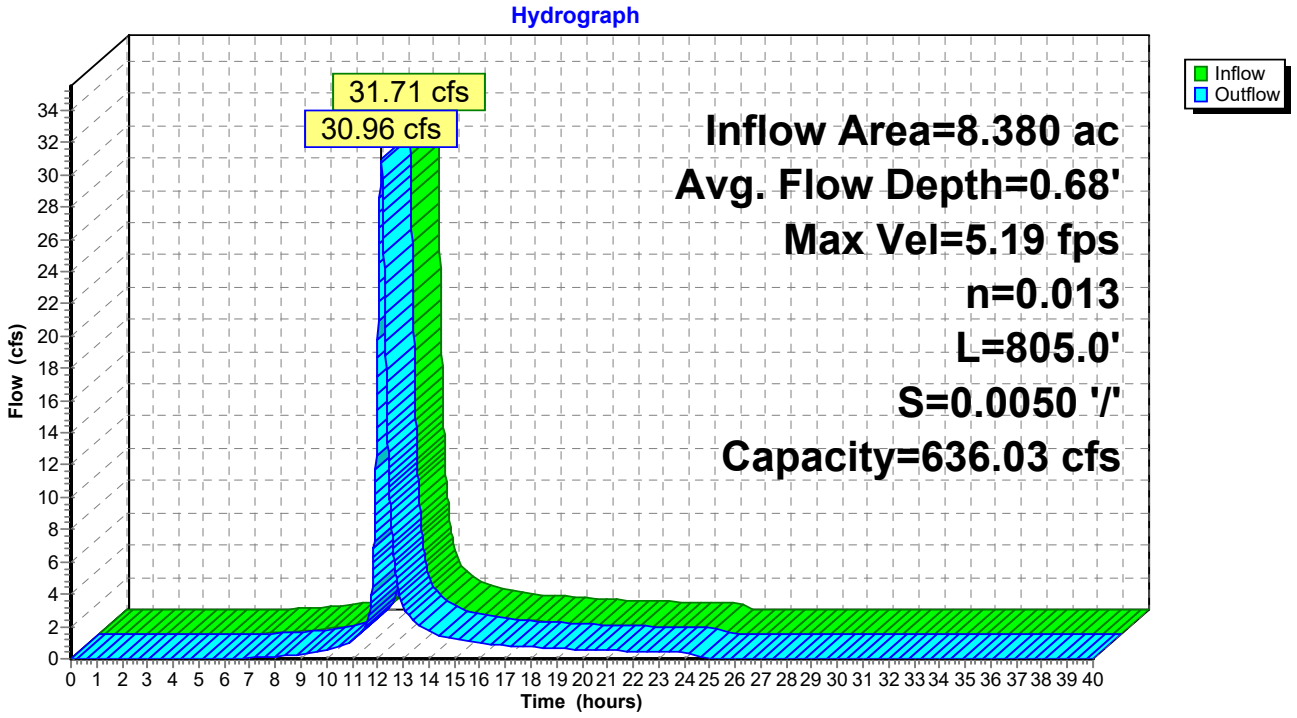
Peak Storage= 4,805 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.68'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 636.03 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 805.0' Slope= 0.0050 '/'
Inlet Invert= 15.27', Outlet Invert= 11.23'



‡

Reach E2R: Channel E2



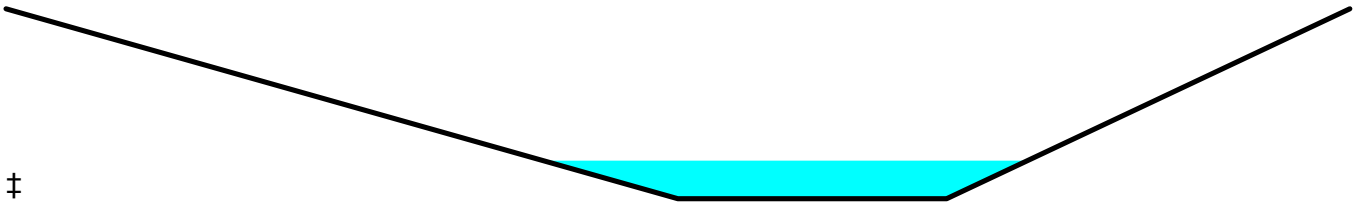
Summary for Reach E3R: Channel E3

Inflow Area = 7.260 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 30.24 cfs @ 12.04 hrs, Volume= 2.040 af
Outflow = 29.37 cfs @ 12.07 hrs, Volume= 2.040 af, Atten= 3%, Lag= 1.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.81 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.59 fps, Avg. Travel Time= 8.9 min

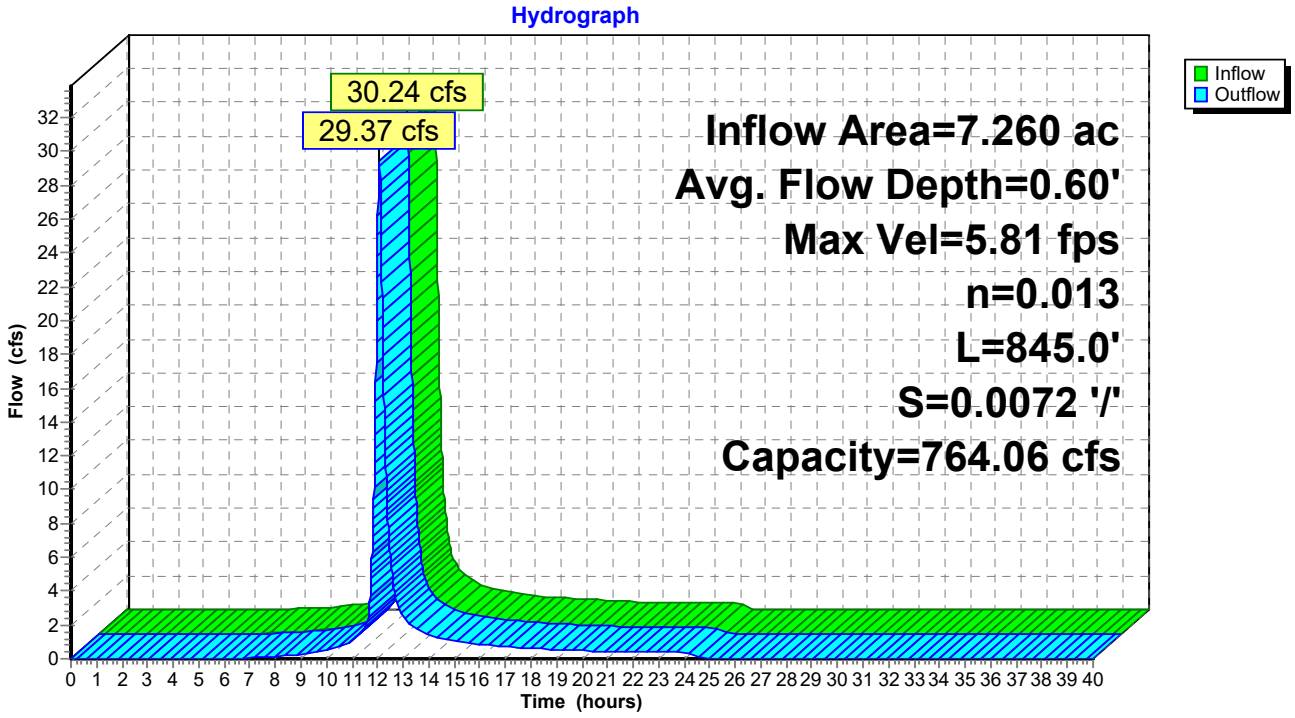
Peak Storage= 4,275 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.60'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 764.06 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 845.0' Slope= 0.0072 '/'
Inlet Invert= 17.35', Outlet Invert= 11.23'



‡

Reach E3R: Channel E3



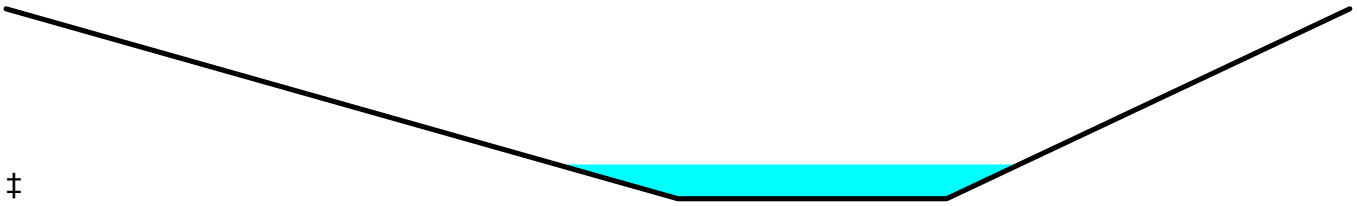
Summary for Reach W1R: Channel W1

Inflow Area = 12.780 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 29.63 cfs @ 12.05 hrs, Volume= 3.590 af
Outflow = 28.22 cfs @ 12.10 hrs, Volume= 3.590 af, Atten= 5%, Lag= 3.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 6.39 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 2.06 fps, Avg. Travel Time= 11.8 min

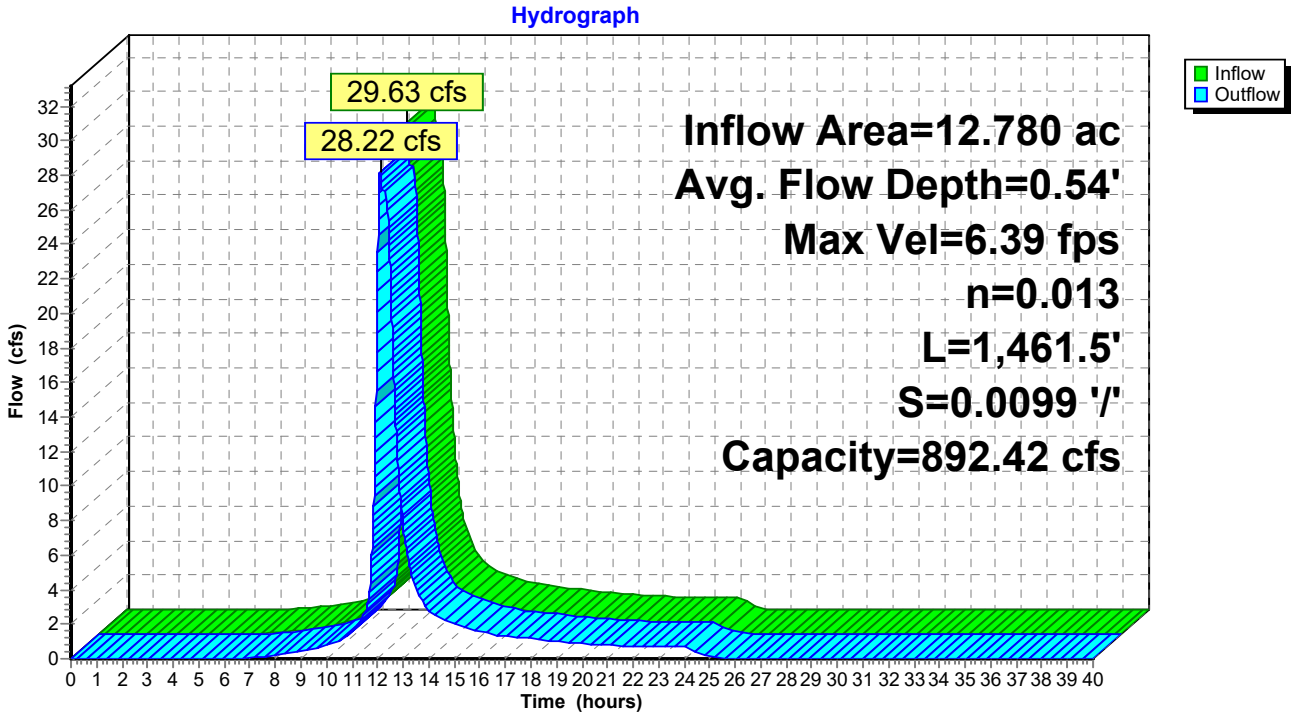
Peak Storage= 6,453 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 892.42 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 1,461.5' Slope= 0.0099 '/'
Inlet Invert= 20.31', Outlet Invert= 5.87'



‡

Reach W1R: Channel W1



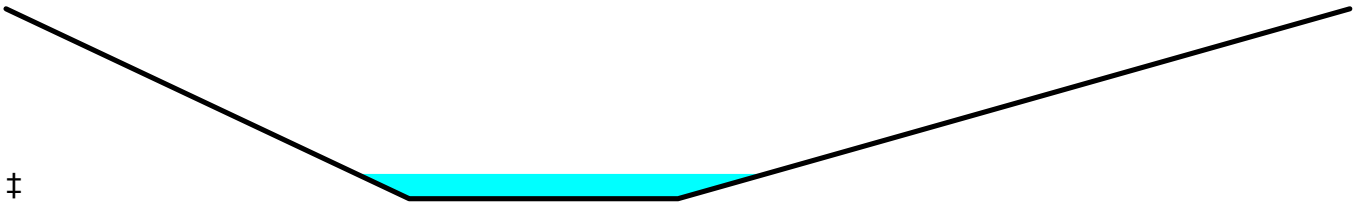
Summary for Reach W2R: Channel W2

Inflow Area = 1.640 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 9.58 cfs @ 11.97 hrs, Volume= 0.461 af
Outflow = 8.70 cfs @ 12.00 hrs, Volume= 0.461 af, Atten= 9%, Lag= 2.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 2.92 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 0.74 fps, Avg. Travel Time= 14.8 min

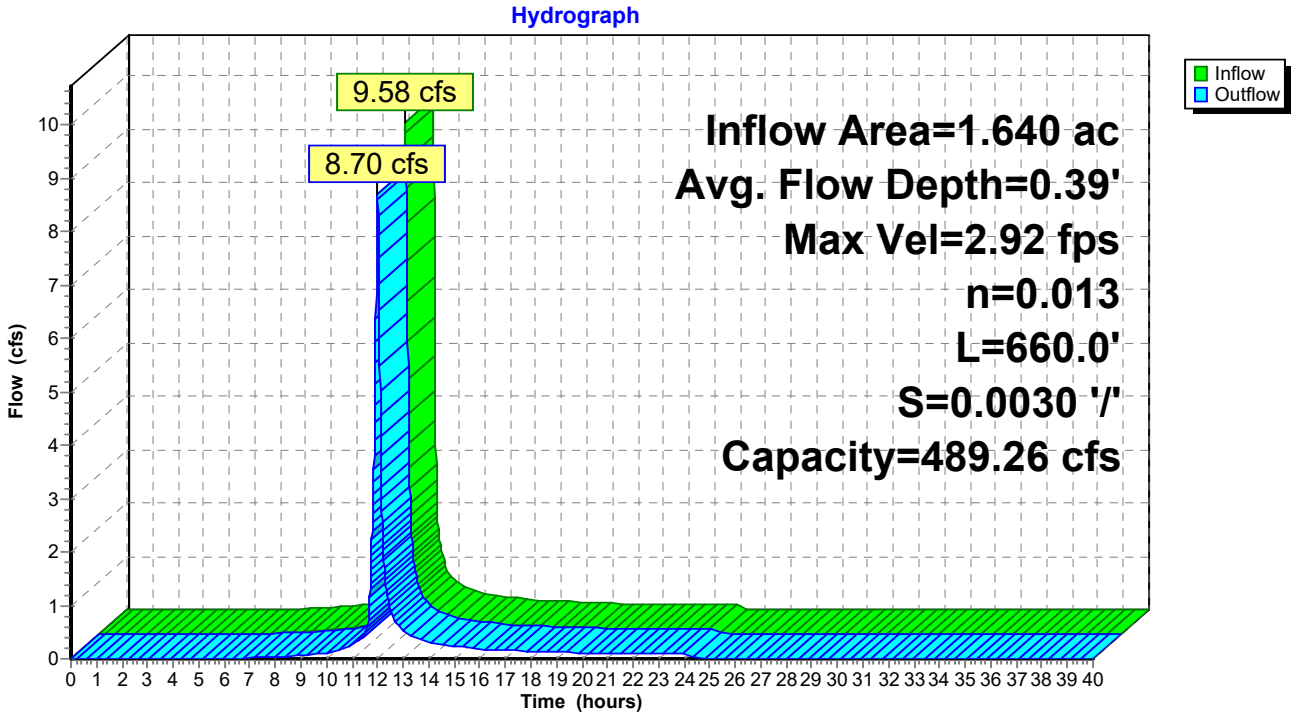
Peak Storage= 1,963 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 489.26 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 660.0' Slope= 0.0030 '/'
Inlet Invert= 7.83', Outlet Invert= 5.87'



‡

Reach W2R: Channel W2



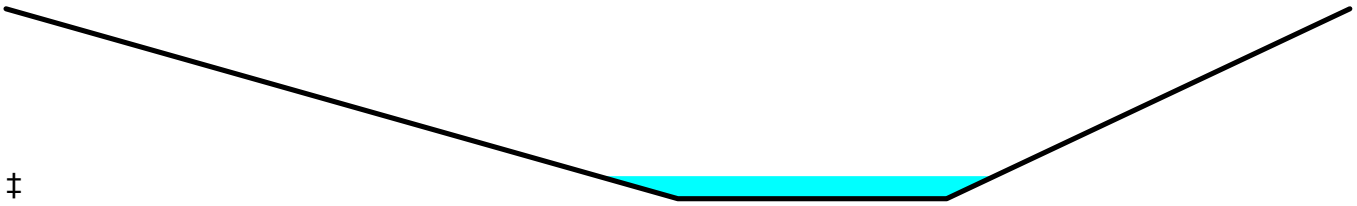
Summary for Reach W3R: Channel W3

Inflow Area = 1.490 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 8.71 cfs @ 11.97 hrs, Volume= 0.419 af
Outflow = 7.98 cfs @ 12.00 hrs, Volume= 0.419 af, Atten= 8%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 3.02 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 13.7 min

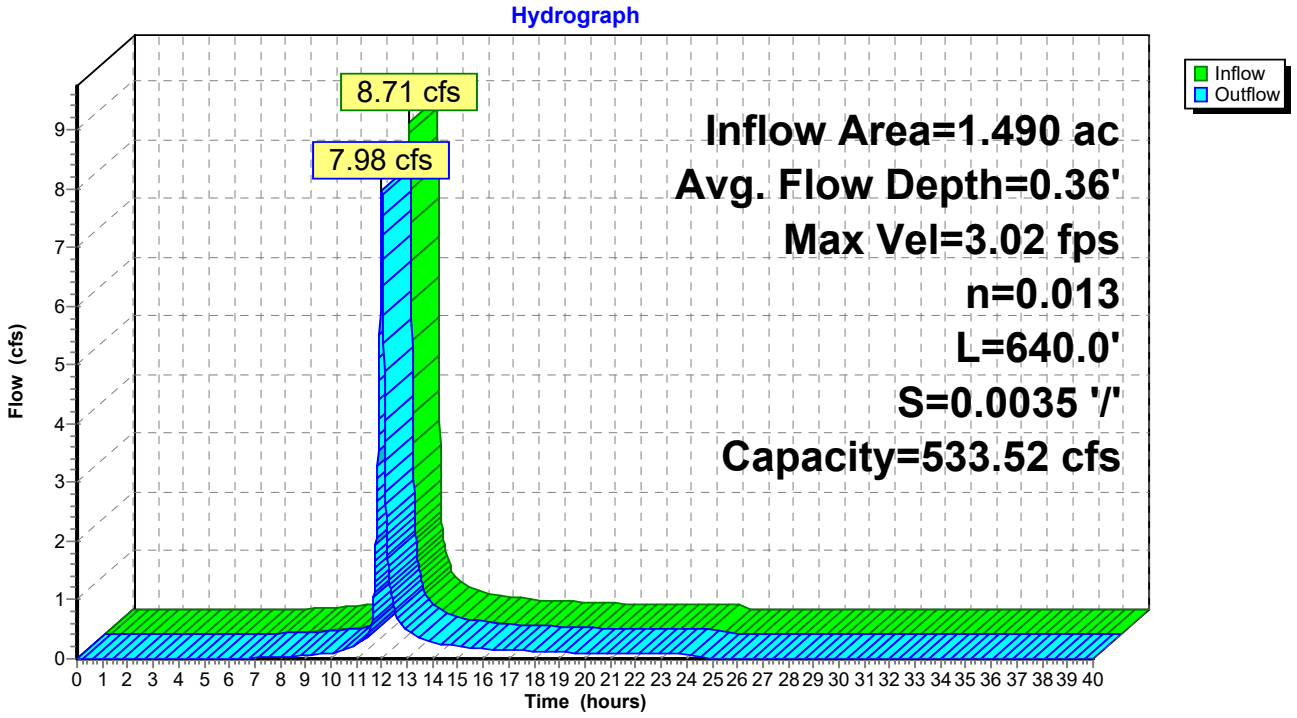
Peak Storage= 1,692 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 533.52 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 640.0' Slope= 0.0035 '/'
Inlet Invert= 7.83', Outlet Invert= 5.57'



‡

Reach W3R: Channel W3



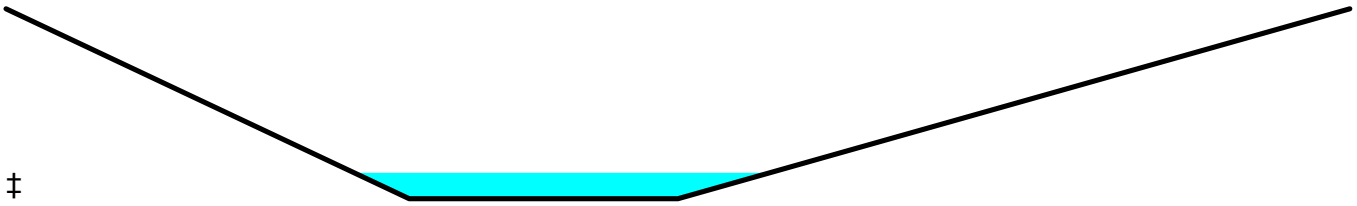
Summary for Reach W4R: Channel W4

Inflow Area = 5.360 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 17.95 cfs @ 11.98 hrs, Volume= 1.506 af
Outflow = 16.09 cfs @ 12.02 hrs, Volume= 1.506 af, Atten= 10%, Lag= 2.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.13 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 14.8 min

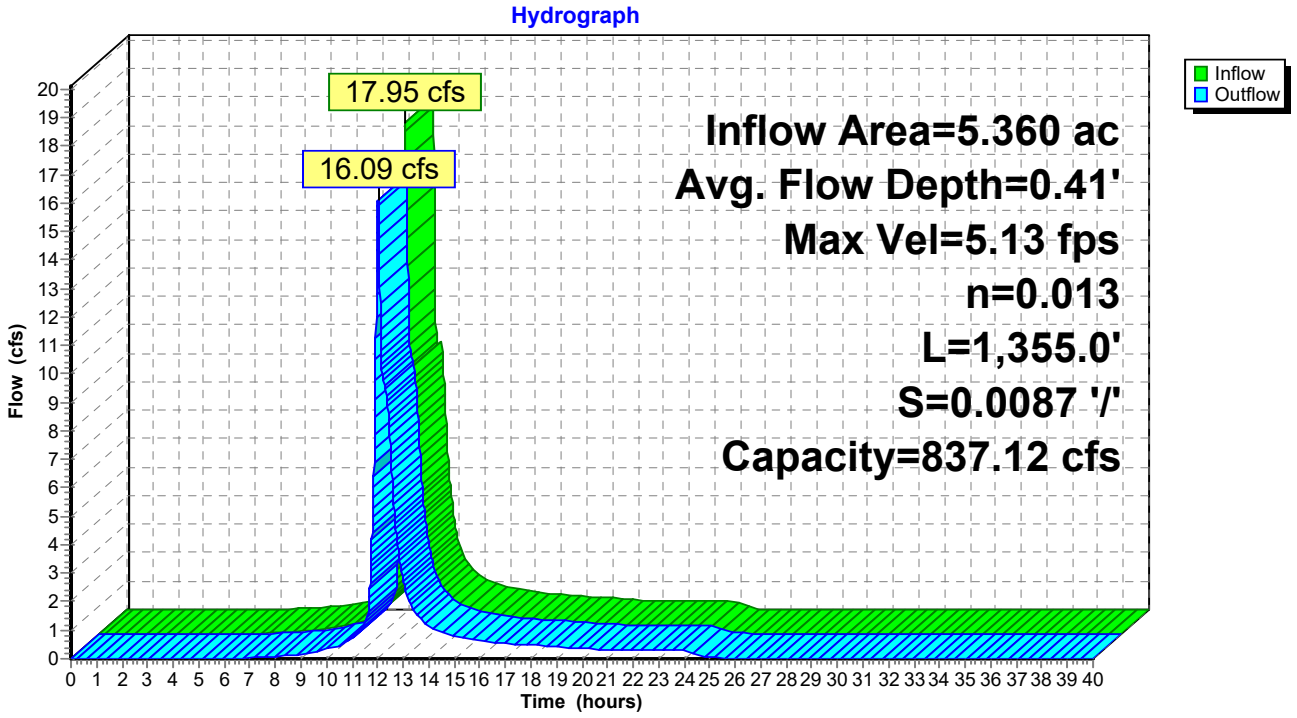
Peak Storage= 4,248 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 837.12 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,355.0' Slope= 0.0087 '/'
Inlet Invert= 17.35', Outlet Invert= 5.57'



‡

Reach W4R: Channel W4



Summary for Pond E1P: Proposed Culvert E1

[62] Hint: Exceeded Reach E1R OUTLET depth by 2.06' @ 12.27 hrs

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 37.14 cfs @ 12.11 hrs, Volume= 3.000 af
Outflow = 30.70 cfs @ 12.22 hrs, Volume= 3.000 af, Atten= 17%, Lag= 7.1 min
Primary = 30.70 cfs @ 12.22 hrs, Volume= 3.000 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 11.98' @ 12.22 hrs Surf.Area= 11,074 sf Storage= 11,921 cf

Plug-Flow detention time= 4.0 min calculated for 3.000 af (100% of inflow)
Center-of-Mass det. time= 3.9 min (827.1 - 823.3)

Volume	Invert	Avail.Storage	Storage Description
#1	9.20'	138,439 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

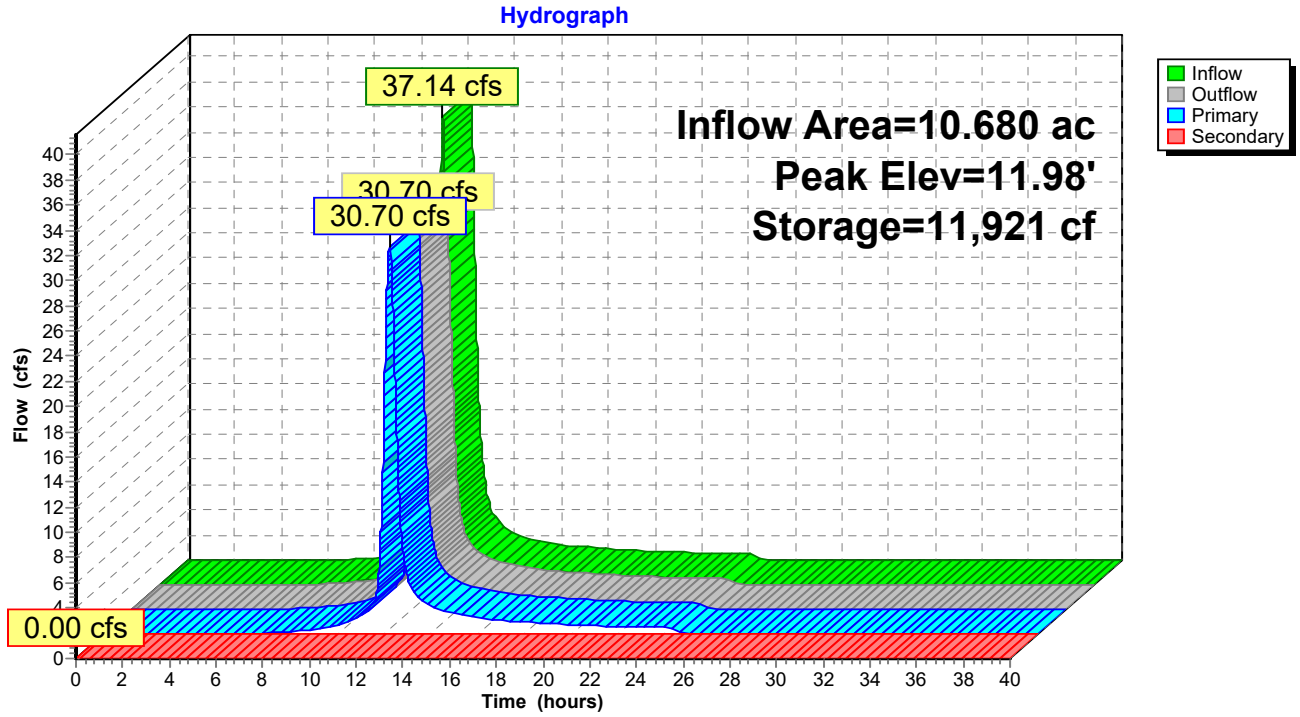
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
9.20	0	0.0	0	0	0
10.00	1,725	385.0	460	460	11,796
11.00	5,530	845.0	3,448	3,908	56,826
12.00	11,180	1,305.0	8,191	12,099	135,535
13.00	18,810	1,770.0	14,831	26,929	249,331
14.00	28,645	2,245.0	23,556	50,485	401,109
15.00	49,400	2,488.0	38,554	89,039	492,663
16.00	49,400	2,488.0	49,400	138,439	495,151

Device	Routing	Invert	Outlet Devices
#1	Primary	9.30'	**36.0" Round 36" Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.30' / 8.70' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=30.69 cfs @ 12.22 hrs HW=11.98' TW=6.00' (Dynamic Tailwater)
1=36" Culvert (Barrel Controls 30.69 cfs @ 6.09 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.20' TW=6.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond E1P: Proposed Culvert E1



Summary for Pond E2P: Proposed Culvert E2

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 35.41 cfs @ 12.11 hrs, Volume= 2.742 af
Outflow = 33.82 cfs @ 12.16 hrs, Volume= 2.742 af, Atten= 4%, Lag= 2.8 min
Primary = 33.82 cfs @ 12.16 hrs, Volume= 2.742 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 13.41' @ 12.16 hrs Surf.Area= 5,473 sf Storage= 4,073 cf

Plug-Flow detention time= 0.8 min calculated for 2.741 af (100% of inflow)
Center-of-Mass det. time= 0.8 min (819.1 - 818.3)

Volume	Invert	Avail.Storage	Storage Description
#1	11.50'	56,085 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

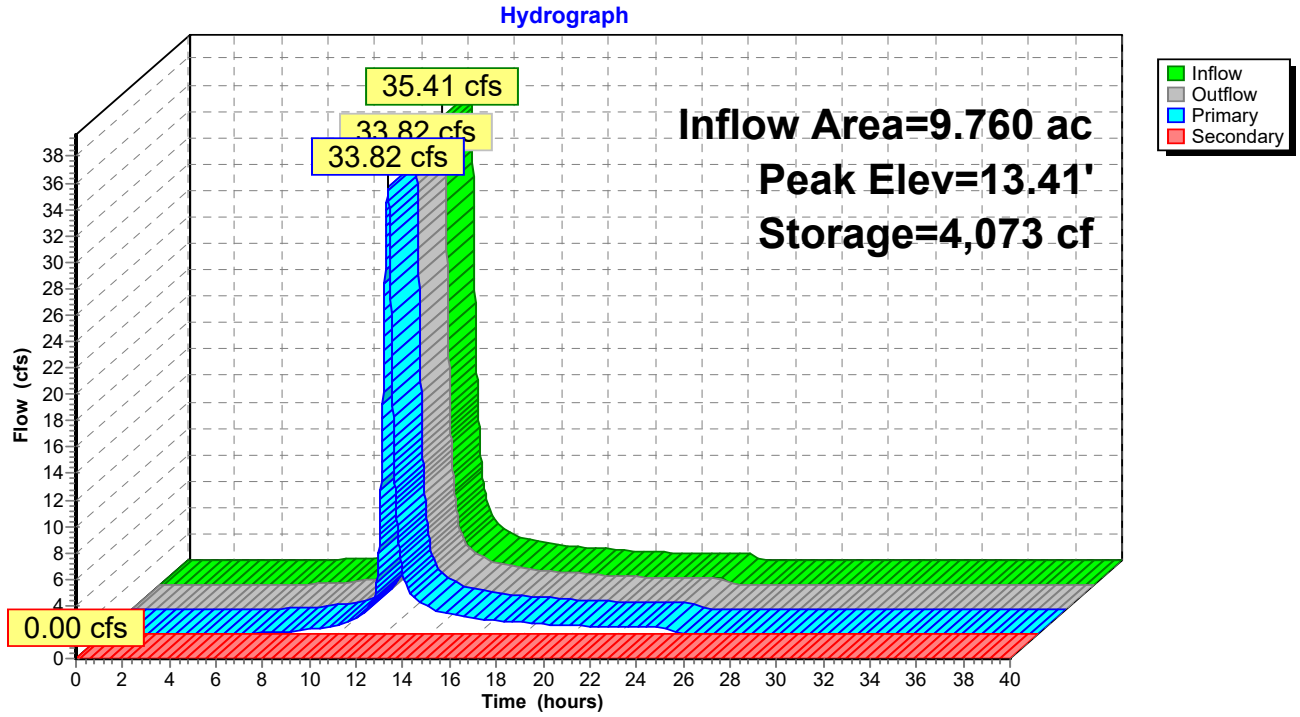
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.50	0	0.0	0	0	0
12.00	765	210.0	128	128	3,510
13.00	3,765	650.0	2,076	2,203	33,625
14.00	8,530	1,095.0	5,987	8,191	95,425
15.00	20,110	1,435.0	13,912	22,103	163,889
16.00	50,095	1,580.0	33,982	56,085	198,711

Device	Routing	Invert	Outlet Devices
#1	Primary	4.12'	**18.0" W x 12.0" H, R=12.0" Elliptical (3) 18x12" Culverts X 3.00** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.12' / 3.60' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.17 sf
#2	Device 1	11.50'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=33.80 cfs @ 12.16 hrs HW=13.41' TW=6.00' (Dynamic Tailwater)
└**1=(3) 18x12" Culverts** (Passes 33.80 cfs of 37.79 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 33.80 cfs @ 4.43 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.50' TW=6.00' (Dynamic Tailwater)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E2P: Proposed Culvert E2



Summary for Pond E3P: Proposed Culvert E3

[62] Hint: Exceeded Reach E2R OUTLET depth by 1.86' @ 12.24 hrs
[62] Hint: Exceeded Reach E3R OUTLET depth by 2.05' @ 12.24 hrs

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 57.59 cfs @ 12.10 hrs, Volume= 4.394 af
Outflow = 46.73 cfs @ 12.21 hrs, Volume= 4.394 af, Atten= 19%, Lag= 6.6 min
Primary = 46.73 cfs @ 12.21 hrs, Volume= 4.394 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 13.73' @ 12.21 hrs Surf.Area= 14,896 sf Storage= 14,944 cf

Plug-Flow detention time= 2.2 min calculated for 4.393 af (100% of inflow)
Center-of-Mass det. time= 2.2 min (824.6 - 822.4)

Volume	Invert	Avail.Storage	Storage Description
#1	11.20'	87,995 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

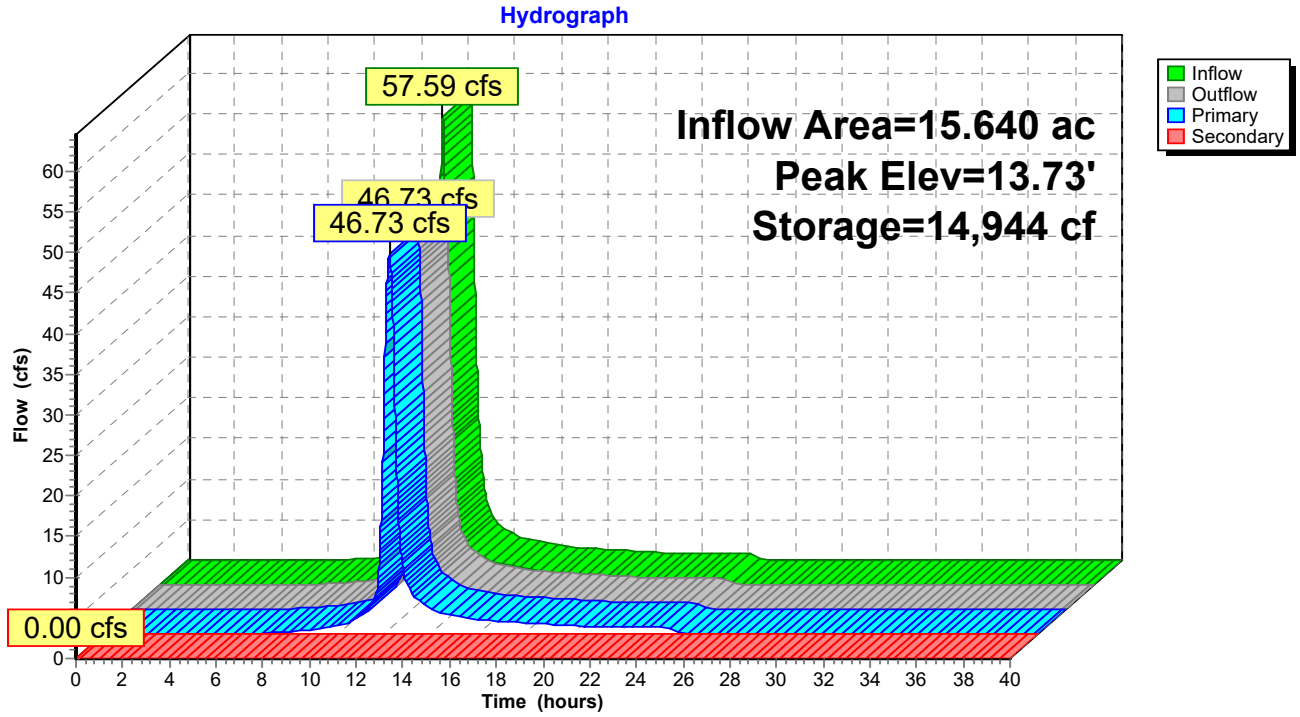
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.20	0	0.0	0	0	0
12.00	2,790	625.0	744	744	31,086
13.00	8,945	1,350.0	5,577	6,321	145,035
14.00	17,465	1,985.0	12,970	19,291	313,567
15.00	30,060	2,655.0	23,479	42,770	560,968
16.00	62,330	3,050.0	45,225	87,995	740,317

Device	Routing	Invert	Outlet Devices
#1	Primary	5.55'	**18.0" Round (3) 18" Culverts X 3.00** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.55' / 5.00' S= 0.0055 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	11.20'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=46.73 cfs @ 12.21 hrs HW=13.73' TW=6.00' (Dynamic Tailwater)
└**1=(3) 18" Culverts** (Passes 46.73 cfs of 62.70 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 46.73 cfs @ 5.84 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' TW=6.00' (Dynamic Tailwater)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E3P: Proposed Culvert E3



Summary for Pond W1P: Proposed Culvert W1

[62] Hint: Exceeded Reach W1R OUTLET depth by 3.51' @ 12.59 hrs
[63] Warning: Exceeded Reach W2R INLET depth by 1.89' @ 12.55 hrs

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 87.65 cfs @ 12.35 hrs, Volume= 11.049 af
Outflow = 71.22 cfs @ 12.54 hrs, Volume= 11.042 af, Atten= 19%, Lag= 11.8 min
Primary = 71.22 cfs @ 12.54 hrs, Volume= 11.042 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 9.82' @ 12.54 hrs Surf.Area= 38,327 sf Storage= 58,206 cf

Plug-Flow detention time= 11.9 min calculated for 11.039 af (100% of inflow)
Center-of-Mass det. time= 11.5 min (847.6 - 836.1)

Volume	Invert	Avail.Storage	Storage Description
#1	5.80'	501,374 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

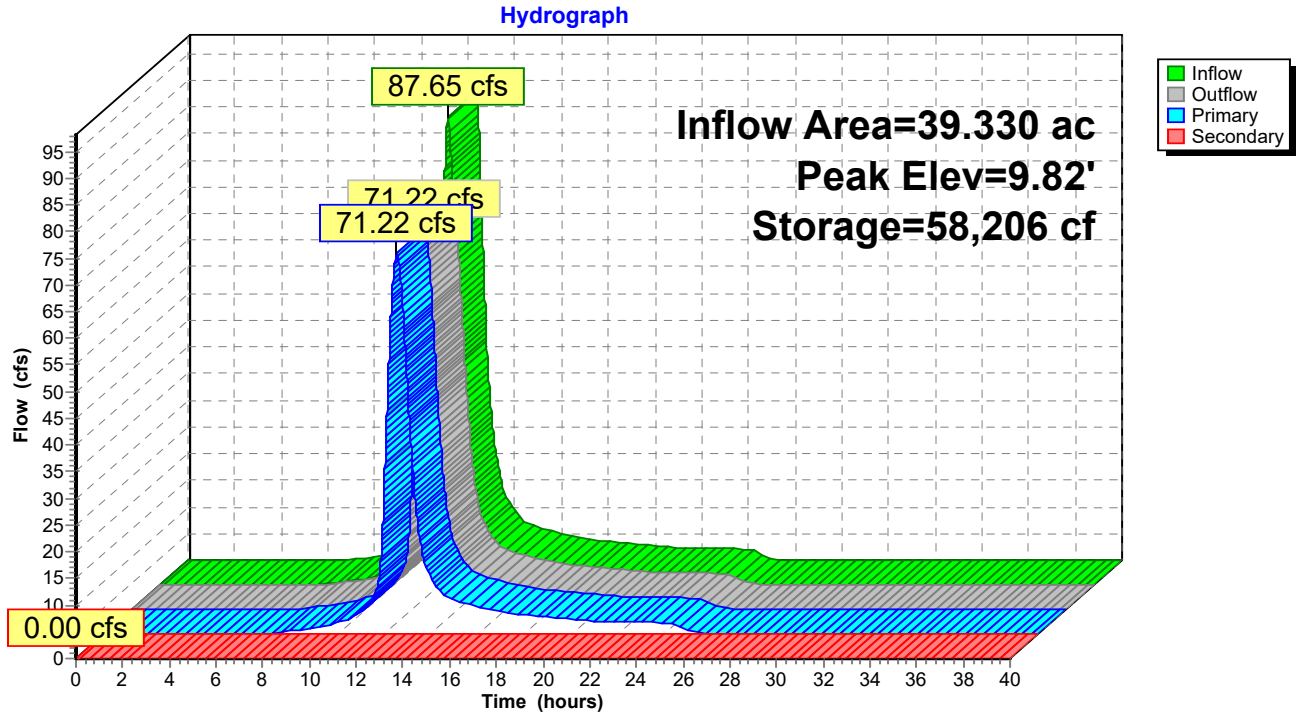
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.80	0	0.0	0	0	0
6.00	475	155.0	32	32	1,912
7.00	5,935	1,130.0	2,696	2,728	101,615
8.00	14,975	2,015.0	10,112	12,840	323,110
9.00	24,795	2,340.0	19,680	32,520	435,763
10.00	41,685	2,720.0	32,876	65,397	588,796
11.00	101,320	3,145.0	69,331	134,728	787,174
12.00	183,080	3,370.0	140,199	274,927	903,870
13.00	272,785	3,650.0	226,447	501,374	1,060,327

Device	Routing	Invert	Outlet Devices
#1	Primary	6.30'	**48.0" Round 48" Culvert** L= 110.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.30' / 5.20' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.25'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=71.22 cfs @ 12.54 hrs HW=9.82' TW=6.00' (Dynamic Tailwater)
↑—**1=48" Culvert** (Barrel Controls 71.22 cfs @ 8.09 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.80' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W1P: Proposed Culvert W1



Summary for Pond W2P: Proposed Culvert W2

[63] Warning: Exceeded Reach W3R INLET depth by 1.31' @ 12.51 hrs
[62] Hint: Exceeded Reach W4R OUTLET depth by 3.40' @ 12.53 hrs

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 70.34 cfs @ 12.37 hrs, Volume= 8.945 af
Outflow = 61.54 cfs @ 12.50 hrs, Volume= 8.941 af, Atten= 13%, Lag= 8.3 min
Primary = 61.54 cfs @ 12.50 hrs, Volume= 8.941 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 9.23' @ 12.50 hrs Surf.Area= 24,693 sf Storage= 35,319 cf

Plug-Flow detention time= 9.3 min calculated for 8.941 af (100% of inflow)
Center-of-Mass det. time= 8.9 min (844.5 - 835.6)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	454,263 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

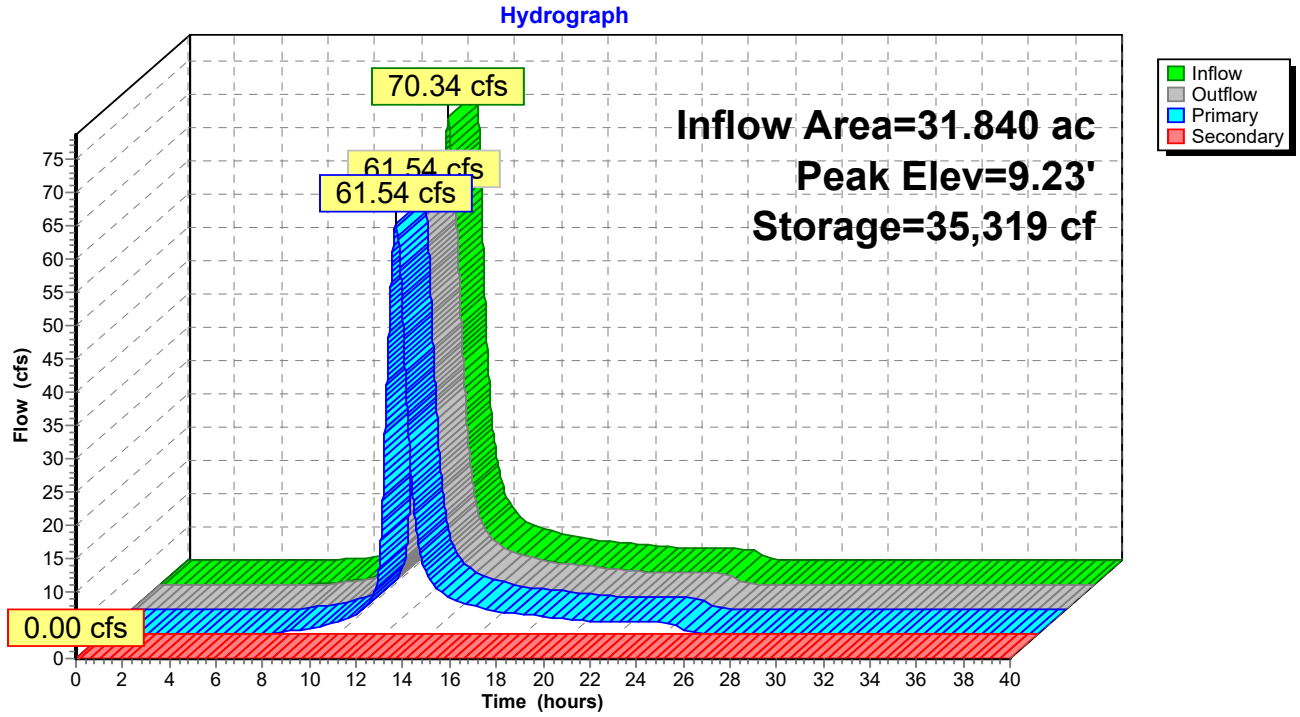
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	0	0.0	0	0	0
6.00	1,200	320.0	160	160	8,149
7.00	6,000	1,030.0	3,294	3,454	84,427
8.00	13,375	1,650.0	9,444	12,899	216,660
9.00	21,190	1,805.0	17,133	30,032	259,310
10.00	38,310	2,000.0	29,331	59,363	318,386
11.00	86,665	2,220.0	60,865	120,228	392,295
12.00	166,100	2,600.0	124,248	244,476	538,069
13.00	256,750	3,035.0	209,787	454,263	733,152

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**48.0" Round 48" Culvert** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0095 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=61.54 cfs @ 12.50 hrs HW=9.23' TW=6.00' (Dynamic Tailwater)
↑—**1=48" Culvert** (Barrel Controls 61.54 cfs @ 7.73 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.60' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W2P: Proposed Culvert W2



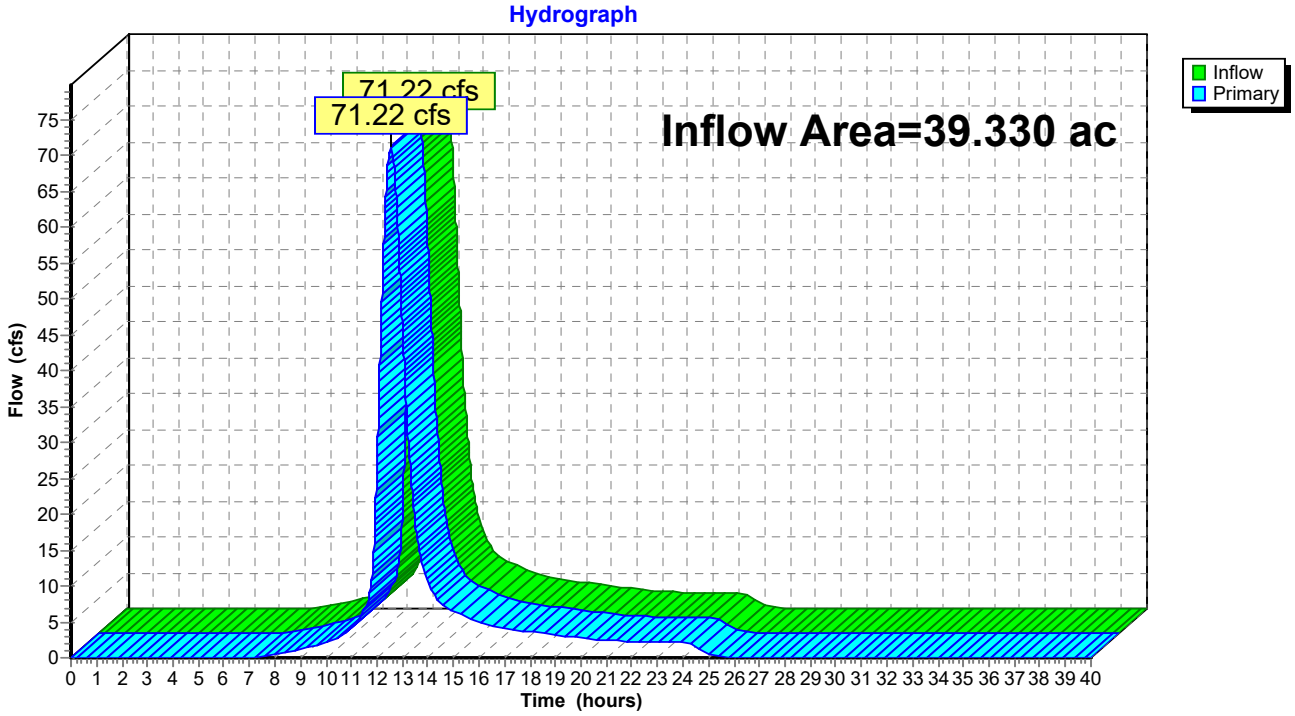
Summary for Link 1L: Thermal Channel

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 71.22 cfs @ 12.54 hrs, Volume= 11.042 af
Primary = 71.22 cfs @ 12.54 hrs, Volume= 11.042 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 1L: Thermal Channel



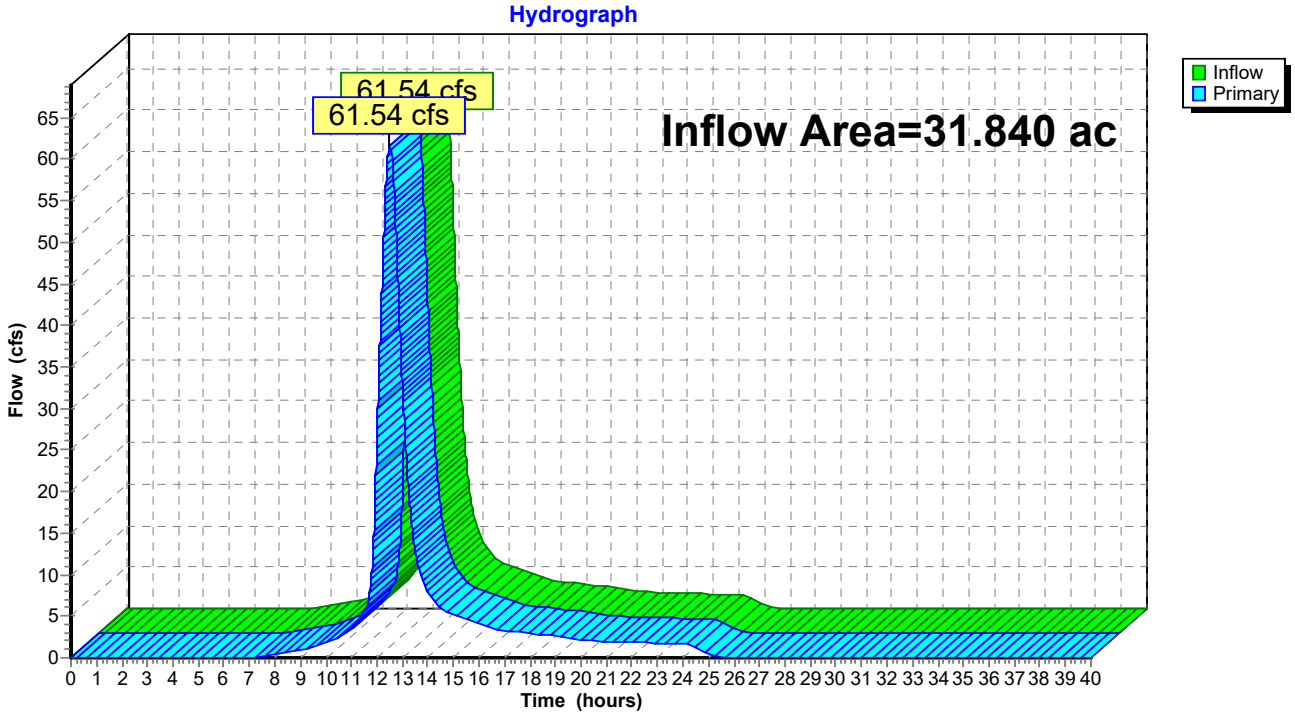
Summary for Link 2L: Thermal Channel

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 61.54 cfs @ 12.50 hrs, Volume= 8.941 af
Primary = 61.54 cfs @ 12.50 hrs, Volume= 8.941 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 2L: Thermal Channel



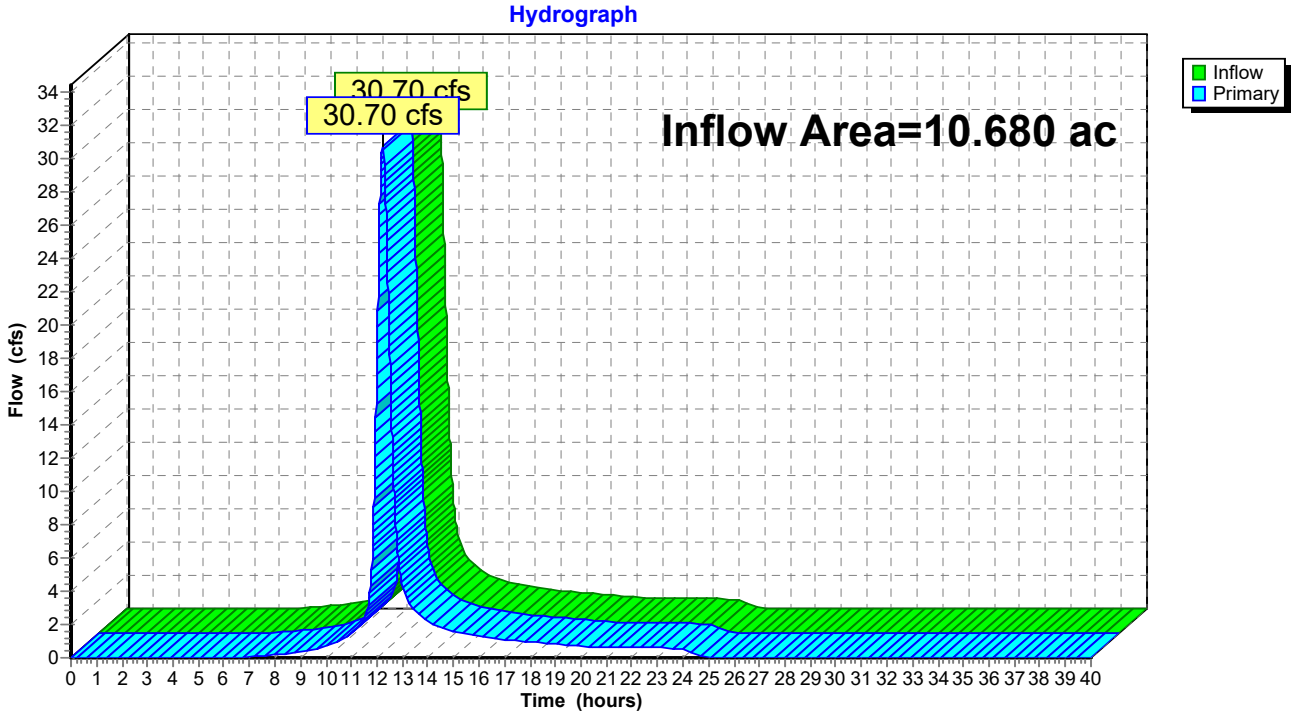
Summary for Link 4L: Ex Channel

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 30.70 cfs @ 12.22 hrs, Volume= 3.000 af
Primary = 30.70 cfs @ 12.22 hrs, Volume= 3.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 4L: Ex Channel



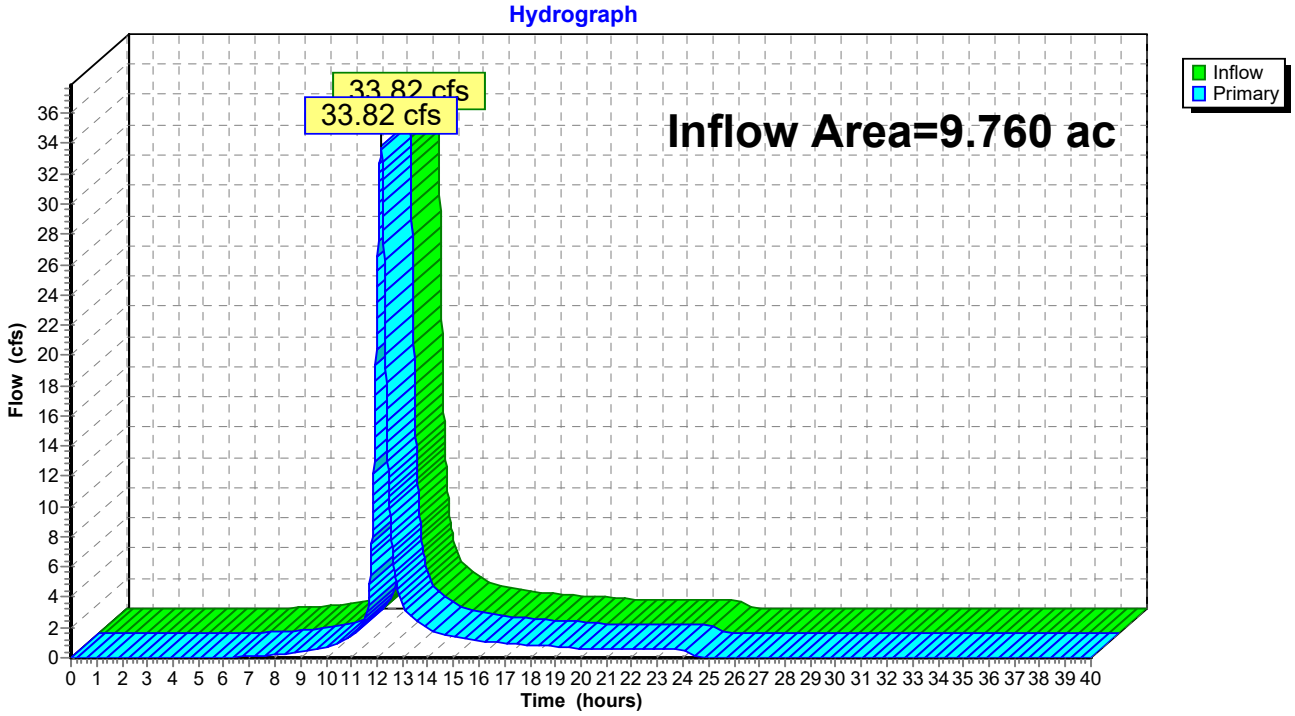
Summary for Link 5L: Swamp

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 33.82 cfs @ 12.16 hrs, Volume= 2.742 af
Primary = 33.82 cfs @ 12.16 hrs, Volume= 2.742 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 5L: Swamp



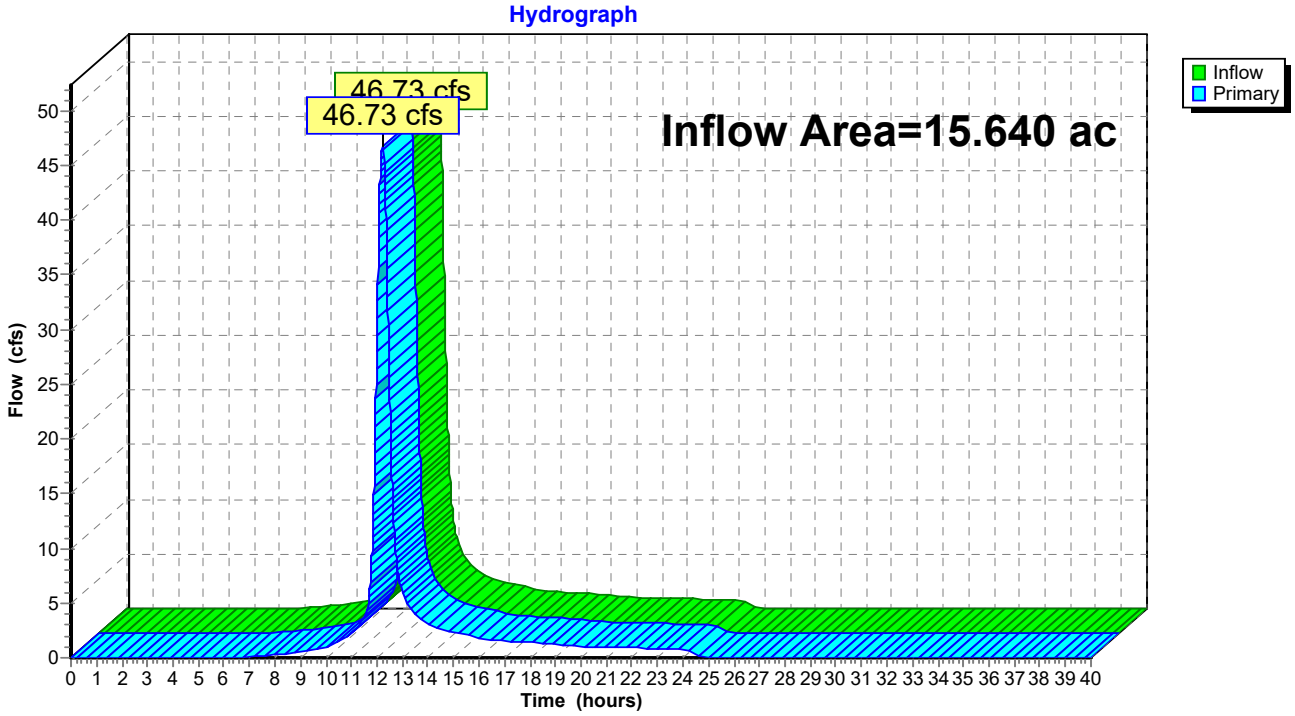
Summary for Link 6L: Swamp

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10yr, 24hr event
Inflow = 46.73 cfs @ 12.21 hrs, Volume= 4.394 af
Primary = 46.73 cfs @ 12.21 hrs, Volume= 4.394 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 6L: Swamp



Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1S: DA E1 Runoff Area=8.090 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=645' Tc=19.9 min CN=84 Runoff=39.88 cfs 3.025 af

Subcatchment E2S: DA E2 Runoff Area=9.110 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=610' Tc=19.5 min CN=84 Runoff=45.48 cfs 3.407 af

Subcatchment E3S: DA E3 Runoff Area=8.380 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=610' Tc=19.5 min CN=84 Runoff=41.83 cfs 3.134 af

Subcatchment E4S: DA E4 Runoff Area=3.750 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=490' Slope=0.0141 '/' Tc=18.4 min CN=84 Runoff=19.27 cfs 1.402 af

Subcatchment E5S: DA E5 Runoff Area=1.110 ac 0.00% Impervious Runoff Depth=4.49"
Tc=10.0 min CN=84 Runoff=7.43 cfs 0.415 af

Subcatchment E6S: DA E6 Runoff Area=1.480 ac 0.00% Impervious Runoff Depth=4.49"
Tc=10.0 min CN=84 Runoff=9.90 cfs 0.553 af

Subcatchment E7S: DA E7 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=4.98 cfs 0.243 af

Subcatchment E8S: DA E8 Runoff Area=3.510 ac 0.00% Impervious Runoff Depth=4.49"
Tc=10.0 min CN=84 Runoff=23.49 cfs 1.313 af

Subcatchment W1S: DA W1 Runoff Area=9.130 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=1,055' Tc=35.3 min CN=84 Runoff=31.70 cfs 3.414 af

Subcatchment W2S: DA W2 Runoff Area=24.910 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=1,485' Tc=40.3 min CN=84 Runoff=78.99 cfs 9.315 af

Subcatchment W3S: DA W3 Runoff Area=24.990 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=1,470' Tc=40.2 min CN=84 Runoff=79.59 cfs 9.345 af

Subcatchment W4S: DA W4 Runoff Area=2.770 ac 0.00% Impervious Runoff Depth=4.49"
Flow Length=820' Tc=32.8 min CN=84 Runoff=10.10 cfs 1.036 af

Subcatchment W5S: DA W5 Runoff Area=3.650 ac 0.00% Impervious Runoff Depth=4.49"
Tc=10.0 min CN=84 Runoff=24.42 cfs 1.365 af

Subcatchment W6S: DA W6 Runoff Area=1.640 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=12.56 cfs 0.613 af

Subcatchment W7S: DA W7 Runoff Area=1.490 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=11.41 cfs 0.557 af

Subcatchment W8S: DA W8 Runoff Area=2.590 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=19.83 cfs 0.969 af

Reach E1R: Channel E1 Avg. Flow Depth=0.83' Max Vel=5.78 fps Inflow=46.19 cfs 3.579 af
n=0.013 L=1,005.0' S=0.0050 '/' Capacity=635.79 cfs Outflow=45.02 cfs 3.579 af

Reach E2R: Channel E2 Avg. Flow Depth=0.79' Max Vel=5.63 fps Inflow=41.83 cfs 3.134 af
n=0.013 L=805.0' S=0.0050 '/' Capacity=636.03 cfs Outflow=40.97 cfs 3.134 af

Reach E3R: Channel E3 Avg. Flow Depth=0.70' Max Vel=6.31 fps Inflow=39.86 cfs 2.715 af
n=0.013 L=845.0' S=0.0072 '/' Capacity=764.06 cfs Outflow=38.88 cfs 2.715 af

Reach W1R: Channel W1 Avg. Flow Depth=0.63' Max Vel=6.98 fps Inflow=39.34 cfs 4.779 af
n=0.013 L=1,461.5' S=0.0099 '/' Capacity=892.42 cfs Outflow=37.73 cfs 4.779 af

Reach W2R: Channel W2 Avg. Flow Depth=0.46' Max Vel=3.20 fps Inflow=12.56 cfs 0.613 af
n=0.013 L=660.0' S=0.0030 '/' Capacity=489.26 cfs Outflow=11.55 cfs 0.613 af

Reach W3R: Channel W3 Avg. Flow Depth=0.42' Max Vel=3.30 fps Inflow=11.41 cfs 0.557 af
n=0.013 L=640.0' S=0.0035 '/' Capacity=533.52 cfs Outflow=10.57 cfs 0.557 af

Reach W4R: Channel W4 Avg. Flow Depth=0.48' Max Vel=5.62 fps Inflow=23.66 cfs 2.004 af
n=0.013 L=1,355.0' S=0.0087 '/' Capacity=837.12 cfs Outflow=21.52 cfs 2.004 af

Pond E1P: Proposed Culvert E1 Peak Elev=12.47' Storage=18,051 cf Inflow=49.35 cfs 3.994 af
Primary=38.54 cfs 3.994 af Secondary=0.00 cfs 0.000 af Outflow=38.54 cfs 3.994 af

Pond E2P: Proposed Culvert E2 Peak Elev=13.97' Storage=7,935 cf Inflow=46.71 cfs 3.650 af
Primary=39.20 cfs 3.650 af Secondary=0.00 cfs 0.000 af Outflow=39.20 cfs 3.650 af

Pond E3P: Proposed Culvert E3 Peak Elev=14.32' Storage=25,478 cf Inflow=76.25 cfs 5.849 af
Primary=55.56 cfs 5.849 af Secondary=0.00 cfs 0.000 af Outflow=55.56 cfs 5.849 af

Pond W1P: Proposed Culvert W1 Peak Elev=10.41' Storage=86,696 cf Inflow=115.92 cfs 14.708 af
Primary=87.76 cfs 14.700 af Secondary=0.00 cfs 0.000 af Outflow=87.76 cfs 14.700 af

Pond W2P: Proposed Culvert W2 Peak Elev=9.81' Storage=52,322 cf Inflow=92.89 cfs 11.907 af
Primary=77.83 cfs 11.902 af Secondary=0.00 cfs 0.000 af Outflow=77.83 cfs 11.902 af

Link 1L: Thermal Channel Inflow=87.76 cfs 14.700 af
Primary=87.76 cfs 14.700 af

Link 2L: Thermal Channel Inflow=77.83 cfs 11.902 af
Primary=77.83 cfs 11.902 af

Link 4L: Ex Channel Inflow=38.54 cfs 3.994 af
Primary=38.54 cfs 3.994 af

Link 5L: Swamp Inflow=39.20 cfs 3.650 af
Primary=39.20 cfs 3.650 af

Link 6L: Swamp Inflow=55.56 cfs 5.849 af
Primary=55.56 cfs 5.849 af

Total Runoff Area = 107.250 ac Runoff Volume = 40.106 af Average Runoff Depth = 4.49"
100.00% Pervious = 107.250 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E1S: DA E1

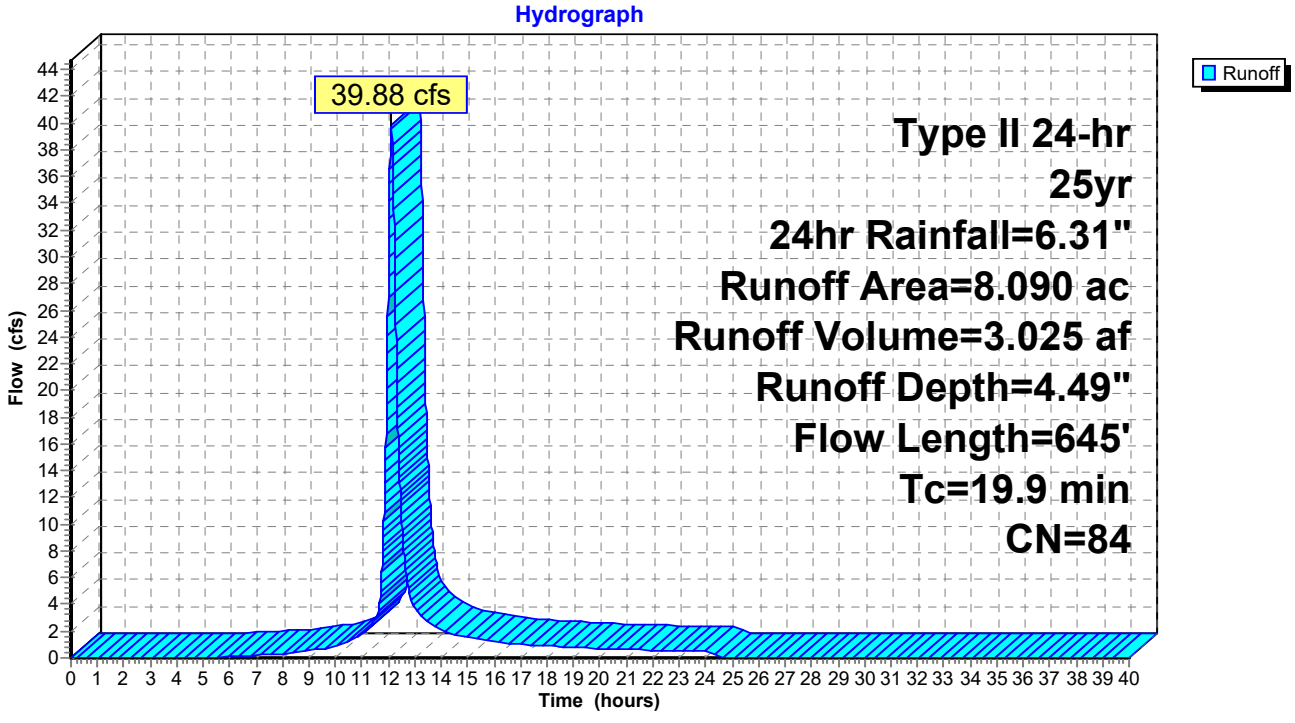
Runoff = 39.88 cfs @ 12.12 hrs, Volume= 3.025 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
8.090	84	50-75% Grass cover, Fair, HSG D
8.090		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.5	150	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.9	645	Total			

Subcatchment E1S: DA E1



Summary for Subcatchment E2S: DA E2

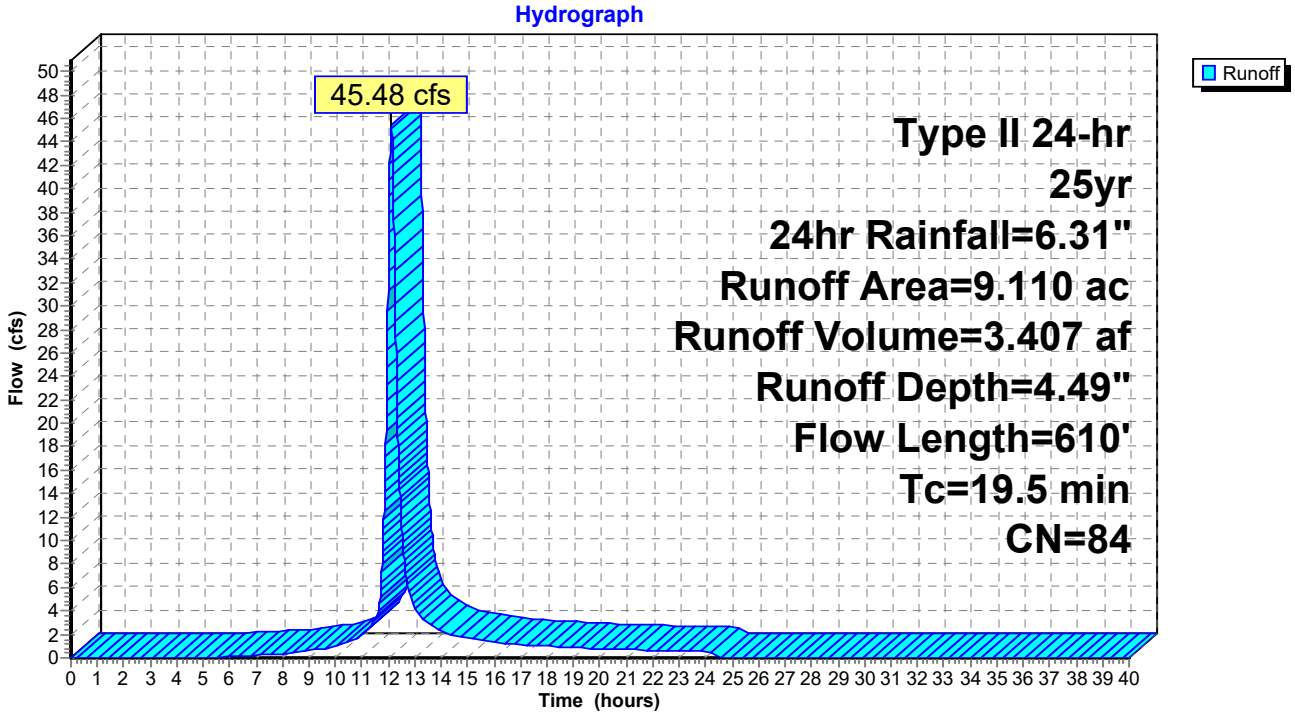
Runoff = 45.48 cfs @ 12.11 hrs, Volume= 3.407 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
9.110	84	50-75% Grass cover, Fair, HSG D
9.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E2S: DA E2



Summary for Subcatchment E3S: DA E3

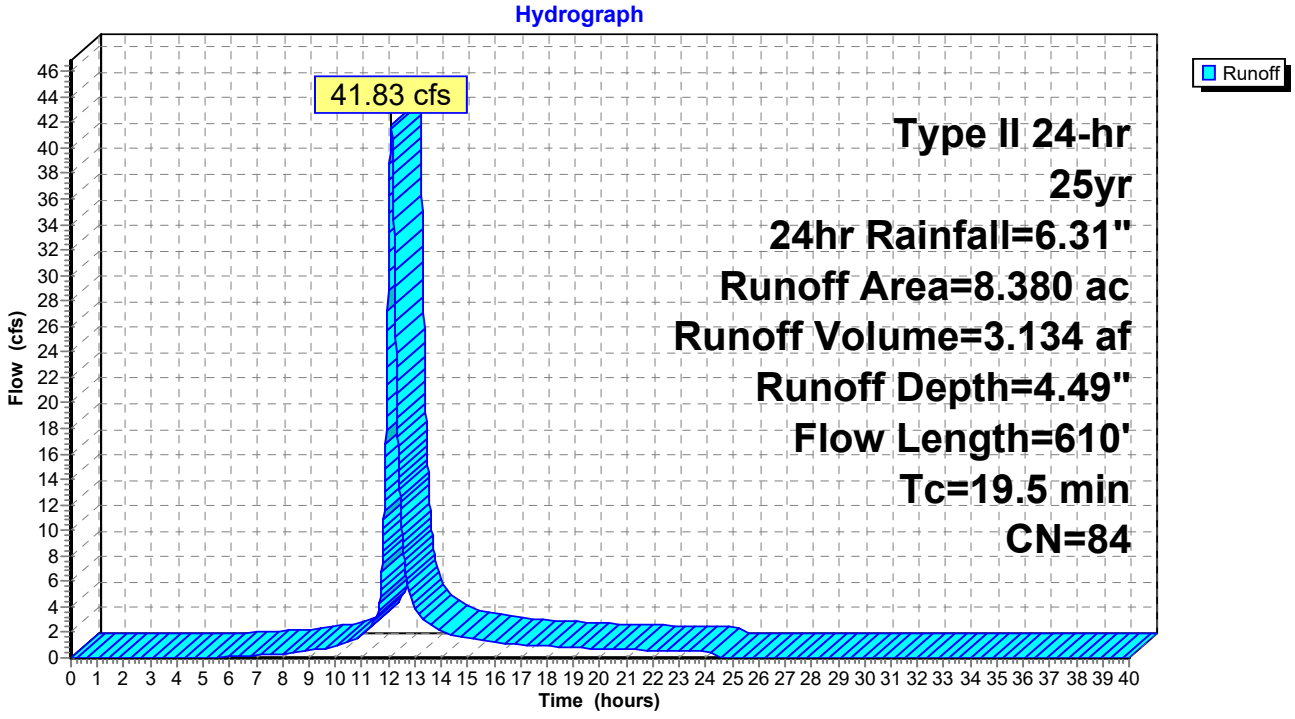
Runoff = 41.83 cfs @ 12.11 hrs, Volume= 3.134 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
8.380	84	50-75% Grass cover, Fair, HSG D
8.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E3S: DA E3



Summary for Subcatchment E4S: DA E4

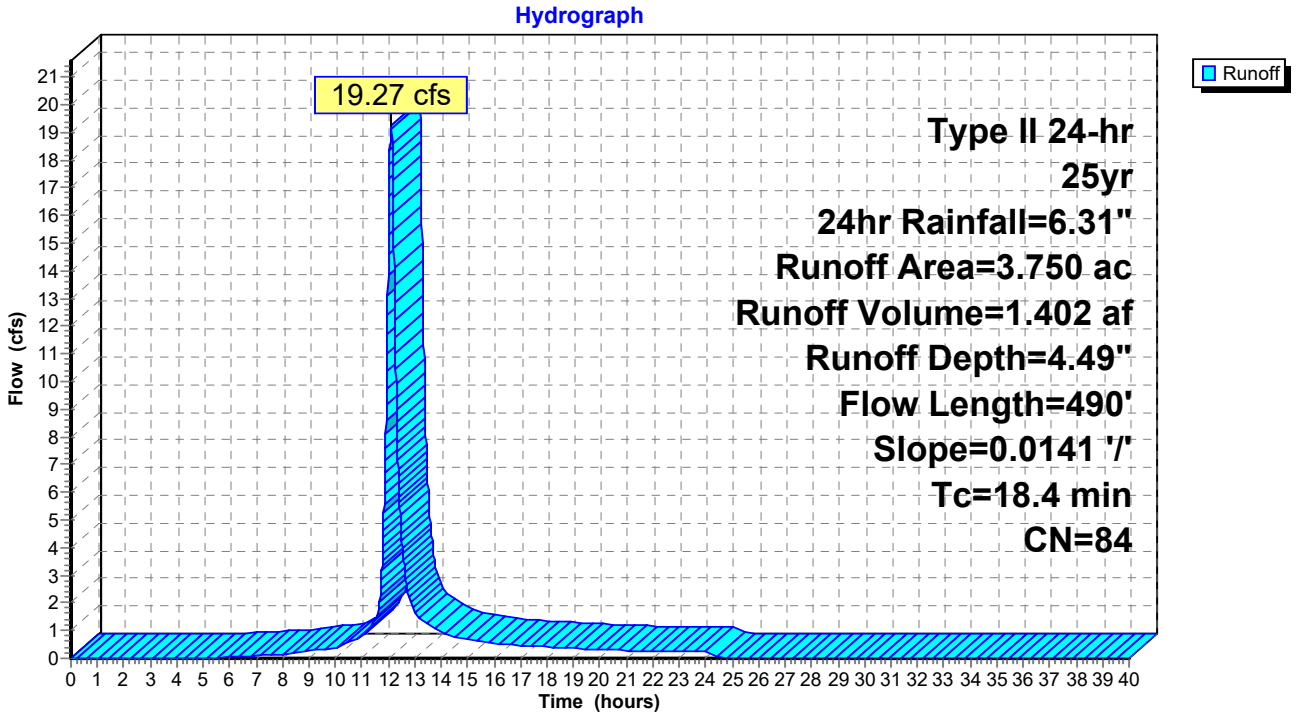
Runoff = 19.27 cfs @ 12.10 hrs, Volume= 1.402 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
3.750	84	50-75% Grass cover, Fair, HSG D
3.750		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	340	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
18.4	490	Total			

Subcatchment E4S: DA E4



Summary for Subcatchment E5S: DA E5

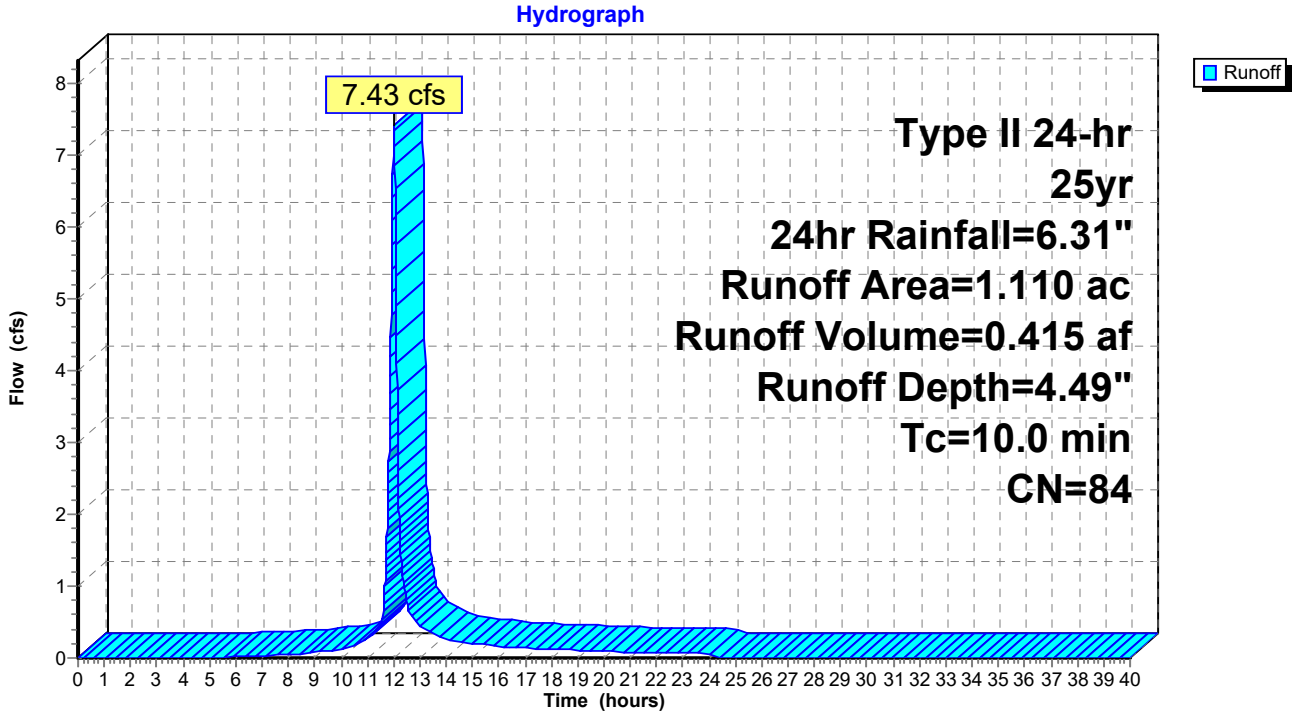
Runoff = 7.43 cfs @ 12.01 hrs, Volume= 0.415 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
1.110	84	50-75% Grass cover, Fair, HSG D
1.110		100.00% Pervious Area

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

Subcatchment E5S: DA E5



Summary for Subcatchment E6S: DA E6

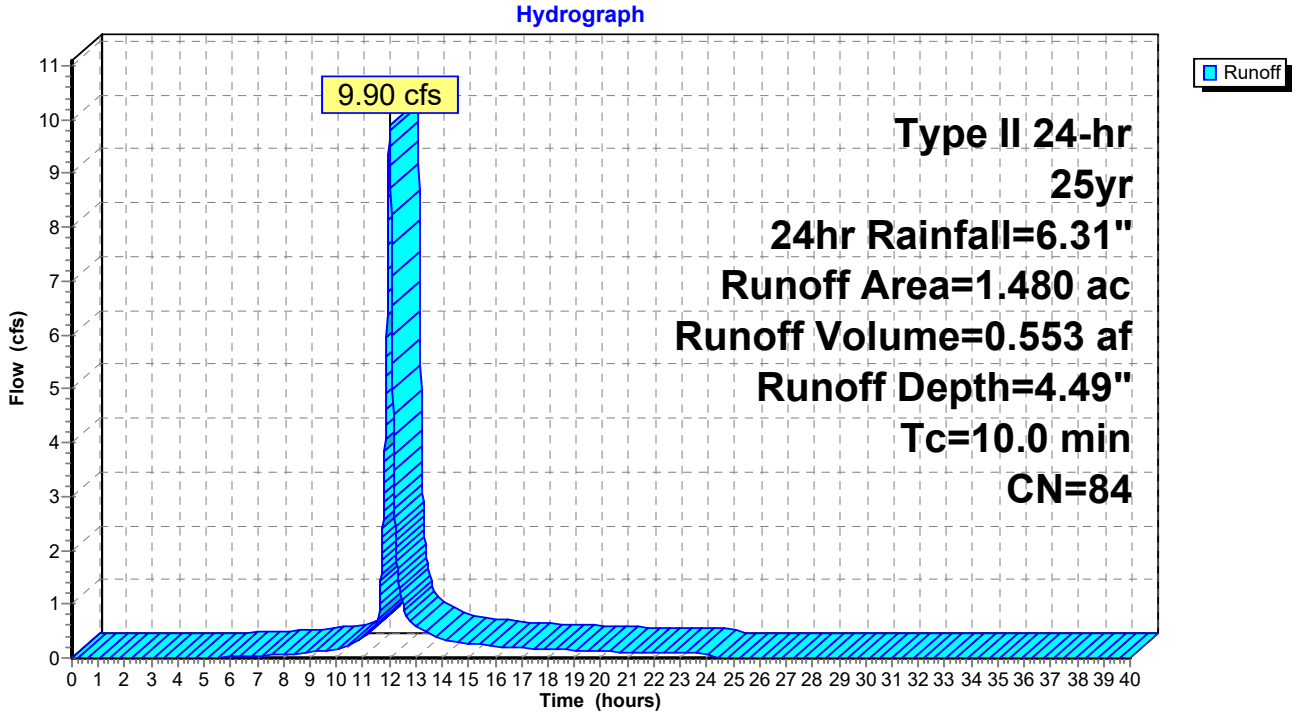
Runoff = 9.90 cfs @ 12.01 hrs, Volume= 0.553 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
1.480	84	50-75% Grass cover, Fair, HSG D
1.480		100.00% Pervious Area

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

Subcatchment E6S: DA E6



Summary for Subcatchment E7S: DA E7

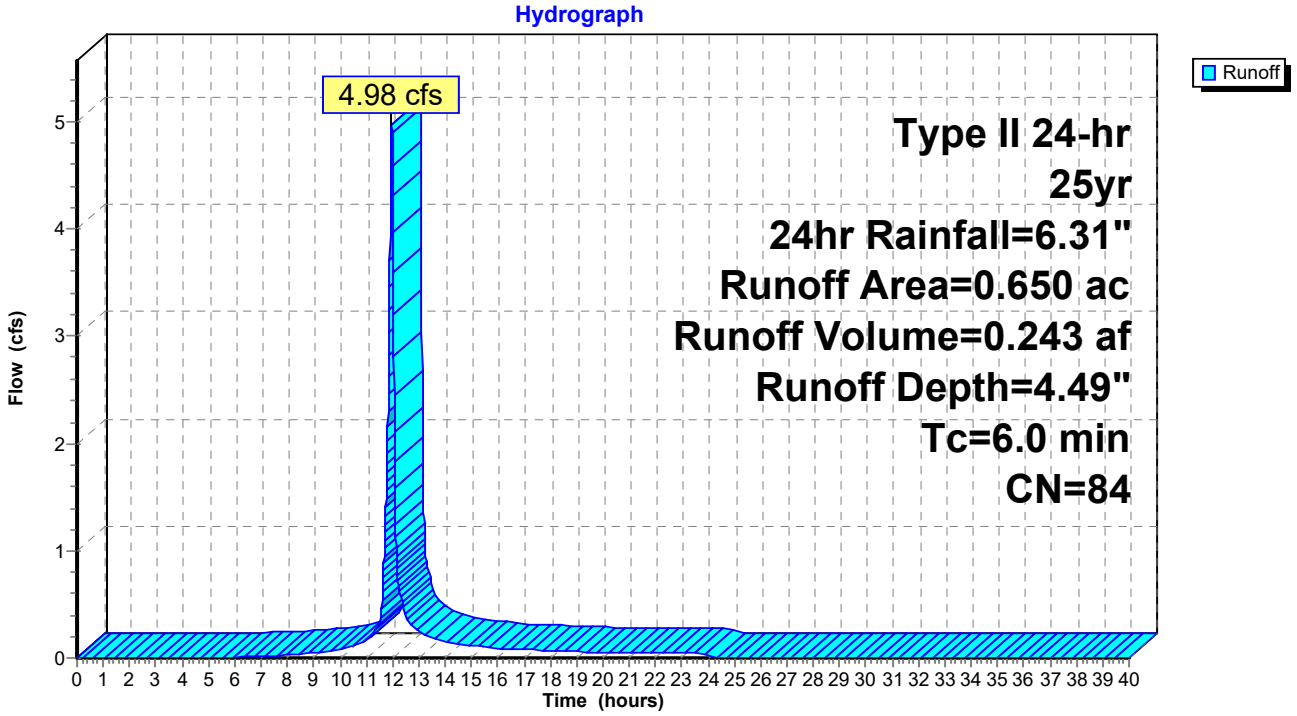
Runoff = 4.98 cfs @ 11.97 hrs, Volume= 0.243 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
0.650	84	50-75% Grass cover, Fair, HSG D
0.650		100.00% Pervious Area

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

Subcatchment E7S: DA E7



Summary for Subcatchment E8S: DA E8

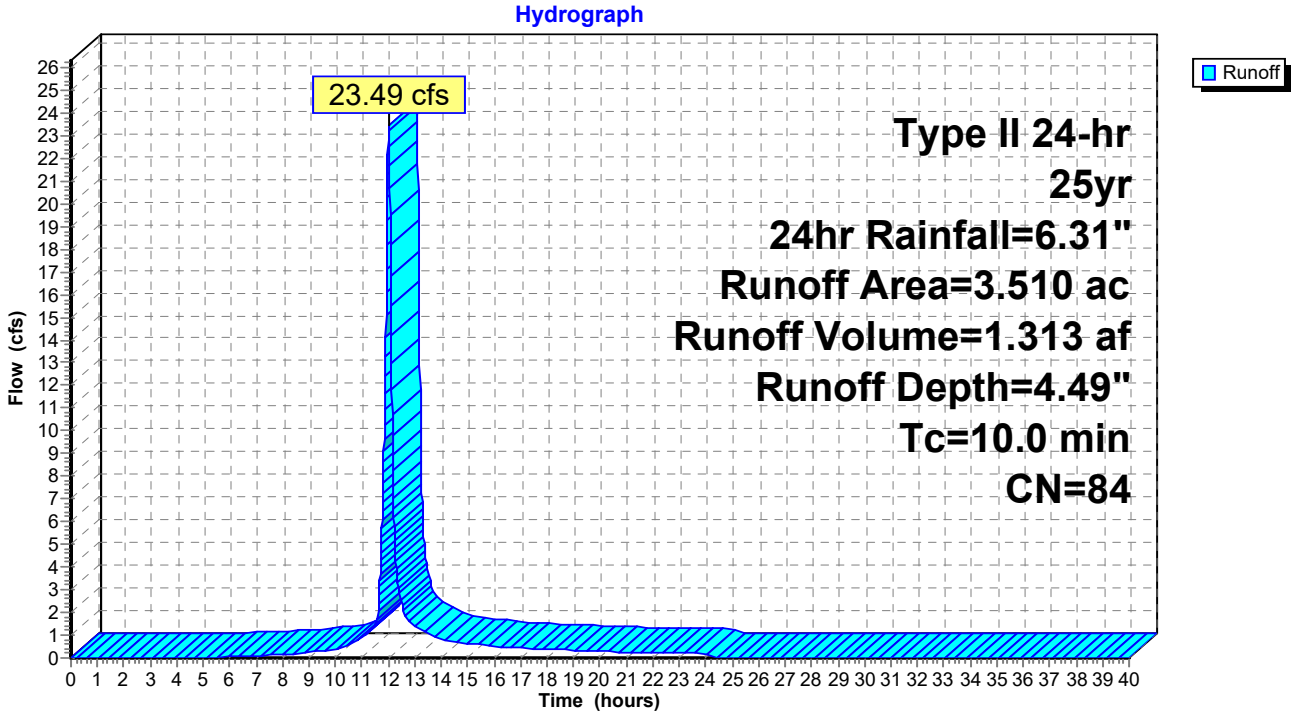
Runoff = 23.49 cfs @ 12.01 hrs, Volume= 1.313 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
3.510	84	50-75% Grass cover, Fair, HSG D
3.510		100.00% Pervious Area

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

Subcatchment E8S: DA E8



Summary for Subcatchment W1S: DA W1

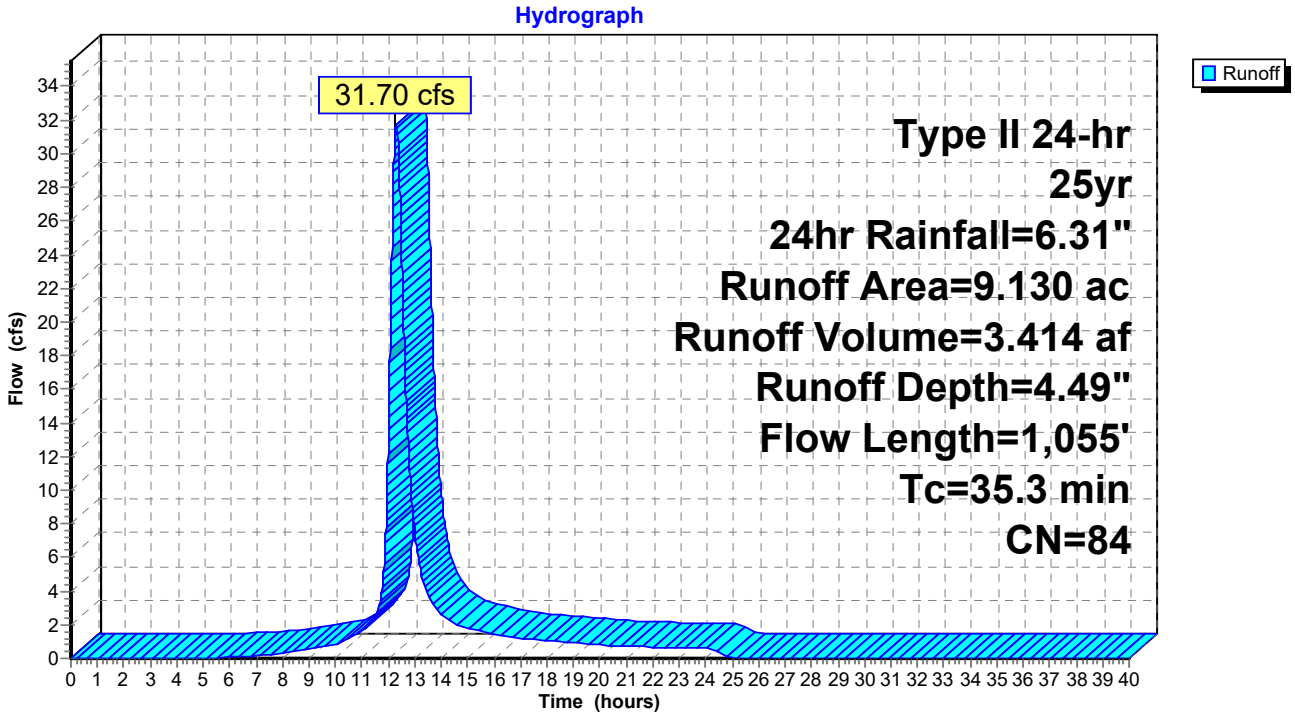
Runoff = 31.70 cfs @ 12.28 hrs, Volume= 3.414 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
9.130	84	50-75% Grass cover, Fair, HSG D
9.130		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.9	565	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
3.4	340	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
35.3	1,055	Total			

Subcatchment W1S: DA W1



Summary for Subcatchment W2S: DA W2

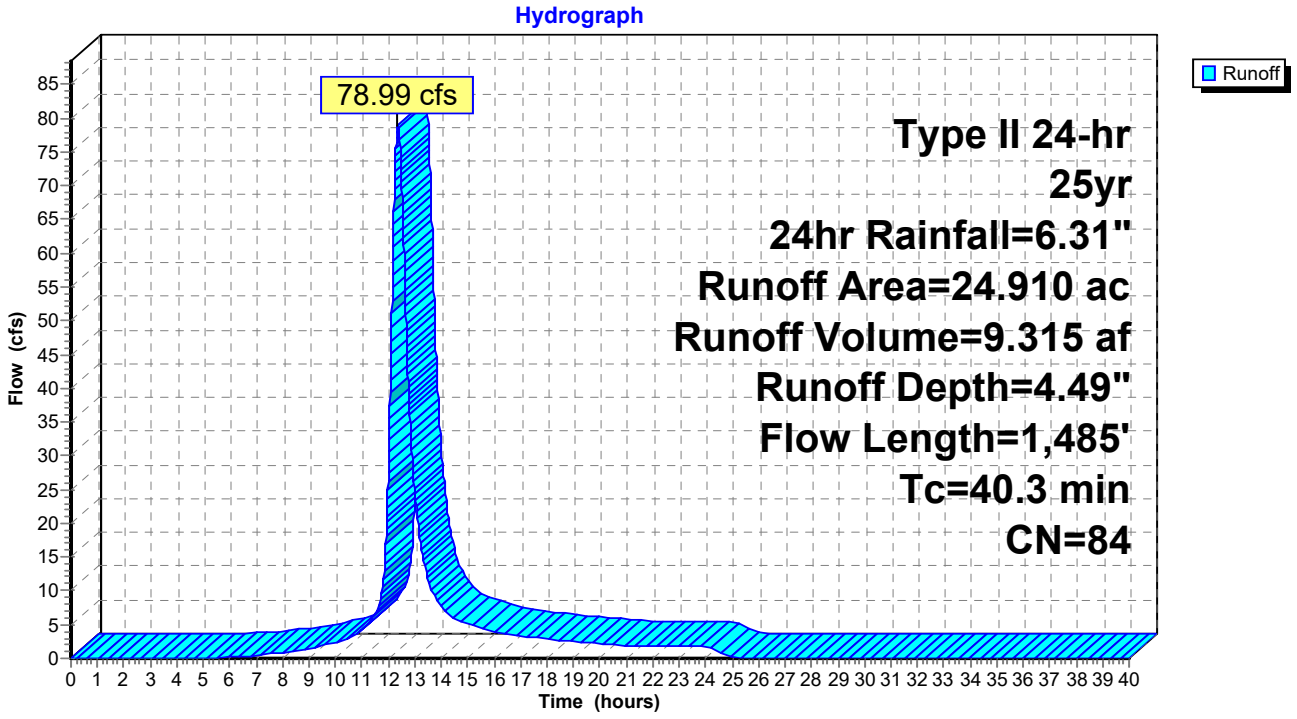
Runoff = 78.99 cfs @ 12.36 hrs, Volume= 9.315 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
24.910	84	50-75% Grass cover, Fair, HSG D
24.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	665	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.9	670	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.3	1,485	Total			

Subcatchment W2S: DA W2



Summary for Subcatchment W3S: DA W3

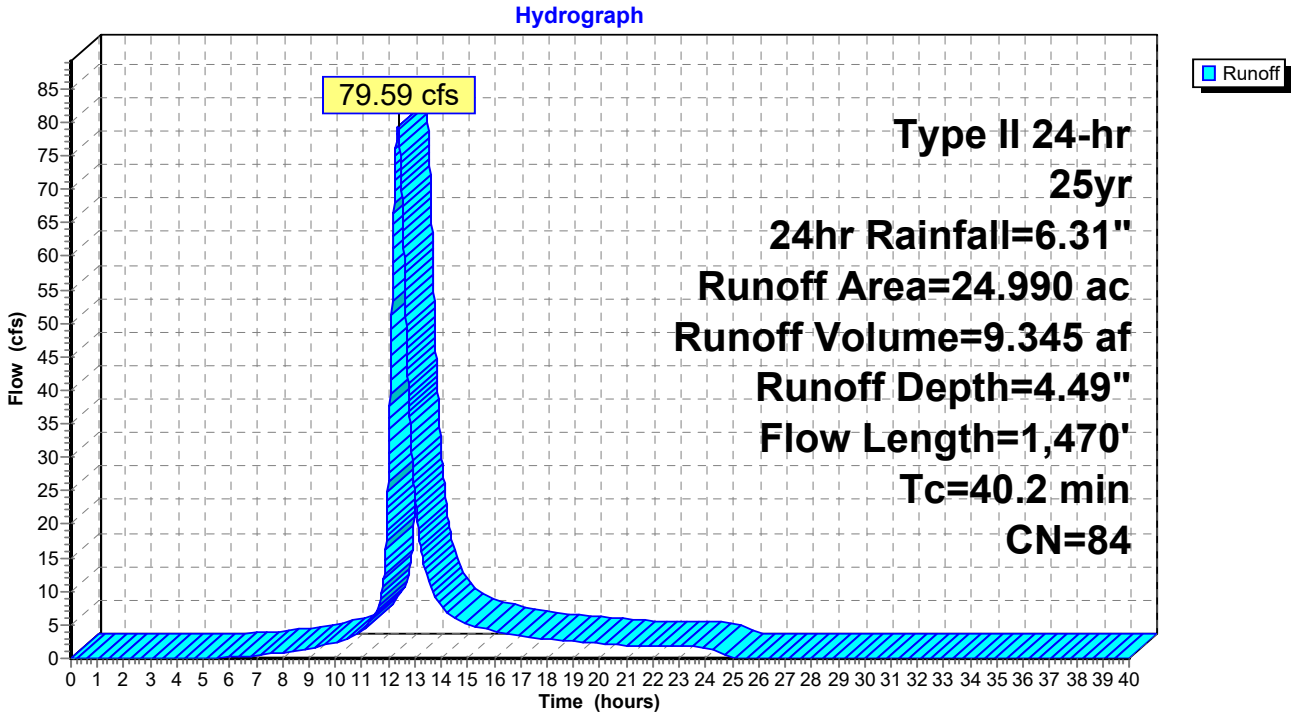
Runoff = 79.59 cfs @ 12.37 hrs, Volume= 9.345 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
24.990	84	50-75% Grass cover, Fair, HSG D
24.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	660	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.8	660	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.2	1,470	Total			

Subcatchment W3S: DA W3



Summary for Subcatchment W4S: DA W4

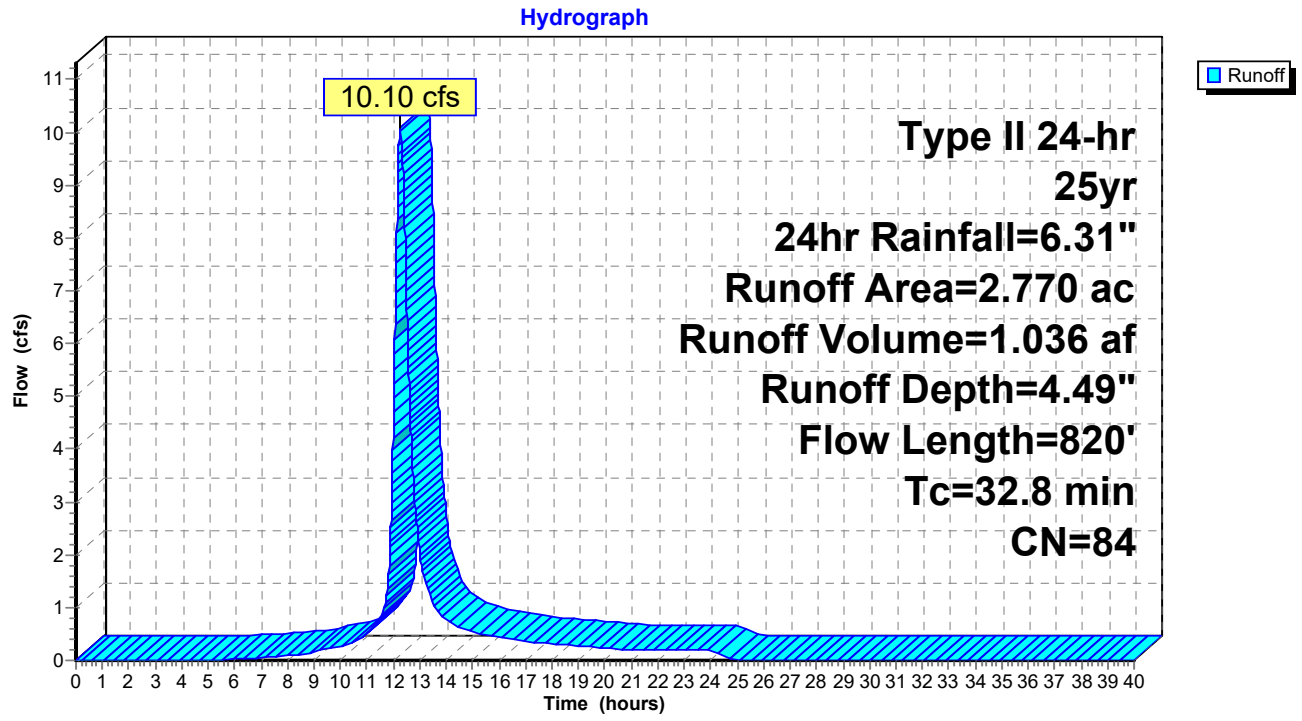
Runoff = 10.10 cfs @ 12.28 hrs, Volume= 1.036 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
2.770	84	50-75% Grass cover, Fair, HSG D
2.770		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.6	550	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
1.2	120	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
32.8	820	Total			

Subcatchment W4S: DA W4



Summary for Subcatchment W5S: DA W5

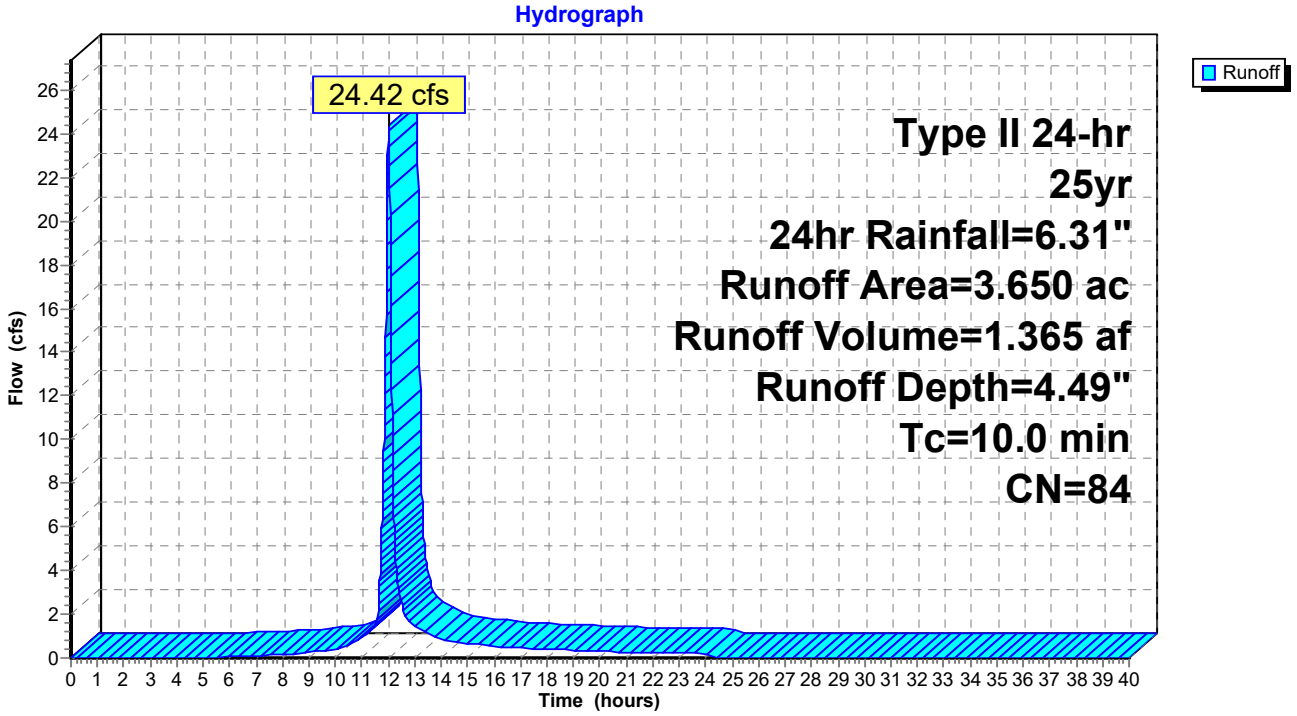
Runoff = 24.42 cfs @ 12.01 hrs, Volume= 1.365 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
3.650	84	50-75% Grass cover, Fair, HSG D
3.650		100.00% Pervious Area

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

Subcatchment W5S: DA W5



Summary for Subcatchment W6S: DA W6

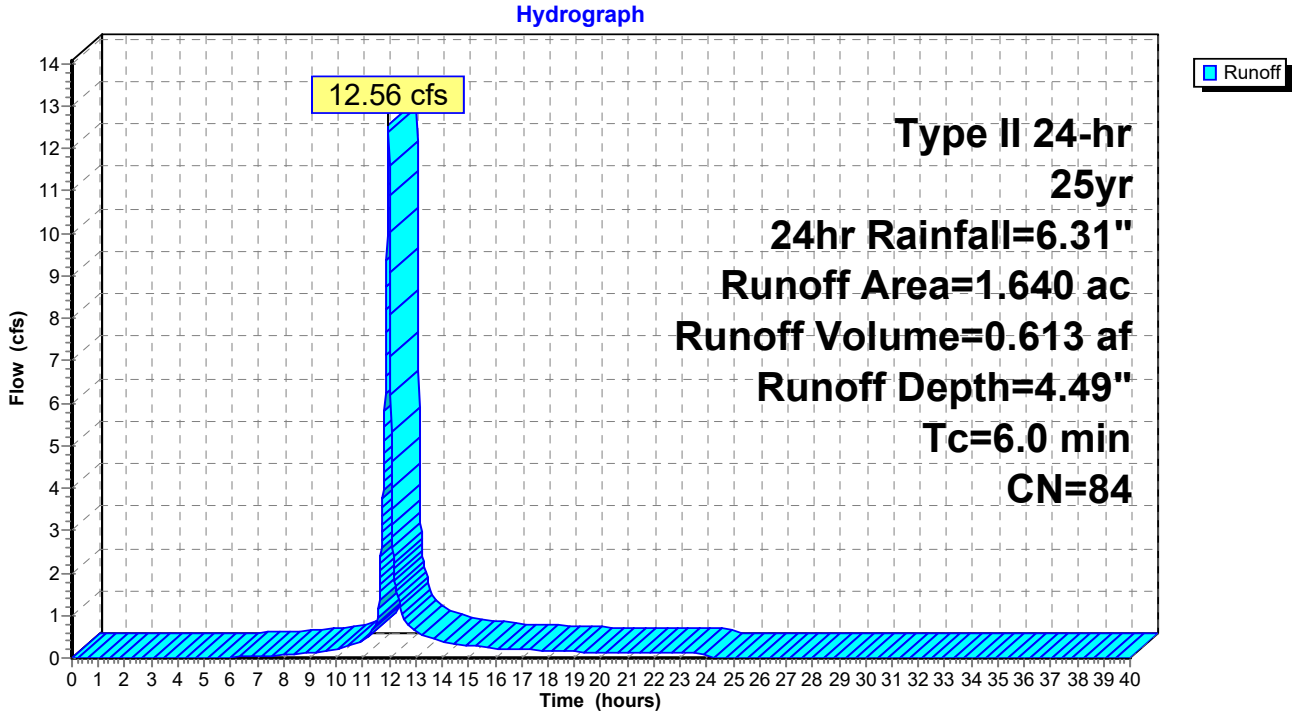
Runoff = 12.56 cfs @ 11.97 hrs, Volume= 0.613 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
1.640	84	50-75% Grass cover, Fair, HSG D
1.640		100.00% Pervious Area

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

Subcatchment W6S: DA W6



Summary for Subcatchment W7S: DA W7

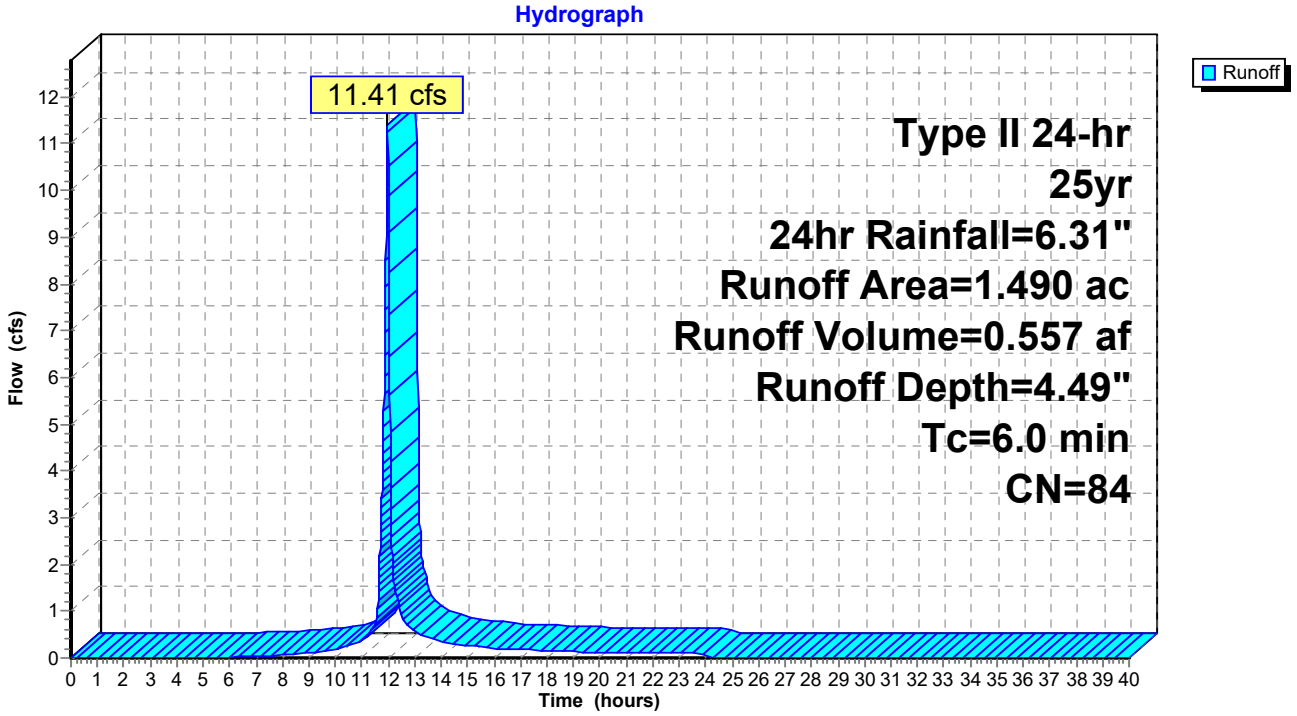
Runoff = 11.41 cfs @ 11.97 hrs, Volume= 0.557 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
1.490	84	50-75% Grass cover, Fair, HSG D
1.490		100.00% Pervious Area

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

Subcatchment W7S: DA W7



Summary for Subcatchment W8S: DA W8

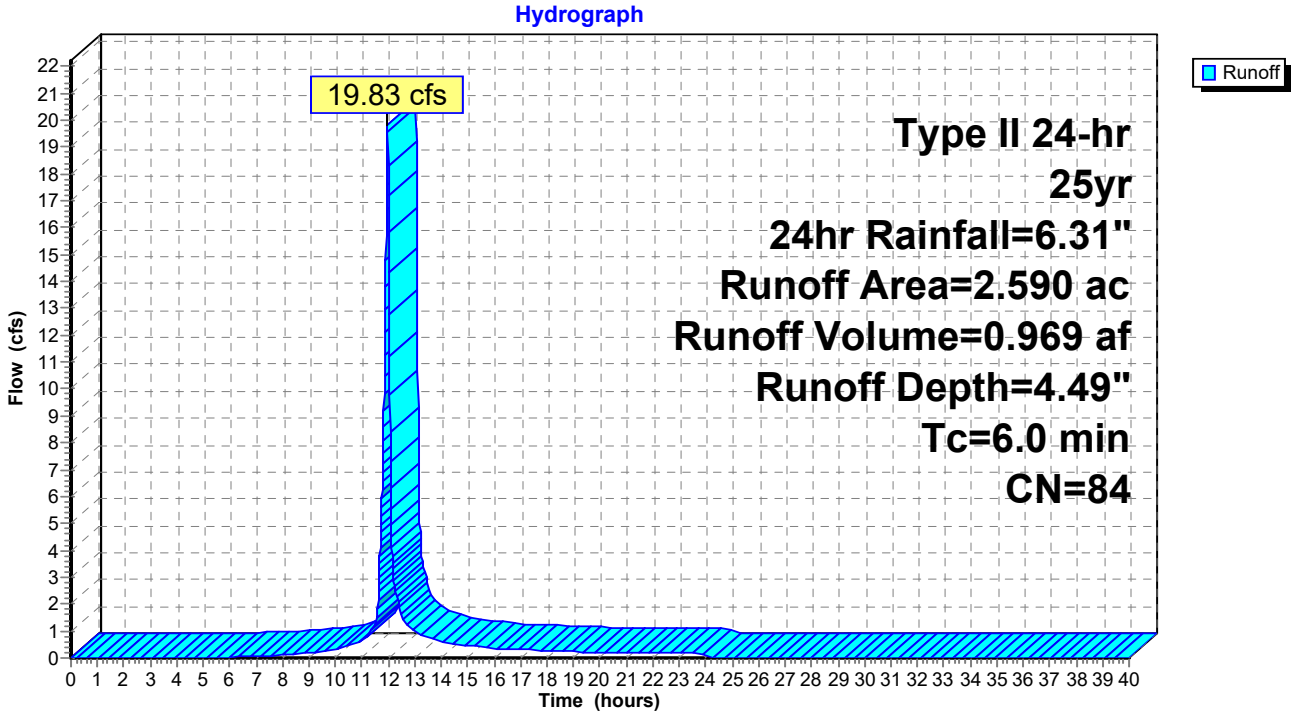
Runoff = 19.83 cfs @ 11.97 hrs, Volume= 0.969 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 25yr, 24hr Rainfall=6.31"

Area (ac)	CN	Description
2.590	84	50-75% Grass cover, Fair, HSG D
2.590		100.00% Pervious Area

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

Subcatchment W8S: DA W8



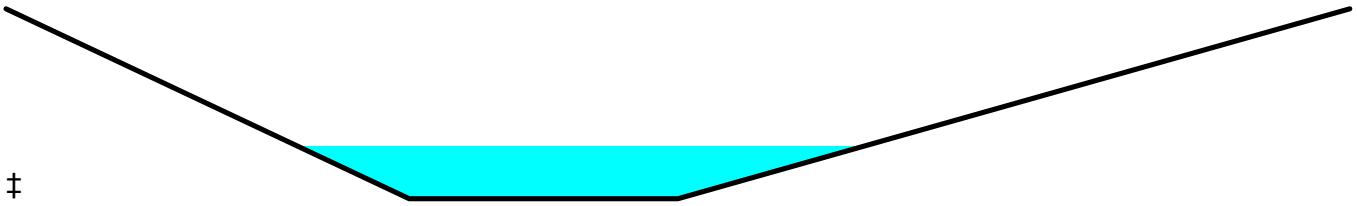
Summary for Reach E1R: Channel E1

Inflow Area = 9.570 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 46.19 cfs @ 12.09 hrs, Volume= 3.579 af
Outflow = 45.02 cfs @ 12.13 hrs, Volume= 3.579 af, Atten= 3%, Lag= 2.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.78 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.61 fps, Avg. Travel Time= 10.4 min

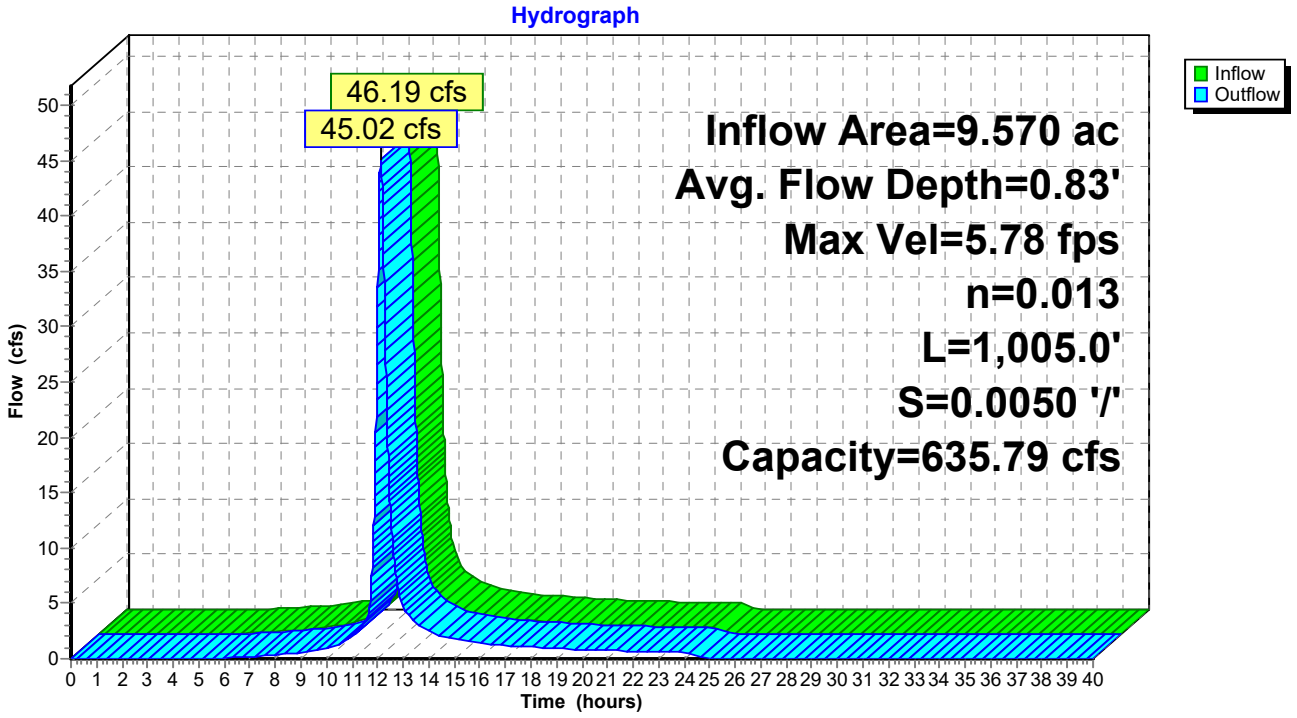
Peak Storage= 7,823 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.83'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 635.79 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,005.0' Slope= 0.0050 '/'
Inlet Invert= 14.32', Outlet Invert= 9.28'



‡

Reach E1R: Channel E1



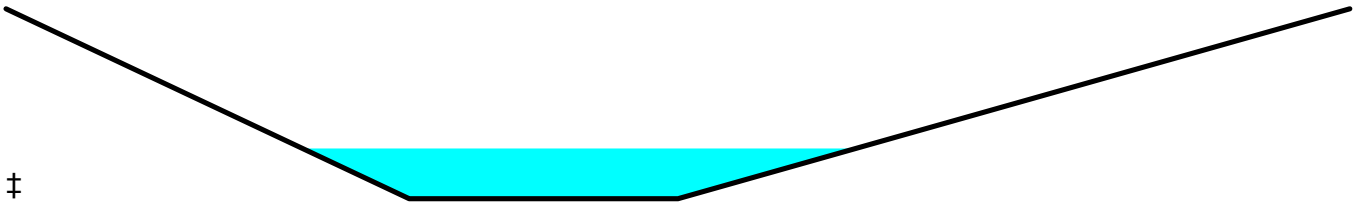
Summary for Reach E2R: Channel E2

Inflow Area = 8.380 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 41.83 cfs @ 12.11 hrs, Volume= 3.134 af
Outflow = 40.97 cfs @ 12.14 hrs, Volume= 3.134 af, Atten= 2%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.63 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.57 fps, Avg. Travel Time= 8.6 min

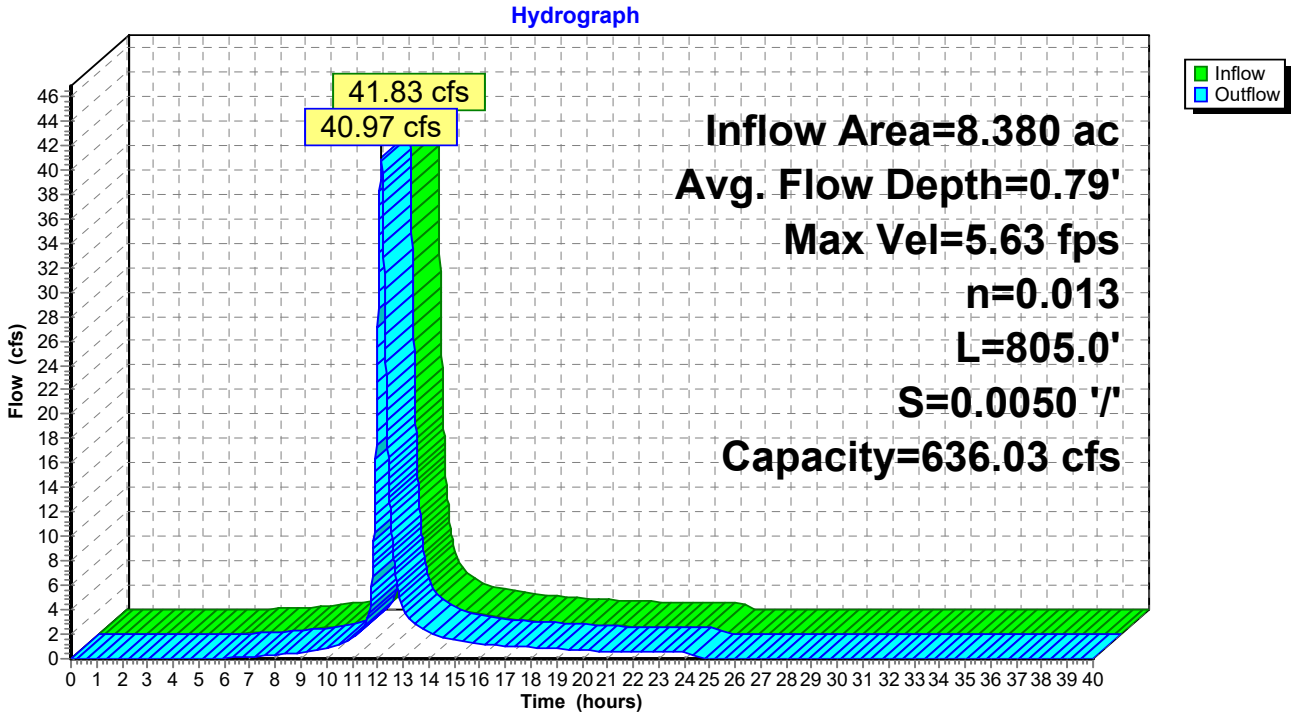
Peak Storage= 5,858 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.79'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 636.03 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 805.0' Slope= 0.0050 '/'
Inlet Invert= 15.27', Outlet Invert= 11.23'



‡

Reach E2R: Channel E2



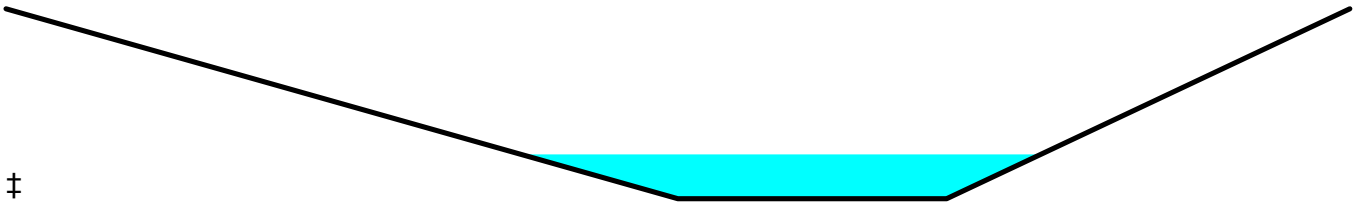
Summary for Reach E3R: Channel E3

Inflow Area = 7.260 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 39.86 cfs @ 12.04 hrs, Volume= 2.715 af
Outflow = 38.88 cfs @ 12.06 hrs, Volume= 2.715 af, Atten= 2%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 6.31 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 1.70 fps, Avg. Travel Time= 8.3 min

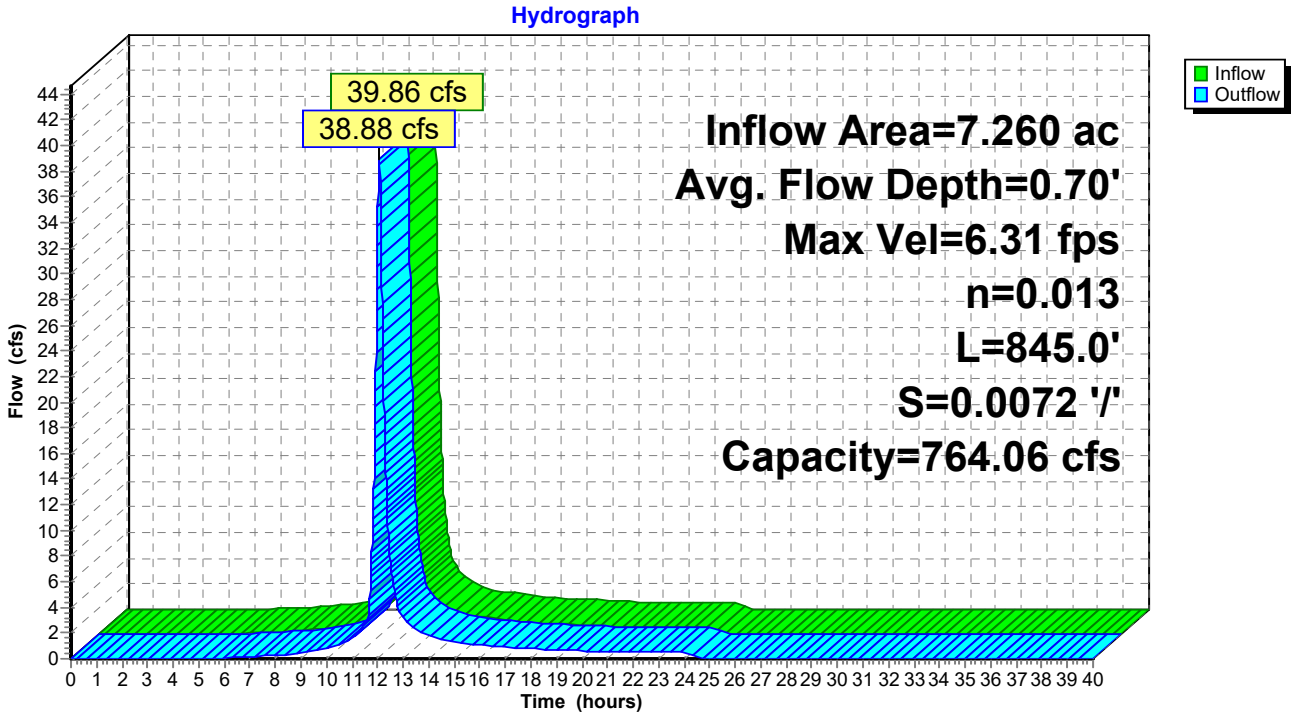
Peak Storage= 5,203 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.70'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 764.06 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 845.0' Slope= 0.0072 '/'
Inlet Invert= 17.35', Outlet Invert= 11.23'



‡

Reach E3R: Channel E3



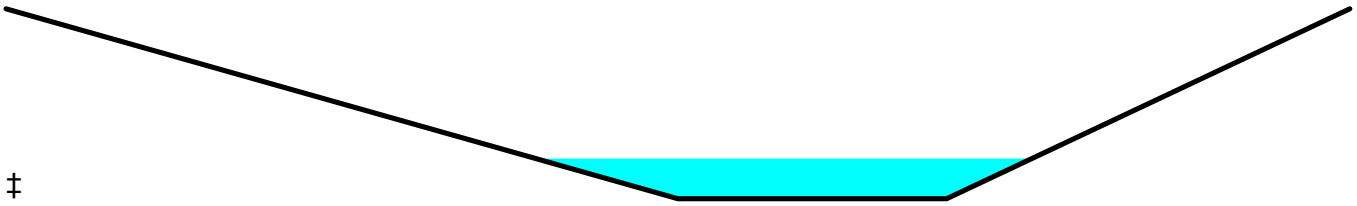
Summary for Reach W1R: Channel W1

Inflow Area = 12.780 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 39.34 cfs @ 12.04 hrs, Volume= 4.779 af
Outflow = 37.73 cfs @ 12.09 hrs, Volume= 4.779 af, Atten= 4%, Lag= 2.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 6.98 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 2.23 fps, Avg. Travel Time= 10.9 min

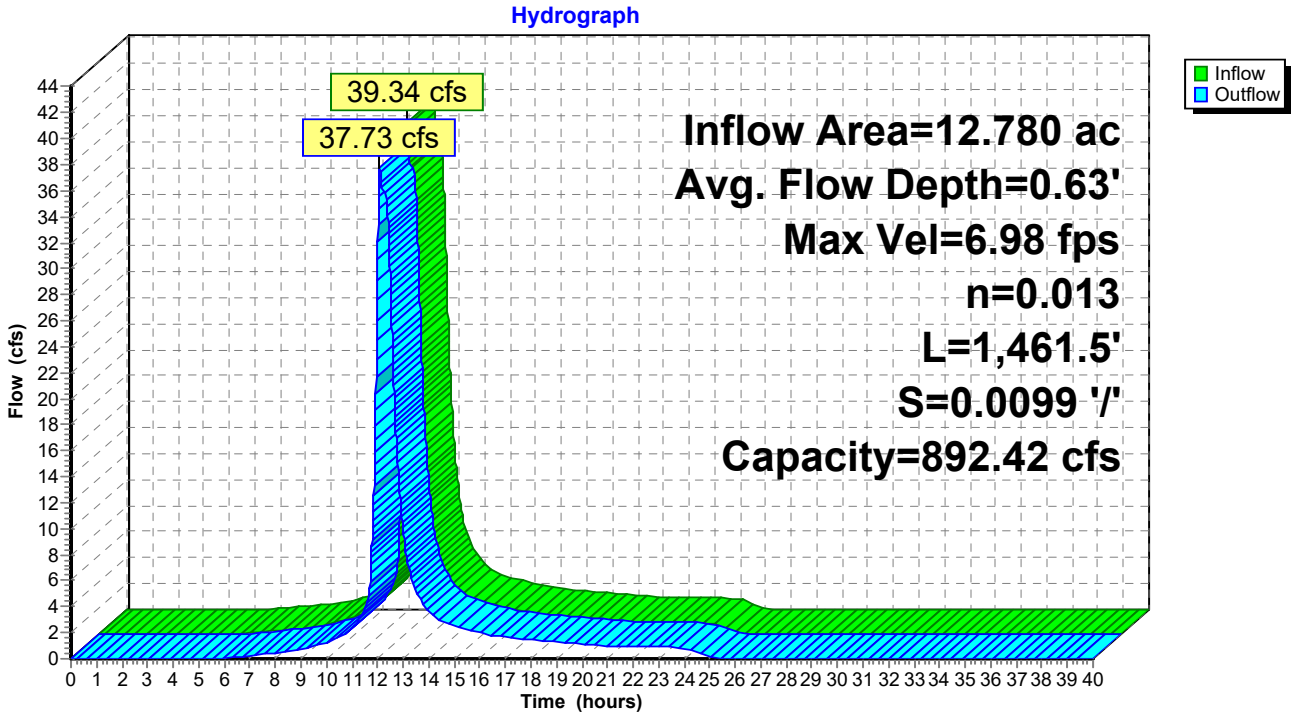
Peak Storage= 7,902 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 892.42 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 1,461.5' Slope= 0.0099 '/'
Inlet Invert= 20.31', Outlet Invert= 5.87'



‡

Reach W1R: Channel W1



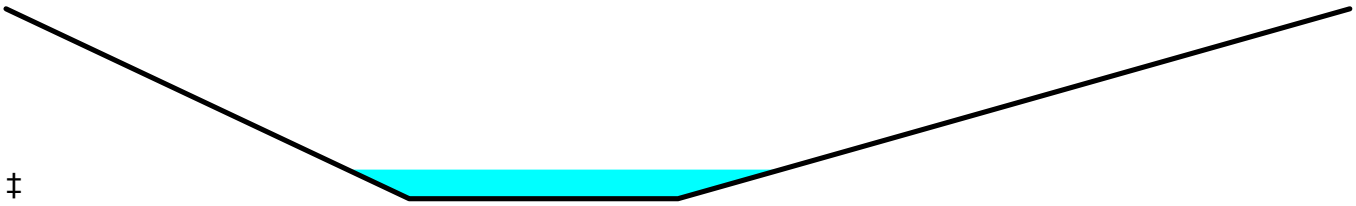
Summary for Reach W2R: Channel W2

Inflow Area = 1.640 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 12.56 cfs @ 11.97 hrs, Volume= 0.613 af
Outflow = 11.55 cfs @ 12.00 hrs, Volume= 0.613 af, Atten= 8%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 3.20 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 0.79 fps, Avg. Travel Time= 13.9 min

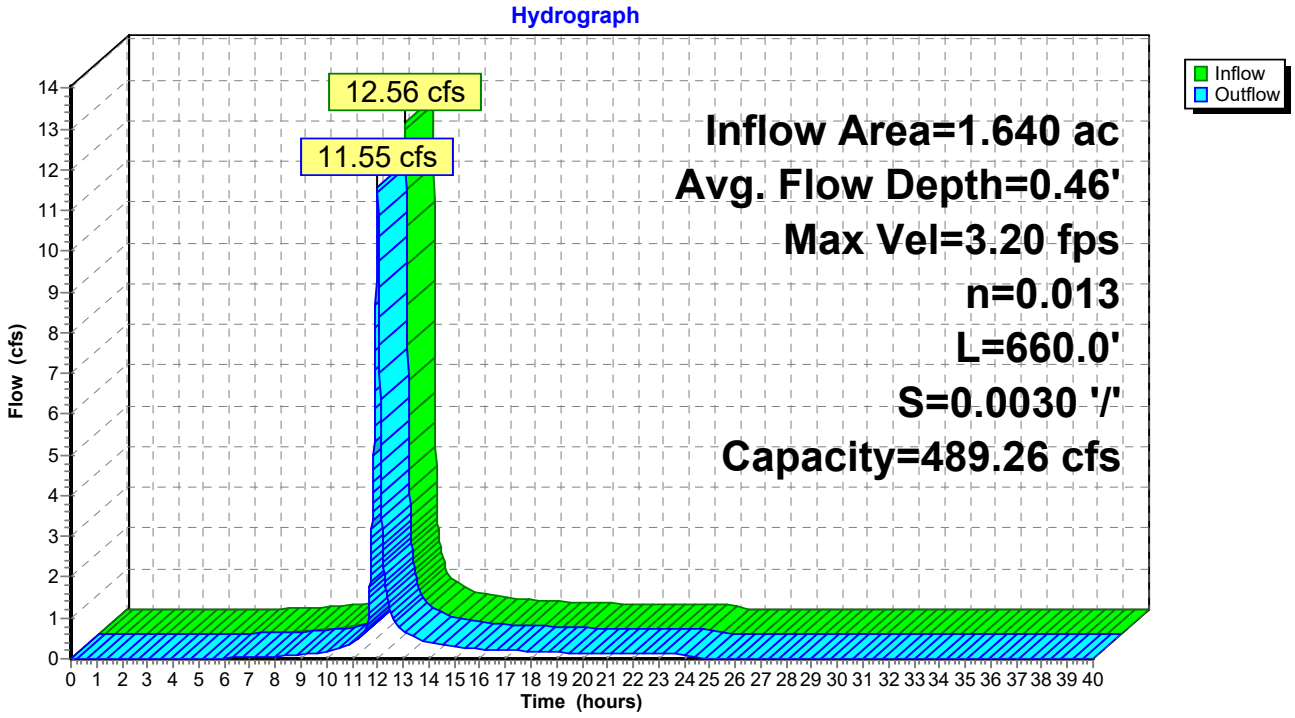
Peak Storage= 2,381 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 489.26 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 660.0' Slope= 0.0030 '/'
Inlet Invert= 7.83', Outlet Invert= 5.87'



‡

Reach W2R: Channel W2



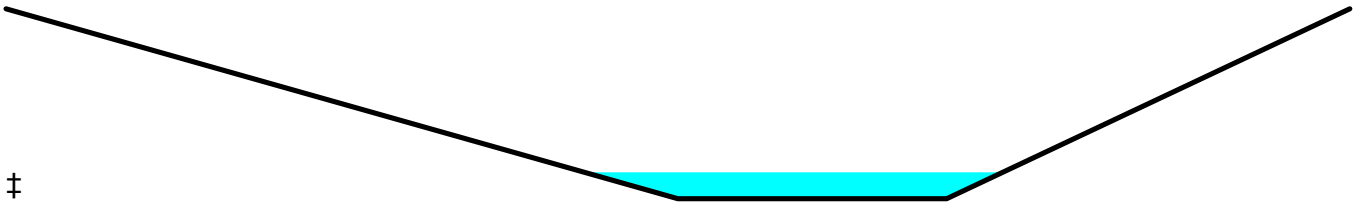
Summary for Reach W3R: Channel W3

Inflow Area = 1.490 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 11.41 cfs @ 11.97 hrs, Volume= 0.557 af
Outflow = 10.57 cfs @ 12.00 hrs, Volume= 0.557 af, Atten= 7%, Lag= 1.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 3.30 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 0.82 fps, Avg. Travel Time= 13.0 min

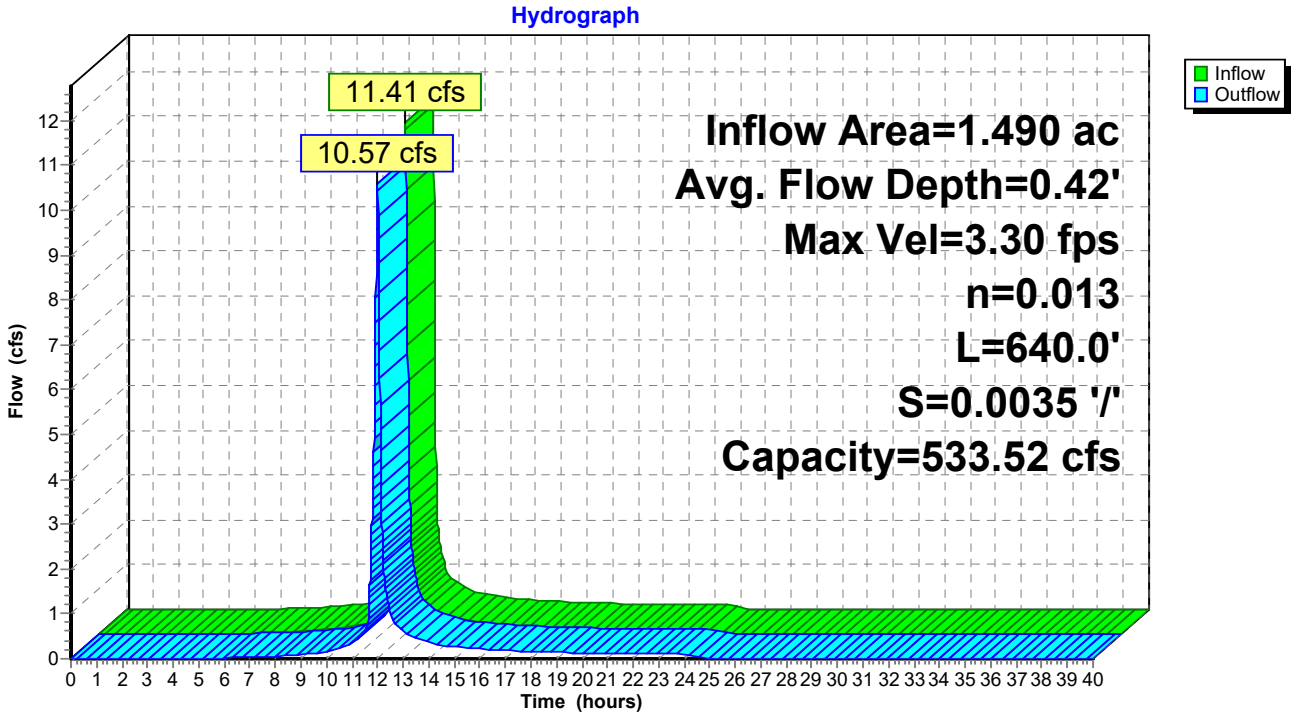
Peak Storage= 2,049 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 533.52 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 640.0' Slope= 0.0035 '/'
Inlet Invert= 7.83', Outlet Invert= 5.57'



‡

Reach W3R: Channel W3



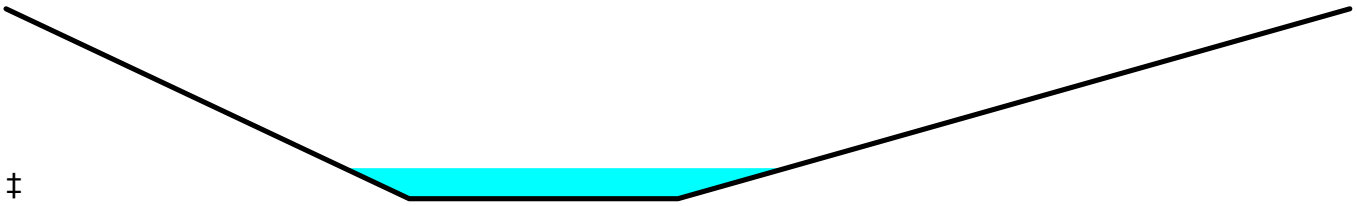
Summary for Reach W4R: Channel W4

Inflow Area = 5.360 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 23.66 cfs @ 11.98 hrs, Volume= 2.004 af
Outflow = 21.52 cfs @ 12.01 hrs, Volume= 2.004 af, Atten= 9%, Lag= 2.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.62 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 1.64 fps, Avg. Travel Time= 13.8 min

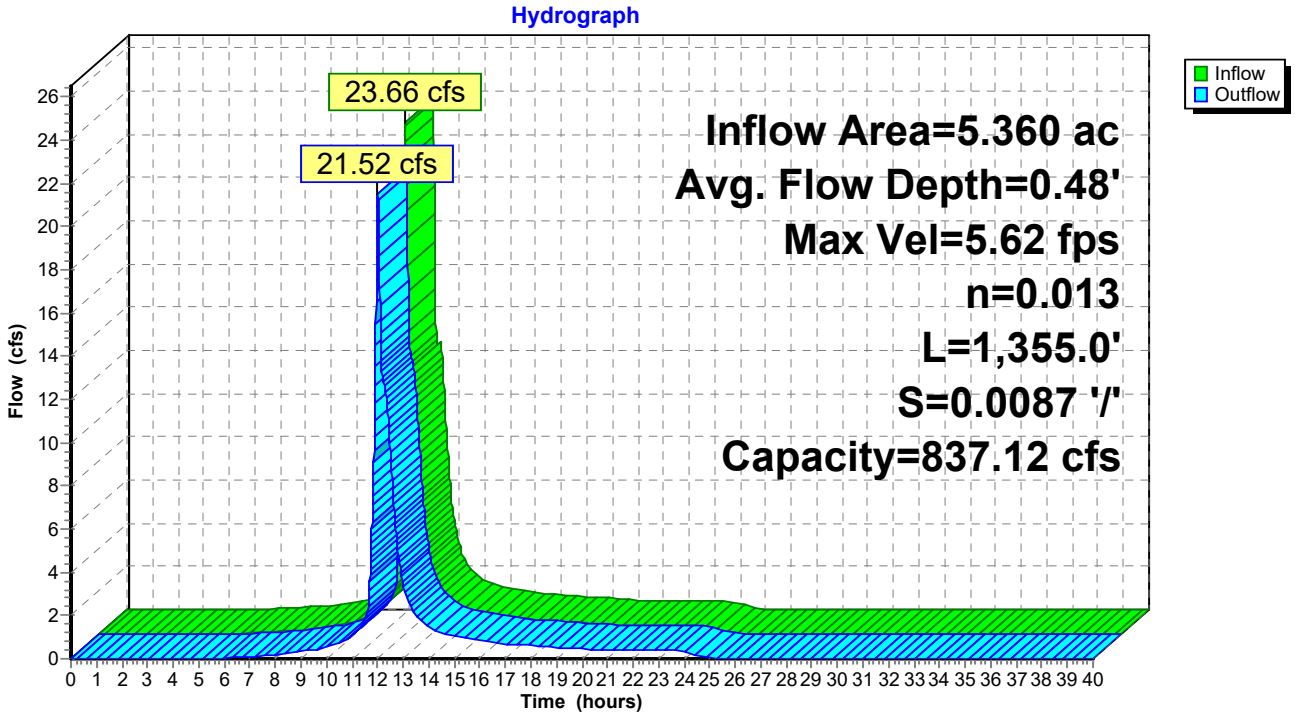
Peak Storage= 5,185 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 837.12 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,355.0' Slope= 0.0087 '/'
Inlet Invert= 17.35', Outlet Invert= 5.57'



‡

Reach W4R: Channel W4



Summary for Pond E1P: Proposed Culvert E1

[62] Hint: Exceeded Reach E1R OUTLET depth by 2.47' @ 12.29 hrs

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 49.35 cfs @ 12.10 hrs, Volume= 3.994 af
Outflow = 38.54 cfs @ 12.24 hrs, Volume= 3.994 af, Atten= 22%, Lag= 8.1 min
Primary = 38.54 cfs @ 12.24 hrs, Volume= 3.994 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 12.47' @ 12.24 hrs Surf.Area= 14,484 sf Storage= 18,051 cf

Plug-Flow detention time= 4.5 min calculated for 3.994 af (100% of inflow)
Center-of-Mass det. time= 4.4 min (819.1 - 814.7)

Volume	Invert	Avail.Storage	Storage Description
#1	9.20'	138,439 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

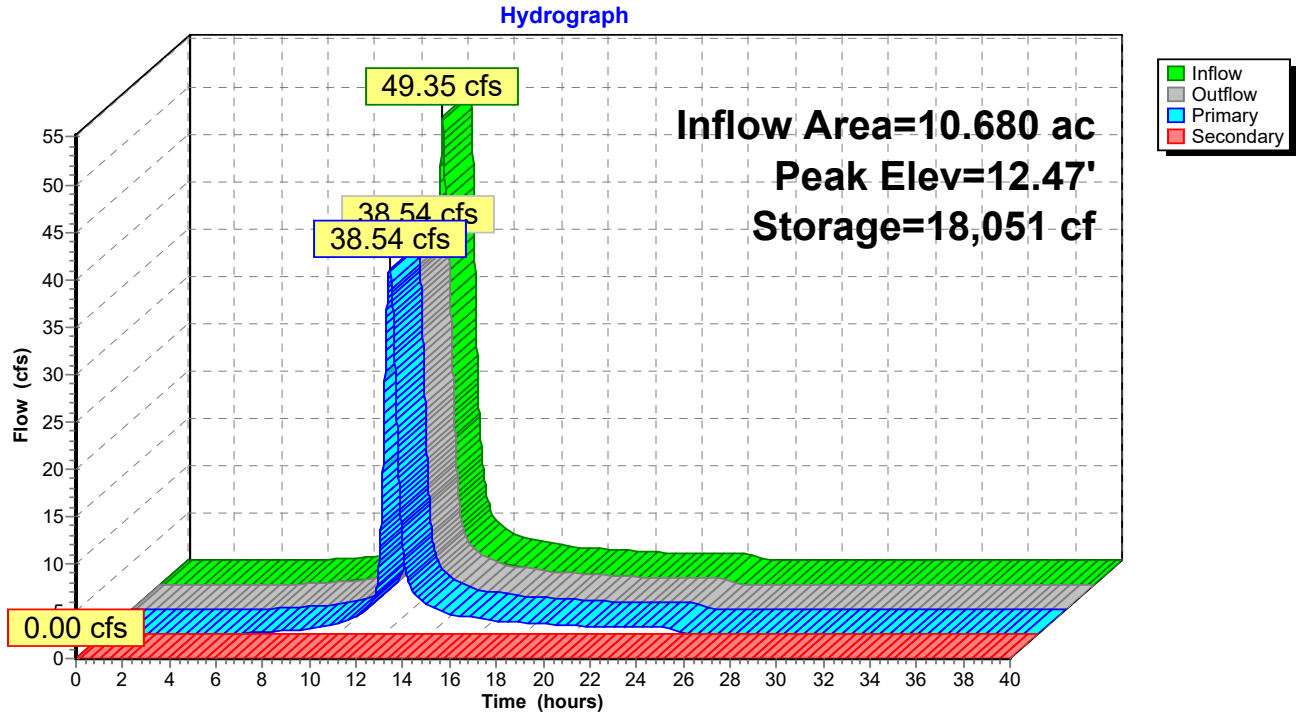
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
9.20	0	0.0	0	0	0
10.00	1,725	385.0	460	460	11,796
11.00	5,530	845.0	3,448	3,908	56,826
12.00	11,180	1,305.0	8,191	12,099	135,535
13.00	18,810	1,770.0	14,831	26,929	249,331
14.00	28,645	2,245.0	23,556	50,485	401,109
15.00	49,400	2,488.0	38,554	89,039	492,663
16.00	49,400	2,488.0	49,400	138,439	495,151

Device	Routing	Invert	Outlet Devices
#1	Primary	9.30'	**36.0" Round 36" Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.30' / 8.70' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=38.53 cfs @ 12.24 hrs HW=12.46' TW=6.00' (Dynamic Tailwater)
↑—**1=36" Culvert** (Barrel Controls 38.53 cfs @ 6.42 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.20' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Proposed Culvert E1



Summary for Pond E2P: Proposed Culvert E2

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 46.71 cfs @ 12.11 hrs, Volume= 3.650 af
Outflow = 39.20 cfs @ 12.20 hrs, Volume= 3.650 af, Atten= 16%, Lag= 5.5 min
Primary = 39.20 cfs @ 12.20 hrs, Volume= 3.650 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 13.97' @ 12.20 hrs Surf.Area= 8,358 sf Storage= 7,935 cf

Plug-Flow detention time= 1.2 min calculated for 3.649 af (100% of inflow)
Center-of-Mass det. time= 1.2 min (811.3 - 810.2)

Volume	Invert	Avail.Storage	Storage Description
#1	11.50'	56,085 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

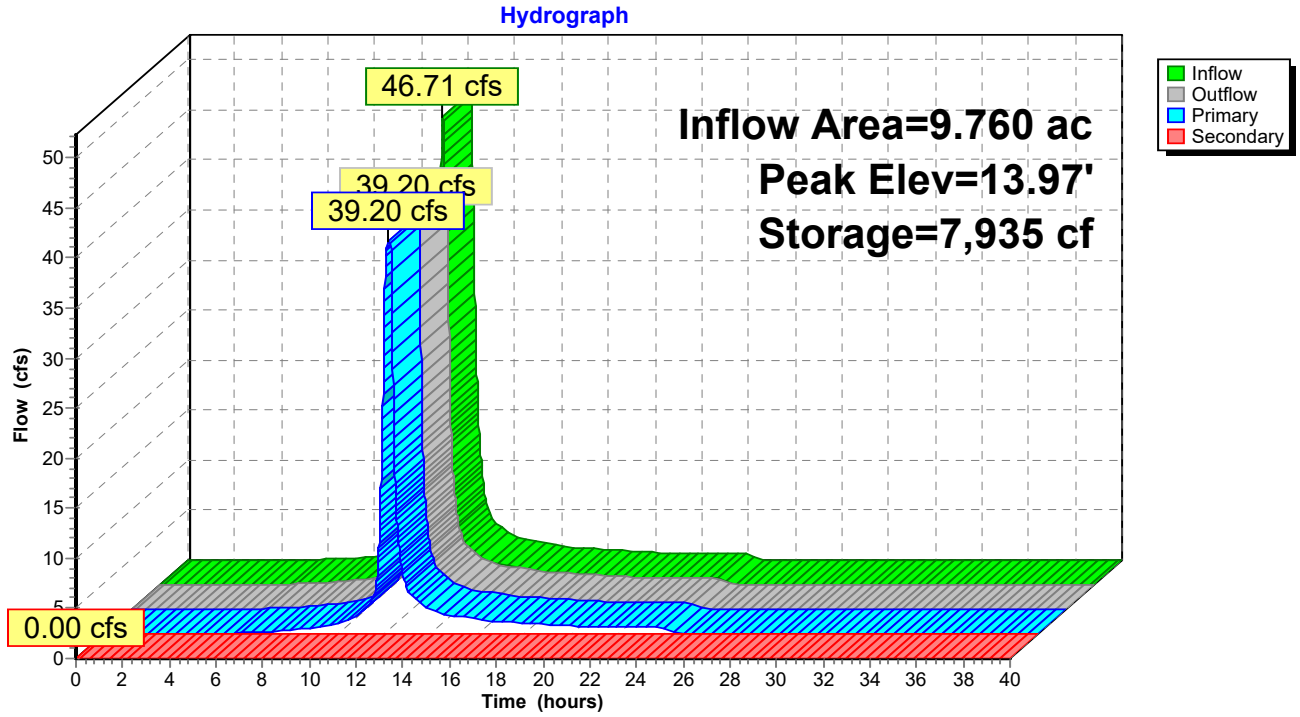
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.50	0	0.0	0	0	0
12.00	765	210.0	128	128	3,510
13.00	3,765	650.0	2,076	2,203	33,625
14.00	8,530	1,095.0	5,987	8,191	95,425
15.00	20,110	1,435.0	13,912	22,103	163,889
16.00	50,095	1,580.0	33,982	56,085	198,711

Device	Routing	Invert	Outlet Devices
#1	Primary	4.12'	**18.0" W x 12.0" H, R=12.0" Elliptical (3) 18x12" Culverts X 3.00** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.12' / 3.60' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.17 sf
#2	Device 1	11.50'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=39.20 cfs @ 12.20 hrs HW=13.97' TW=6.00' (Dynamic Tailwater)
1=(3) 18x12" Culverts (Outlet Controls 39.20 cfs @ 11.14 fps)
2=Orifice/Grate (Passes 39.20 cfs of 45.69 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.50' TW=6.00' (Dynamic Tailwater)
3=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond E2P: Proposed Culvert E2



Summary for Pond E3P: Proposed Culvert E3

[62] Hint: Exceeded Reach E2R OUTLET depth by 2.40' @ 12.28 hrs
[62] Hint: Exceeded Reach E3R OUTLET depth by 2.61' @ 12.27 hrs

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 76.25 cfs @ 12.10 hrs, Volume= 5.849 af
Outflow = 55.56 cfs @ 12.24 hrs, Volume= 5.849 af, Atten= 27%, Lag= 8.3 min
Primary = 55.56 cfs @ 12.24 hrs, Volume= 5.849 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 14.32' @ 12.24 hrs Surf.Area= 21,138 sf Storage= 25,478 cf

Plug-Flow detention time= 2.9 min calculated for 5.847 af (100% of inflow)
Center-of-Mass det. time= 2.9 min (816.8 - 813.9)

Volume	Invert	Avail.Storage	Storage Description
#1	11.20'	87,995 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

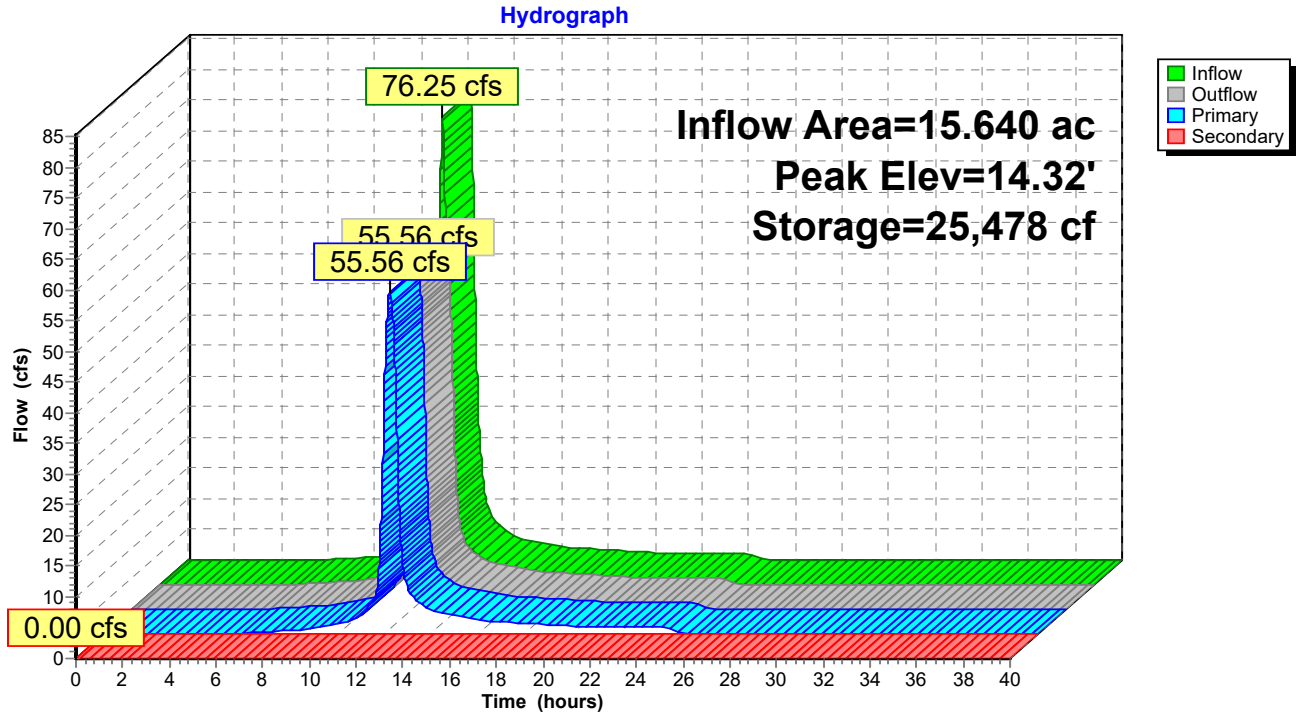
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.20	0	0.0	0	0	0
12.00	2,790	625.0	744	744	31,086
13.00	8,945	1,350.0	5,577	6,321	145,035
14.00	17,465	1,985.0	12,970	19,291	313,567
15.00	30,060	2,655.0	23,479	42,770	560,968
16.00	62,330	3,050.0	45,225	87,995	740,317

Device	Routing	Invert	Outlet Devices
#1	Primary	5.55'	**18.0" Round (3) 18" Culverts X 3.00** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.55' / 5.00' S= 0.0055 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	11.20'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=55.55 cfs @ 12.24 hrs HW=14.32' TW=6.00' (Dynamic Tailwater)
└**1=(3) 18" Culverts** (Passes 55.55 cfs of 65.21 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 55.55 cfs @ 6.94 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' TW=6.00' (Dynamic Tailwater)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E3P: Proposed Culvert E3



Summary for Pond W1P: Proposed Culvert W1

[62] Hint: Exceeded Reach W1R OUTLET depth by 4.06' @ 12.63 hrs
[63] Warning: Exceeded Reach W2R INLET depth by 2.47' @ 12.59 hrs

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 115.92 cfs @ 12.33 hrs, Volume= 14.708 af
Outflow = 87.76 cfs @ 12.57 hrs, Volume= 14.700 af, Atten= 24%, Lag= 14.8 min
Primary = 87.76 cfs @ 12.57 hrs, Volume= 14.700 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 10.41' @ 12.57 hrs Surf.Area= 62,977 sf Storage= 86,696 cf

Plug-Flow detention time= 12.7 min calculated for 14.700 af (100% of inflow)
Center-of-Mass det. time= 12.3 min (840.1 - 827.8)

Volume	Invert	Avail.Storage	Storage Description
#1	5.80'	501,374 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

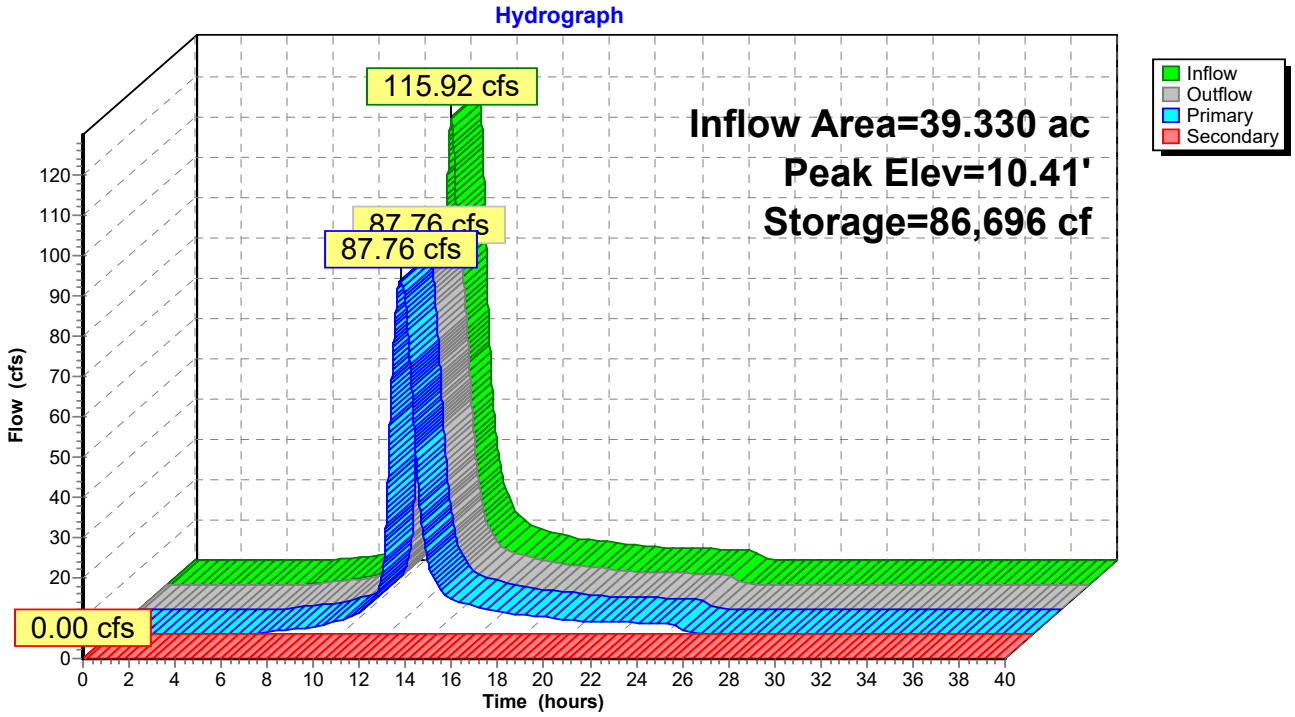
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.80	0	0.0	0	0	0
6.00	475	155.0	32	32	1,912
7.00	5,935	1,130.0	2,696	2,728	101,615
8.00	14,975	2,015.0	10,112	12,840	323,110
9.00	24,795	2,340.0	19,680	32,520	435,763
10.00	41,685	2,720.0	32,876	65,397	588,796
11.00	101,320	3,145.0	69,331	134,728	787,174
12.00	183,080	3,370.0	140,199	274,927	903,870
13.00	272,785	3,650.0	226,447	501,374	1,060,327

Device	Routing	Invert	Outlet Devices
#1	Primary	6.30'	**48.0" Round 48" Culvert** L= 110.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.30' / 5.20' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.25'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=87.75 cfs @ 12.57 hrs HW=10.41' TW=6.00' (Dynamic Tailwater)
↑—**1=48" Culvert** (Barrel Controls 87.75 cfs @ 8.45 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.80' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W1P: Proposed Culvert W1



Summary for Pond W2P: Proposed Culvert W2

[63] Warning: Exceeded Reach W3R INLET depth by 1.87' @ 12.54 hrs
[62] Hint: Exceeded Reach W4R OUTLET depth by 3.95' @ 12.56 hrs

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 92.89 cfs @ 12.36 hrs, Volume= 11.907 af
Outflow = 77.83 cfs @ 12.53 hrs, Volume= 11.902 af, Atten= 16%, Lag= 10.1 min
Primary = 77.83 cfs @ 12.53 hrs, Volume= 11.902 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 9.81' @ 12.53 hrs Surf.Area= 34,611 sf Storage= 52,322 cf

Plug-Flow detention time= 9.5 min calculated for 11.902 af (100% of inflow)
Center-of-Mass det. time= 9.2 min (836.6 - 827.4)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	454,263 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

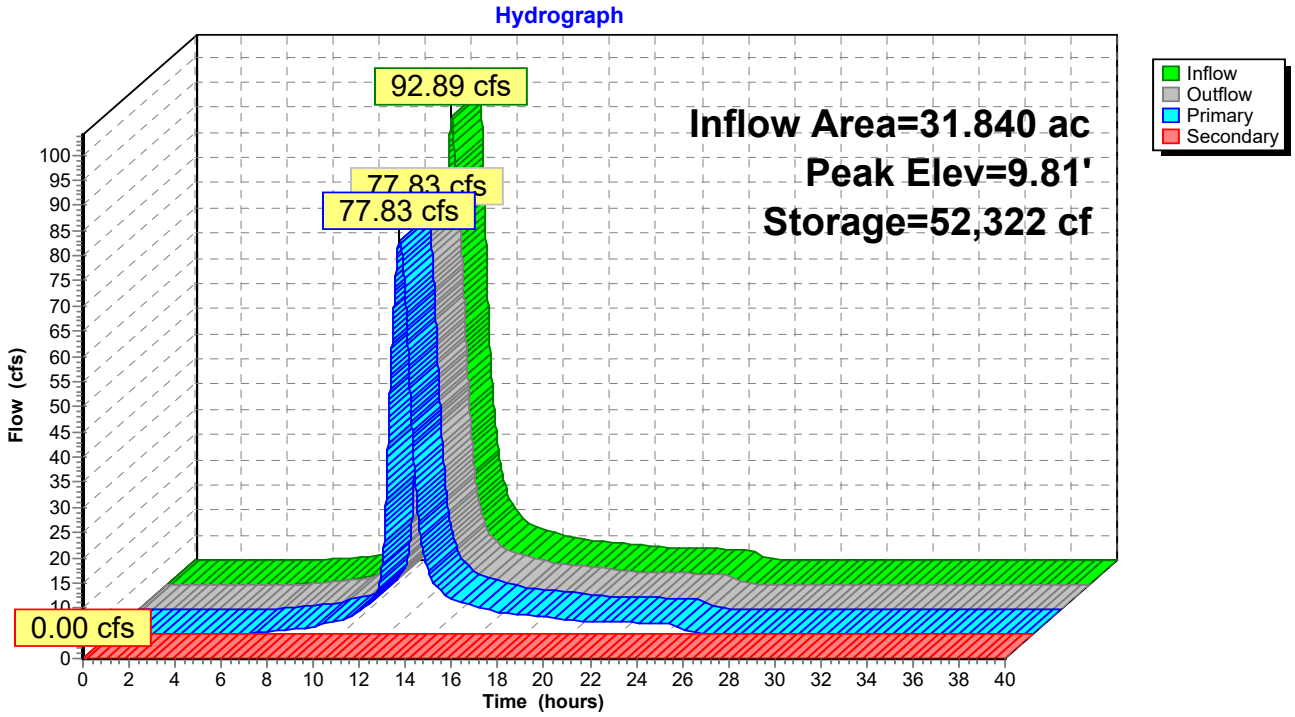
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	0	0.0	0	0	0
6.00	1,200	320.0	160	160	8,149
7.00	6,000	1,030.0	3,294	3,454	84,427
8.00	13,375	1,650.0	9,444	12,899	216,660
9.00	21,190	1,805.0	17,133	30,032	259,310
10.00	38,310	2,000.0	29,331	59,363	318,386
11.00	86,665	2,220.0	60,865	120,228	392,295
12.00	166,100	2,600.0	124,248	244,476	538,069
13.00	256,750	3,035.0	209,787	454,263	733,152

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**48.0" Round 48" Culvert** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0095 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=77.82 cfs @ 12.53 hrs HW=9.81' TW=6.00' (Dynamic Tailwater)
1=48" Culvert (Barrel Controls 77.82 cfs @ 8.11 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.60' TW=6.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond W2P: Proposed Culvert W2



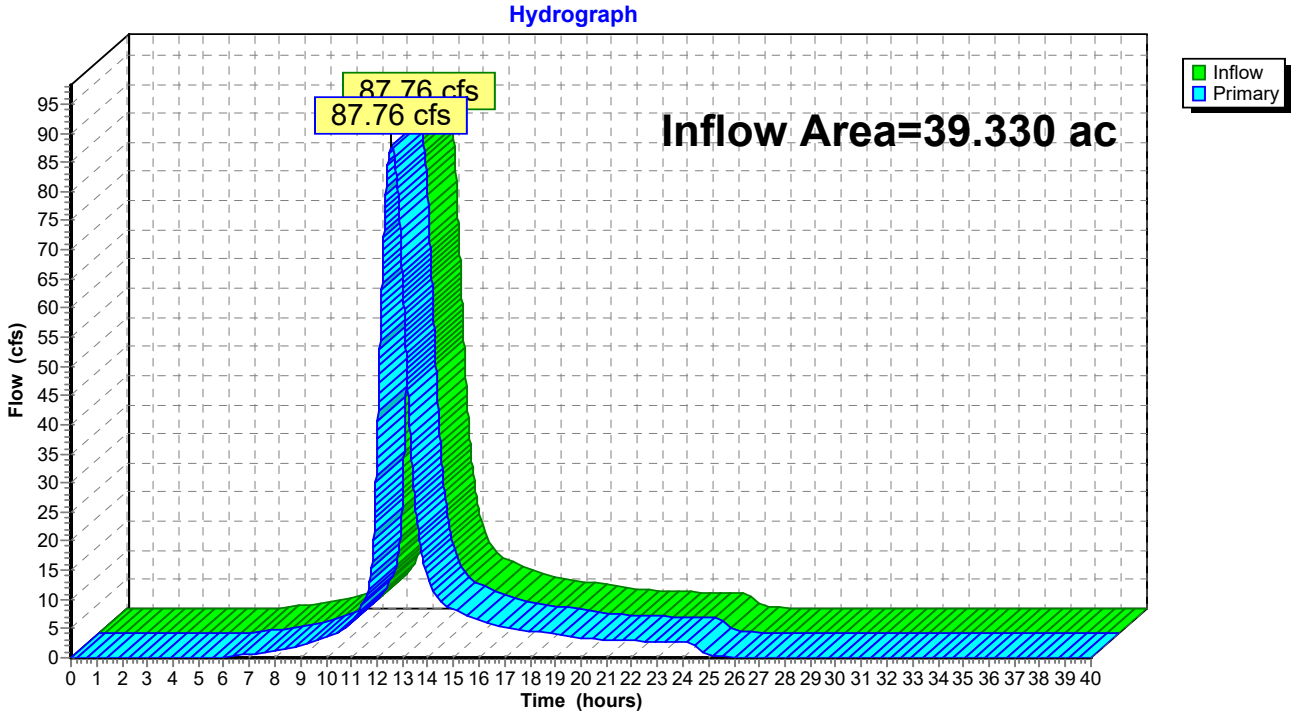
Summary for Link 1L: Thermal Channel

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 87.76 cfs @ 12.57 hrs, Volume= 14.700 af
Primary = 87.76 cfs @ 12.57 hrs, Volume= 14.700 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 1L: Thermal Channel



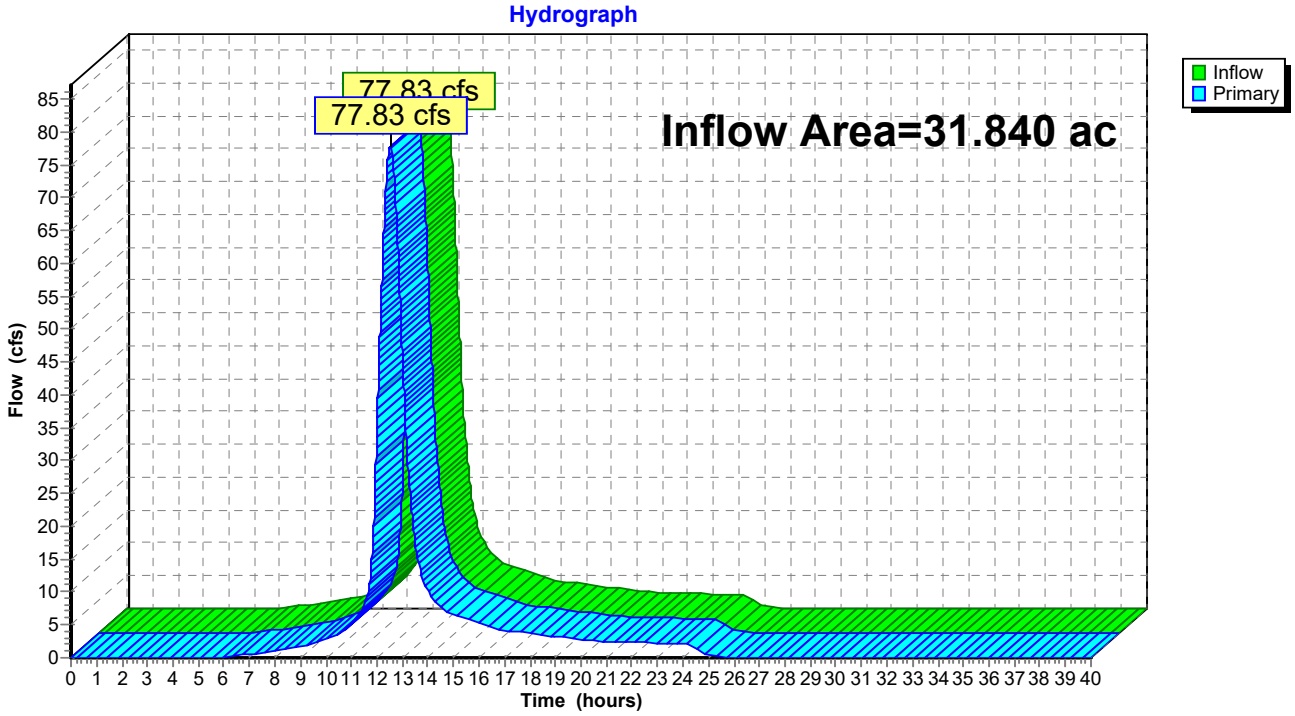
Summary for Link 2L: Thermal Channel

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 77.83 cfs @ 12.53 hrs, Volume= 11.902 af
Primary = 77.83 cfs @ 12.53 hrs, Volume= 11.902 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 2L: Thermal Channel



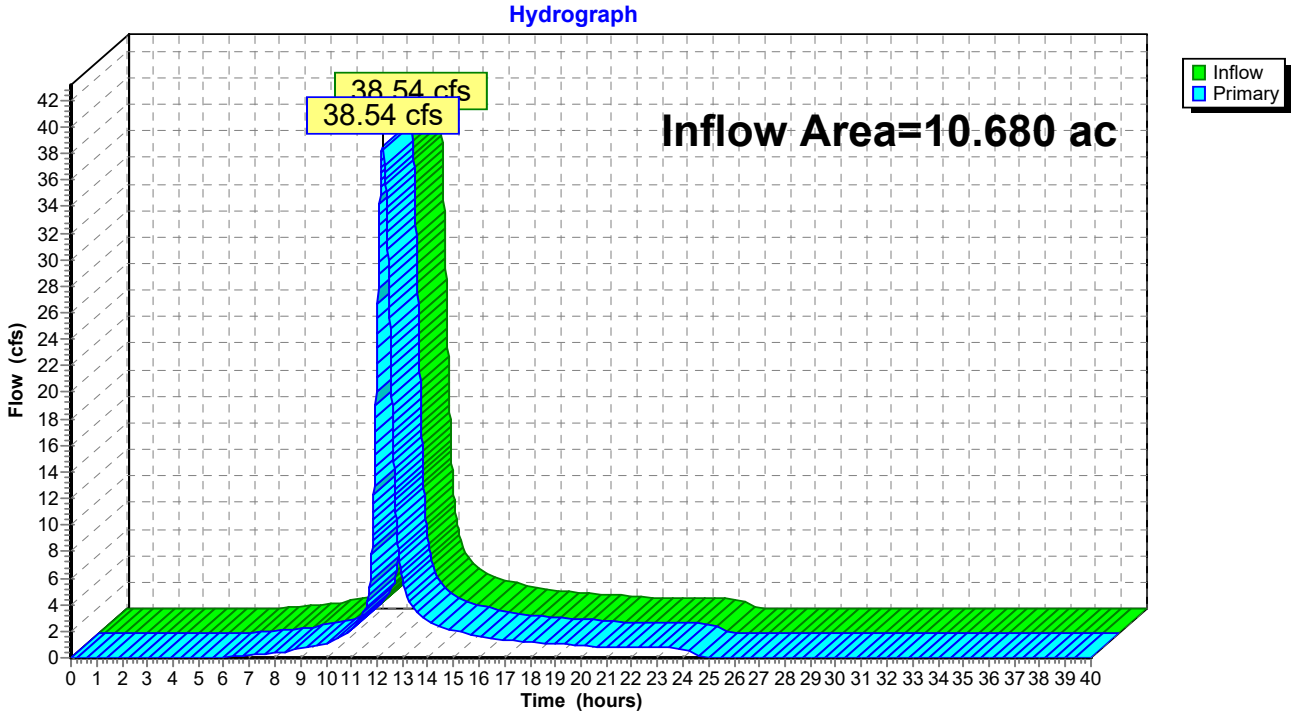
Summary for Link 4L: Ex Channel

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 38.54 cfs @ 12.24 hrs, Volume= 3.994 af
Primary = 38.54 cfs @ 12.24 hrs, Volume= 3.994 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 4L: Ex Channel



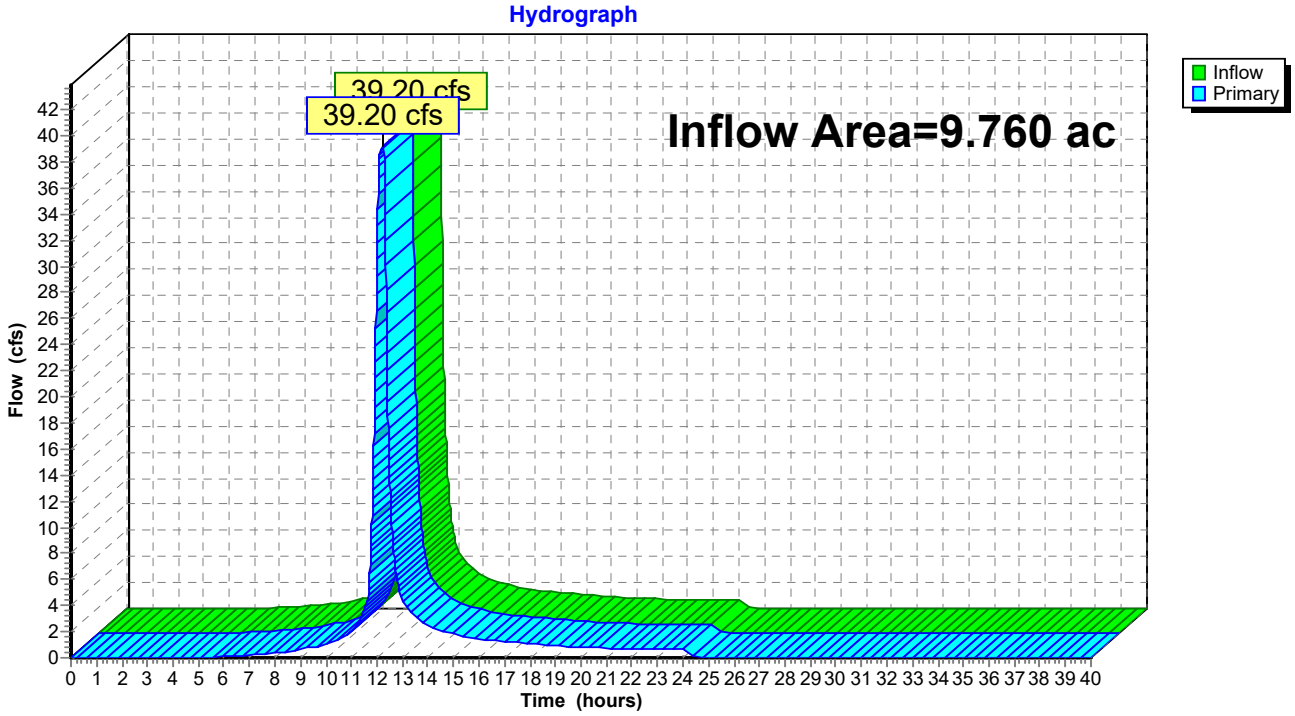
Summary for Link 5L: Swamp

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 39.20 cfs @ 12.20 hrs, Volume= 3.650 af
Primary = 39.20 cfs @ 12.20 hrs, Volume= 3.650 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 5L: Swamp



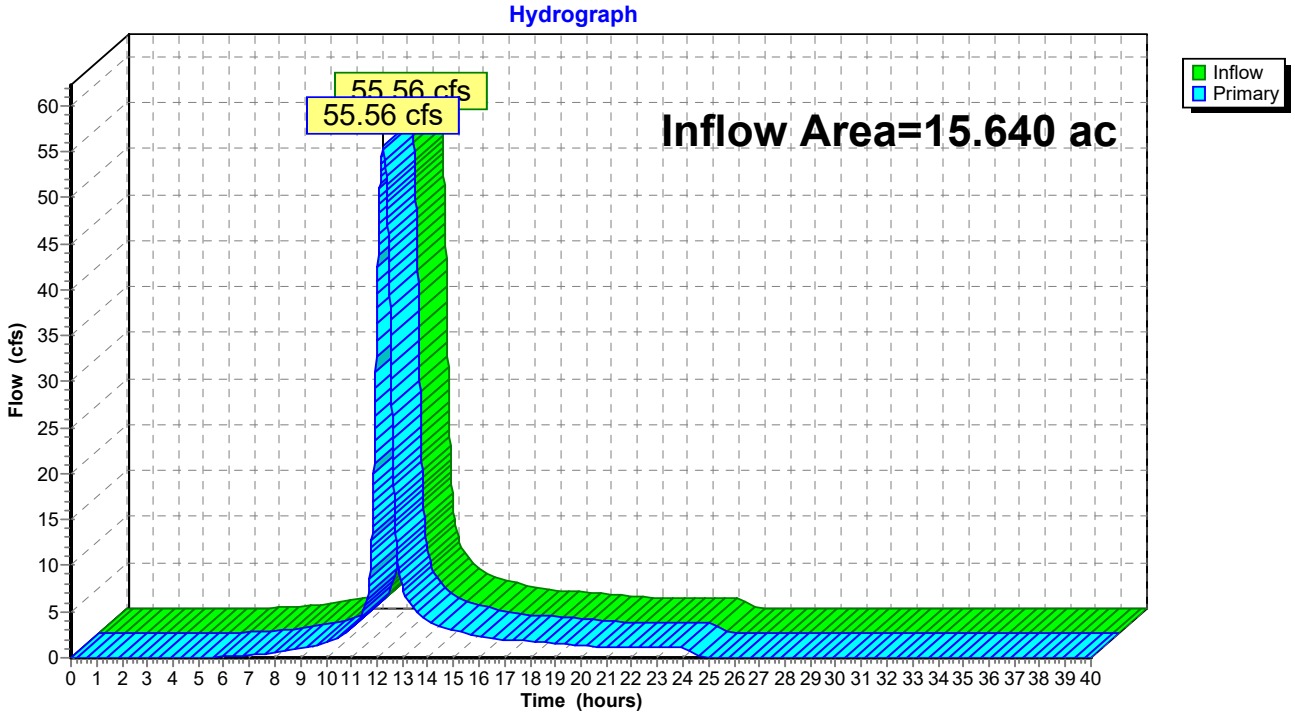
Summary for Link 6L: Swamp

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 55.56 cfs @ 12.24 hrs, Volume= 5.849 af
Primary = 55.56 cfs @ 12.24 hrs, Volume= 5.849 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 6L: Swamp



Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment E1S: DA E1 Runoff Area=8.090 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=645' Tc=19.9 min CN=84 Runoff=57.10 cfs 4.401 af

Subcatchment E2S: DA E2 Runoff Area=9.110 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=610' Tc=19.5 min CN=84 Runoff=65.12 cfs 4.956 af

Subcatchment E3S: DA E3 Runoff Area=8.380 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=610' Tc=19.5 min CN=84 Runoff=59.90 cfs 4.559 af

Subcatchment E4S: DA E4 Runoff Area=3.750 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=490' Slope=0.0141 '/' Tc=18.4 min CN=84 Runoff=27.58 cfs 2.040 af

Subcatchment E5S: DA E5 Runoff Area=1.110 ac 0.00% Impervious Runoff Depth=6.53"
Tc=10.0 min CN=84 Runoff=10.58 cfs 0.604 af

Subcatchment E6S: DA E6 Runoff Area=1.480 ac 0.00% Impervious Runoff Depth=6.53"
Tc=10.0 min CN=84 Runoff=14.11 cfs 0.805 af

Subcatchment E7S: DA E7 Runoff Area=0.650 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=7.07 cfs 0.354 af

Subcatchment E8S: DA E8 Runoff Area=3.510 ac 0.00% Impervious Runoff Depth=6.53"
Tc=10.0 min CN=84 Runoff=33.47 cfs 1.909 af

Subcatchment W1S: DA W1 Runoff Area=9.130 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=1,055' Tc=35.3 min CN=84 Runoff=45.60 cfs 4.967 af

Subcatchment W2S: DA W2 Runoff Area=24.910 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=1,485' Tc=40.3 min CN=84 Runoff=113.58 cfs 13.551 af

Subcatchment W3S: DA W3 Runoff Area=24.990 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=1,470' Tc=40.2 min CN=84 Runoff=114.38 cfs 13.595 af

Subcatchment W4S: DA W4 Runoff Area=2.770 ac 0.00% Impervious Runoff Depth=6.53"
Flow Length=820' Tc=32.8 min CN=84 Runoff=14.50 cfs 1.507 af

Subcatchment W5S: DA W5 Runoff Area=3.650 ac 0.00% Impervious Runoff Depth=6.53"
Tc=10.0 min CN=84 Runoff=34.80 cfs 1.986 af

Subcatchment W6S: DA W6 Runoff Area=1.640 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=17.84 cfs 0.892 af

Subcatchment W7S: DA W7 Runoff Area=1.490 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=16.21 cfs 0.811 af

Subcatchment W8S: DA W8 Runoff Area=2.590 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=28.18 cfs 1.409 af

Reach E1R: Channel E1 Avg. Flow Depth=1.01' Max Vel=6.41 fps Inflow=66.18 cfs 5.206 af
n=0.013 L=1,005.0' S=0.0050 '/' Capacity=635.79 cfs Outflow=64.79 cfs 5.206 af

Reach E2R: Channel E2 Avg. Flow Depth=0.96' Max Vel=6.24 fps Inflow=59.90 cfs 4.559 af
n=0.013 L=805.0' S=0.0050 '/' Capacity=636.03 cfs Outflow=58.85 cfs 4.559 af

Reach E3R: Channel E3 Avg. Flow Depth=0.85' Max Vel=7.01 fps Inflow=57.01 cfs 3.949 af
n=0.013 L=845.0' S=0.0072 '/' Capacity=764.06 cfs Outflow=55.84 cfs 3.949 af

Reach W1R: Channel W1 Avg. Flow Depth=0.77' Max Vel=7.79 fps Inflow=56.74 cfs 6.952 af
n=0.013 L=1,461.5' S=0.0099 '/' Capacity=892.42 cfs Outflow=54.83 cfs 6.952 af

Reach W2R: Channel W2 Avg. Flow Depth=0.56' Max Vel=3.58 fps Inflow=17.84 cfs 0.892 af
n=0.013 L=660.0' S=0.0030 '/' Capacity=489.26 cfs Outflow=16.63 cfs 0.892 af

Reach W3R: Channel W3 Avg. Flow Depth=0.51' Max Vel=3.70 fps Inflow=16.21 cfs 0.811 af
n=0.013 L=640.0' S=0.0035 '/' Capacity=533.52 cfs Outflow=15.22 cfs 0.811 af

Reach W4R: Channel W4 Avg. Flow Depth=0.59' Max Vel=6.31 fps Inflow=33.86 cfs 2.916 af
n=0.013 L=1,355.0' S=0.0087 '/' Capacity=837.12 cfs Outflow=31.27 cfs 2.916 af

Pond E1P: Proposed Culvert E1 Peak Elev=13.29' Storage=32,843 cf Inflow=71.22 cfs 5.810 af
Primary=47.10 cfs 5.810 af Secondary=0.00 cfs 0.000 af Outflow=47.10 cfs 5.810 af

Pond E2P: Proposed Culvert E2 Peak Elev=15.09' Storage=23,990 cf Inflow=66.86 cfs 5.309 af
Primary=41.86 cfs 5.309 af Secondary=0.00 cfs 0.000 af Outflow=41.86 cfs 5.309 af

Pond E3P: Proposed Culvert E3 Peak Elev=15.23' Storage=50,415 cf Inflow=109.63 cfs 8.508 af
Primary=66.74 cfs 8.508 af Secondary=0.00 cfs 0.000 af Outflow=66.74 cfs 8.508 af

Pond W1P: Proposed Culvert W1 Peak Elev=11.23' Storage=159,436 cf Inflow=166.62 cfs 21.396 af
Primary=103.50 cfs 21.388 af Secondary=0.00 cfs 0.000 af Outflow=103.50 cfs 21.388 af

Pond W2P: Proposed Culvert W2 Peak Elev=10.66' Storage=94,016 cf Inflow=133.34 cfs 17.321 af
Primary=98.69 cfs 17.317 af Secondary=0.00 cfs 0.000 af Outflow=98.69 cfs 17.317 af

Link 1L: Thermal Channel Inflow=103.50 cfs 21.388 af
Primary=103.50 cfs 21.388 af

Link 2L: Thermal Channel Inflow=98.69 cfs 17.317 af
Primary=98.69 cfs 17.317 af

Link 4L: Ex Channel Inflow=47.10 cfs 5.810 af
Primary=47.10 cfs 5.810 af

Link 5L: Swamp Inflow=41.86 cfs 5.309 af
Primary=41.86 cfs 5.309 af

Link 6L: Swamp Inflow=66.74 cfs 8.508 af
Primary=66.74 cfs 8.508 af

Total Runoff Area = 107.250 ac Runoff Volume = 58.344 af Average Runoff Depth = 6.53"
100.00% Pervious = 107.250 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment E1S: DA E1

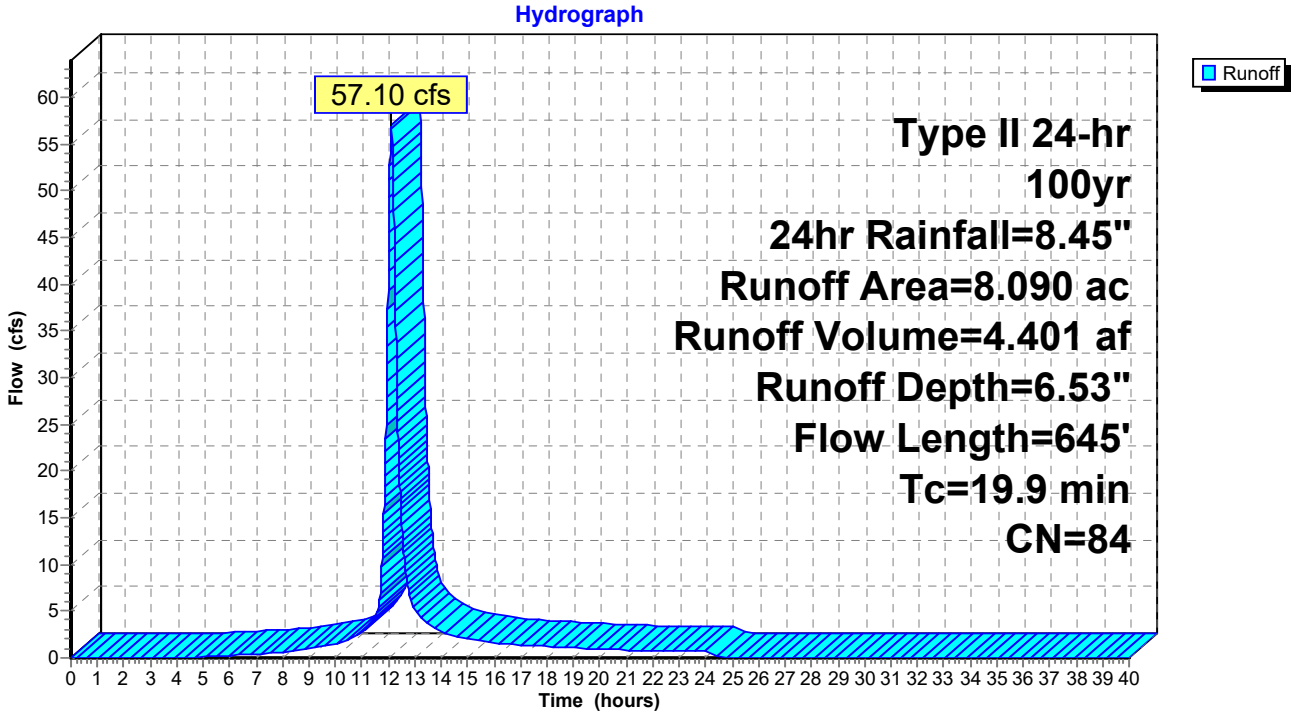
Runoff = 57.10 cfs @ 12.12 hrs, Volume= 4.401 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
8.090	84	50-75% Grass cover, Fair, HSG D
8.090		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.5	150	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.9	645	Total			

Subcatchment E1S: DA E1



Summary for Subcatchment E2S: DA E2

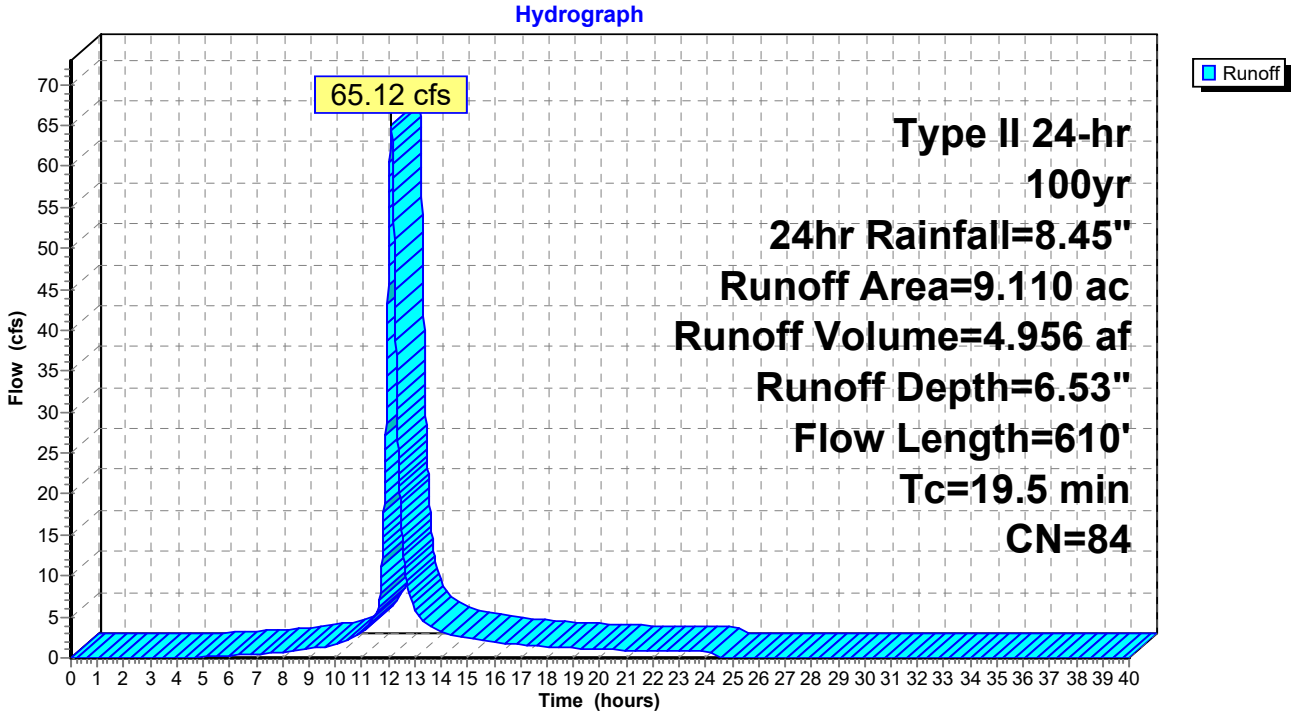
Runoff = 65.12 cfs @ 12.11 hrs, Volume= 4.956 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
9.110	84	50-75% Grass cover, Fair, HSG D
9.110		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E2S: DA E2



Summary for Subcatchment E3S: DA E3

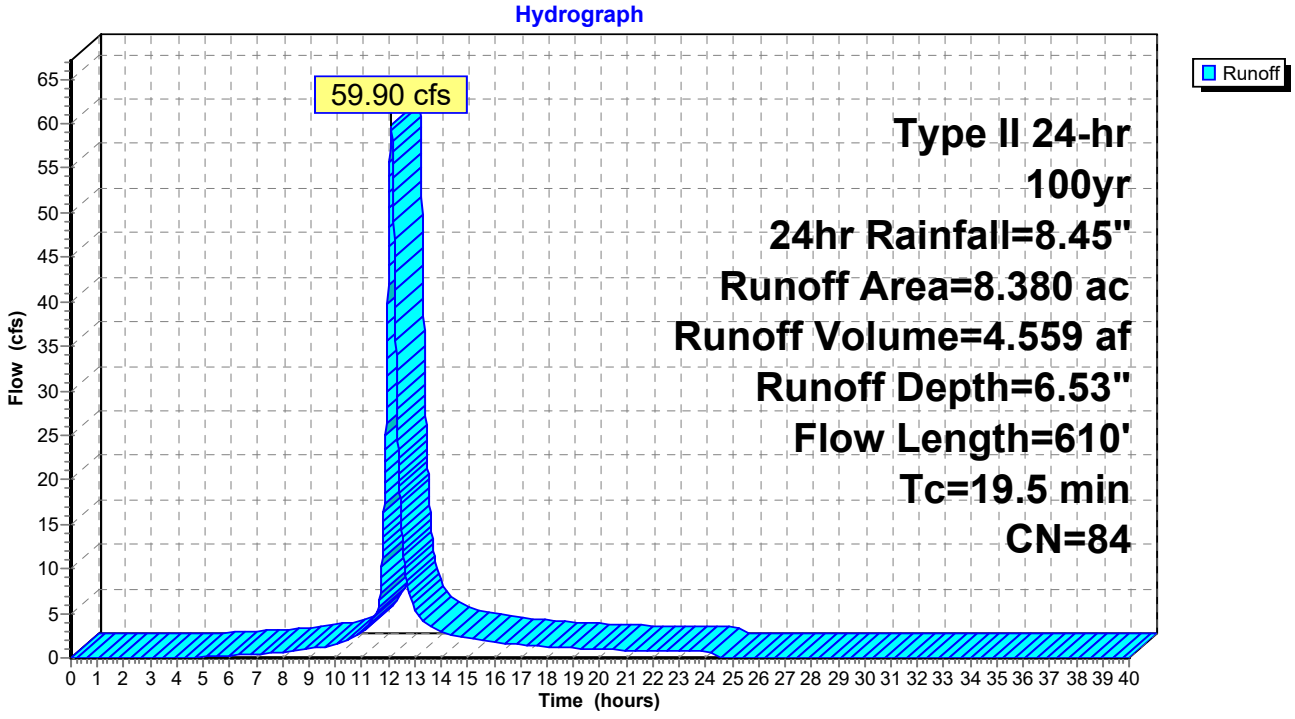
Runoff = 59.90 cfs @ 12.11 hrs, Volume= 4.559 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
8.380	84	50-75% Grass cover, Fair, HSG D
8.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	345	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
1.1	115	0.0100	1.68	29.48	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=0.00' D=0.50' Z= 70.0 '/' Top.W=70.00' n= 0.035
19.5	610	Total			

Subcatchment E3S: DA E3



Summary for Subcatchment E4S: DA E4

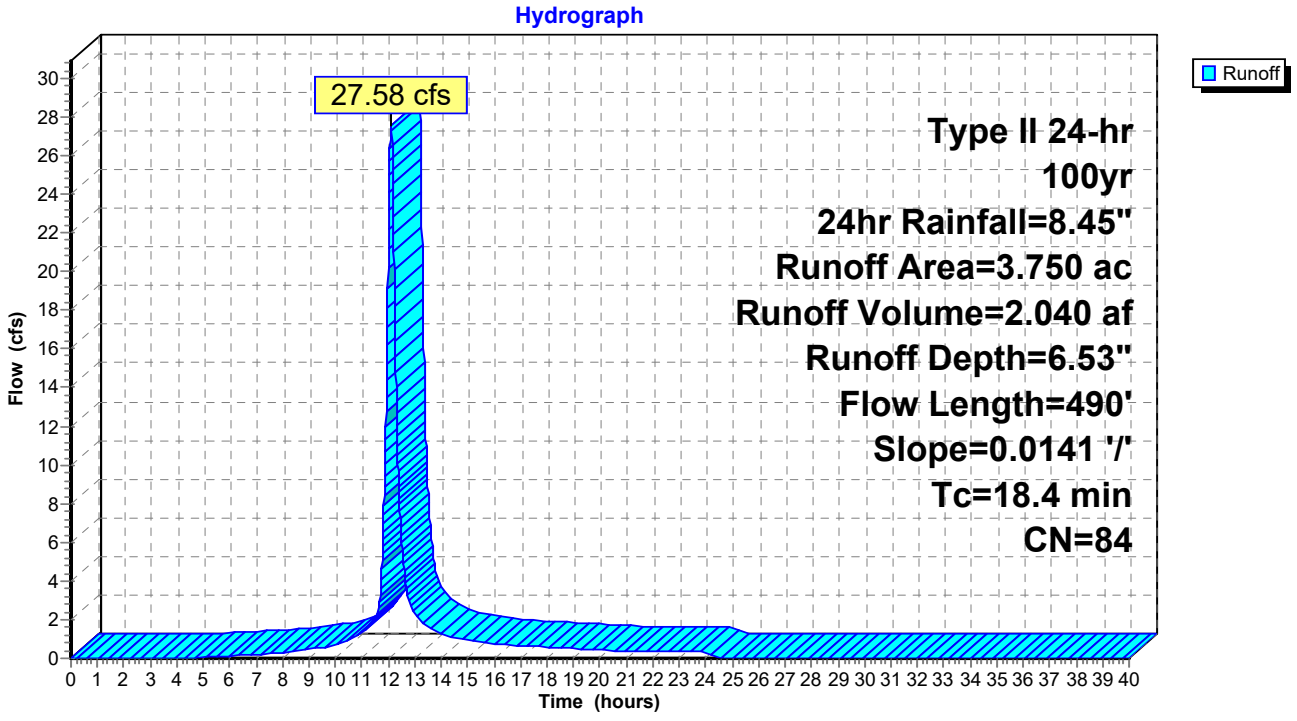
Runoff = 27.58 cfs @ 12.10 hrs, Volume= 2.040 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
3.750	84	50-75% Grass cover, Fair, HSG D
3.750		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.2	150	0.0141	0.16		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
3.2	340	0.0141	1.78		**Shallow Concentrated Flow, Shallow** Grassed Waterway Kv= 15.0 fps
18.4	490	Total			

Subcatchment E4S: DA E4



Summary for Subcatchment E5S: DA E5

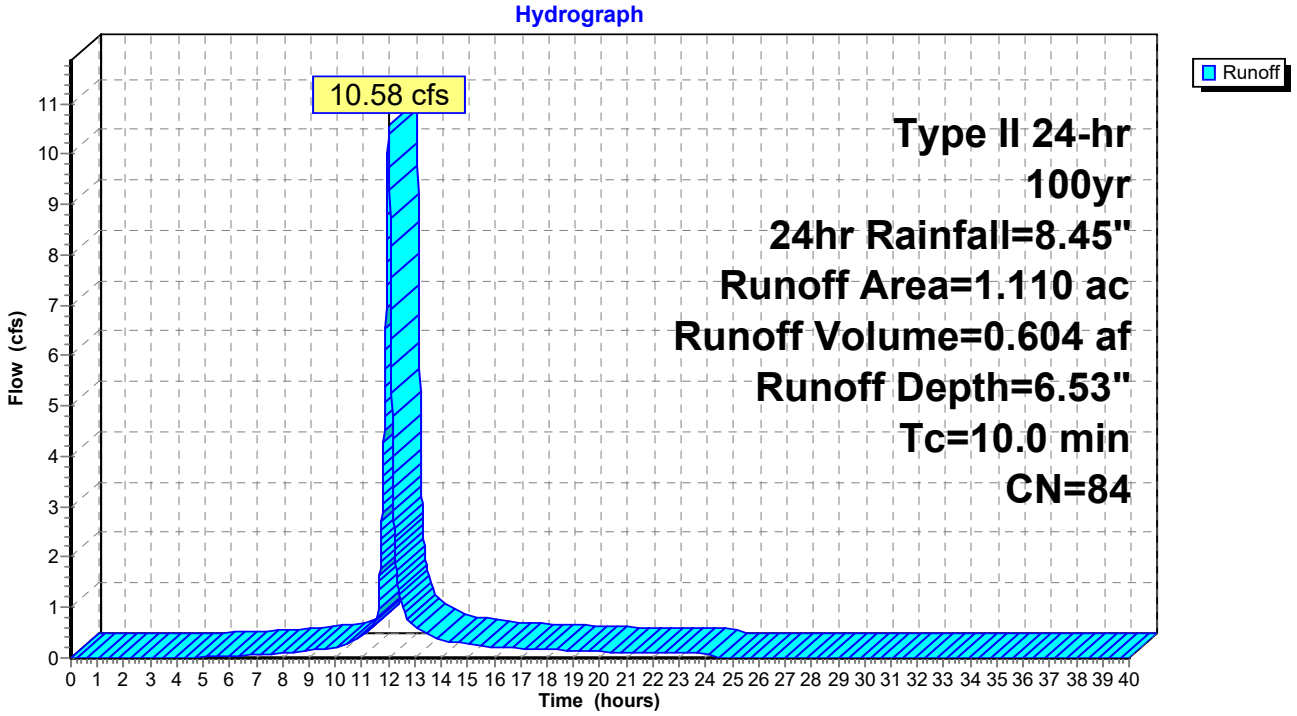
Runoff = 10.58 cfs @ 12.01 hrs, Volume= 0.604 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
1.110	84	50-75% Grass cover, Fair, HSG D
1.110		100.00% Pervious Area

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

Subcatchment E5S: DA E5



Summary for Subcatchment E6S: DA E6

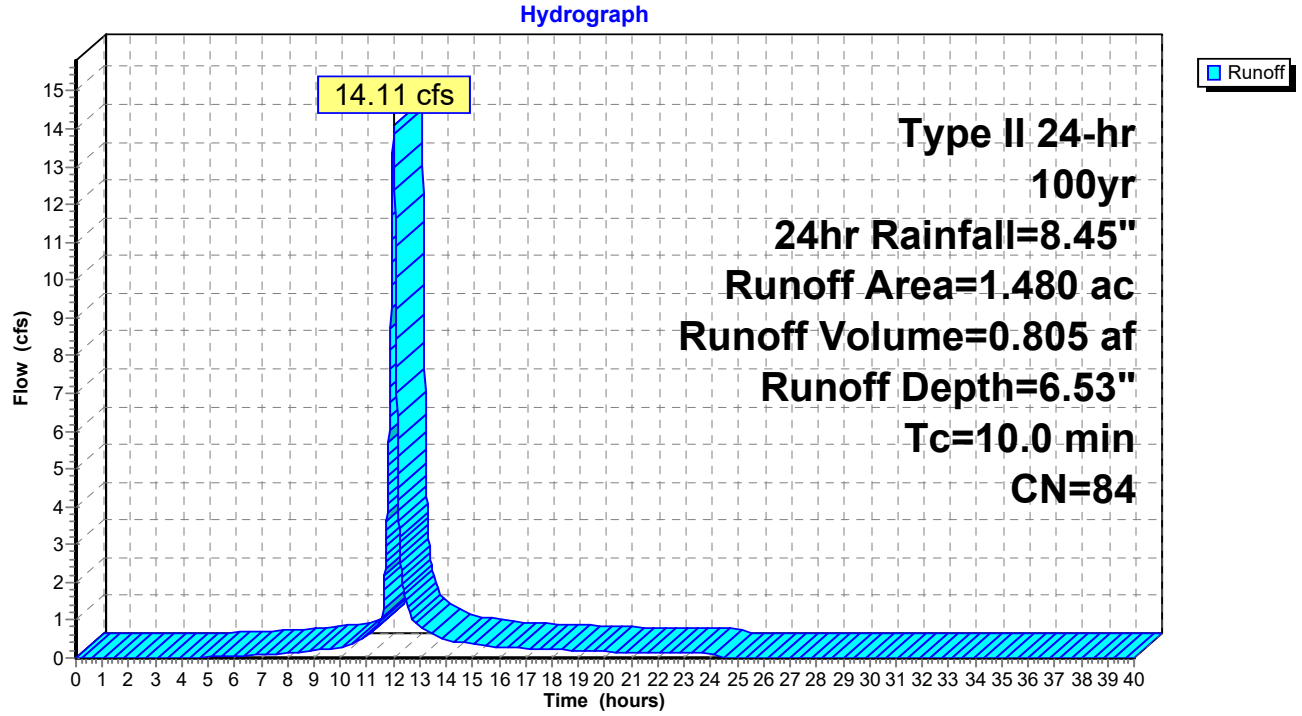
Runoff = 14.11 cfs @ 12.01 hrs, Volume= 0.805 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
1.480	84	50-75% Grass cover, Fair, HSG D
1.480		100.00% Pervious Area

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

Subcatchment E6S: DA E6



Summary for Subcatchment E7S: DA E7

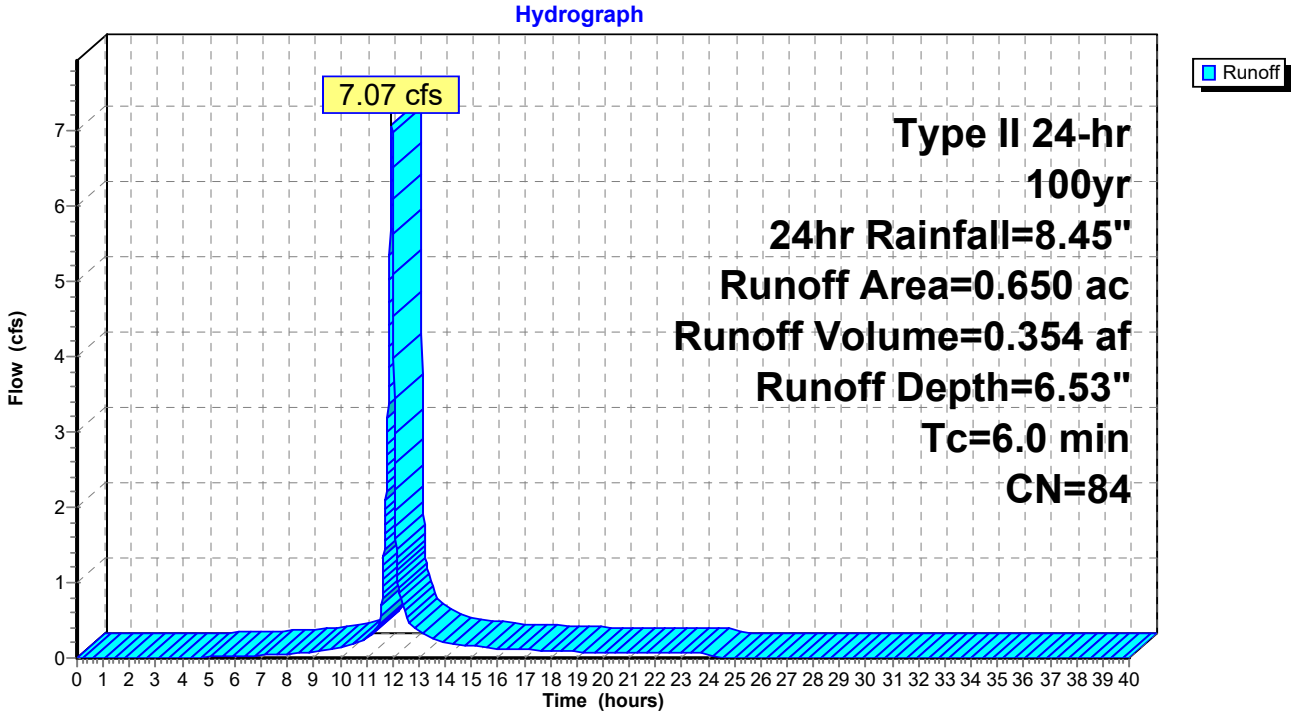
Runoff = 7.07 cfs @ 11.97 hrs, Volume= 0.354 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
0.650	84	50-75% Grass cover, Fair, HSG D
0.650		100.00% Pervious Area

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

Subcatchment E7S: DA E7



Summary for Subcatchment E8S: DA E8

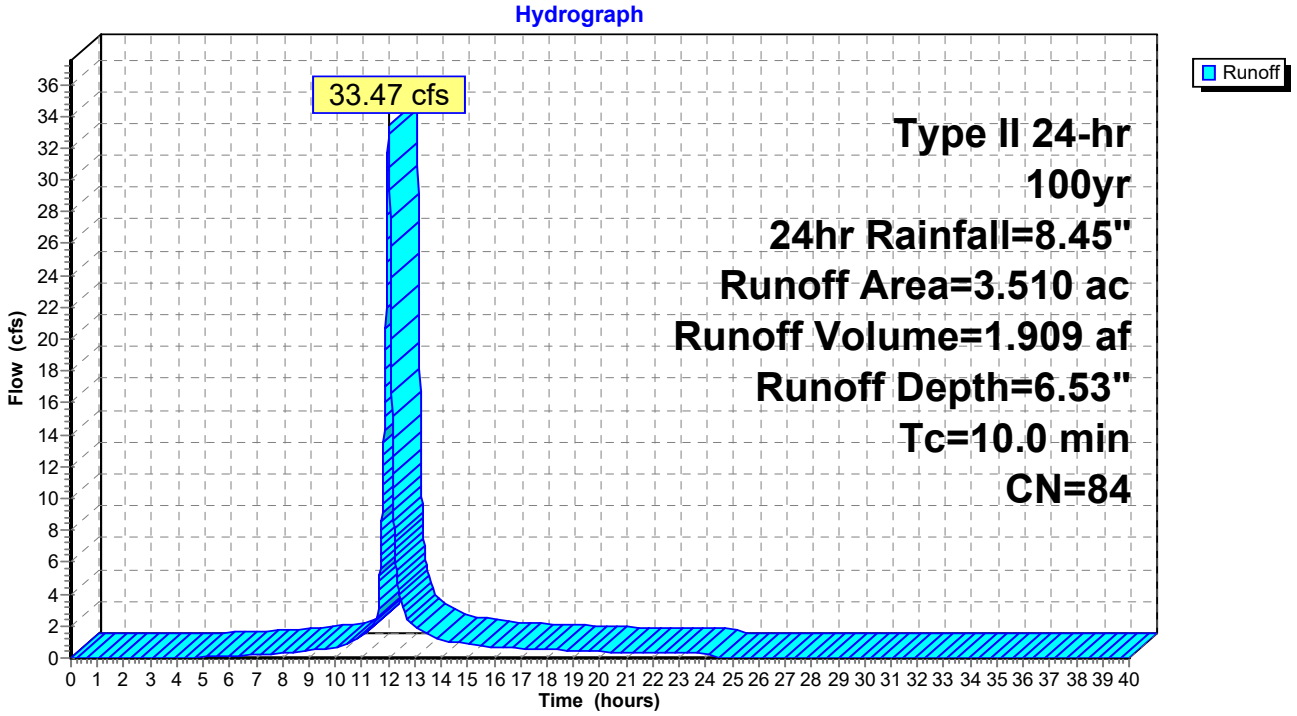
Runoff = 33.47 cfs @ 12.01 hrs, Volume= 1.909 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
3.510	84	50-75% Grass cover, Fair, HSG D
3.510		100.00% Pervious Area

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

Subcatchment E8S: DA E8



Summary for Subcatchment W1S: DA W1

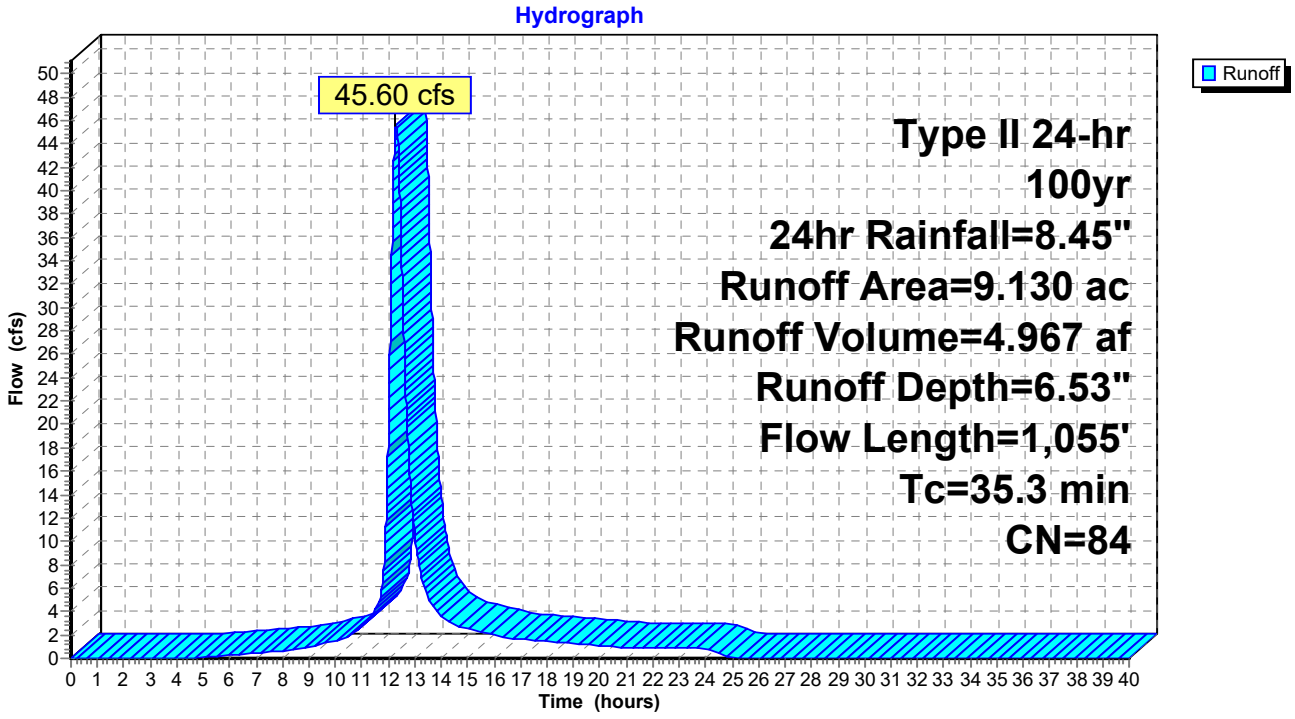
Runoff = 45.60 cfs @ 12.28 hrs, Volume= 4.967 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
9.130	84	50-75% Grass cover, Fair, HSG D
9.130		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.9	565	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
3.4	340	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
35.3	1,055	Total			

Subcatchment W1S: DA W1



Summary for Subcatchment W2S: DA W2

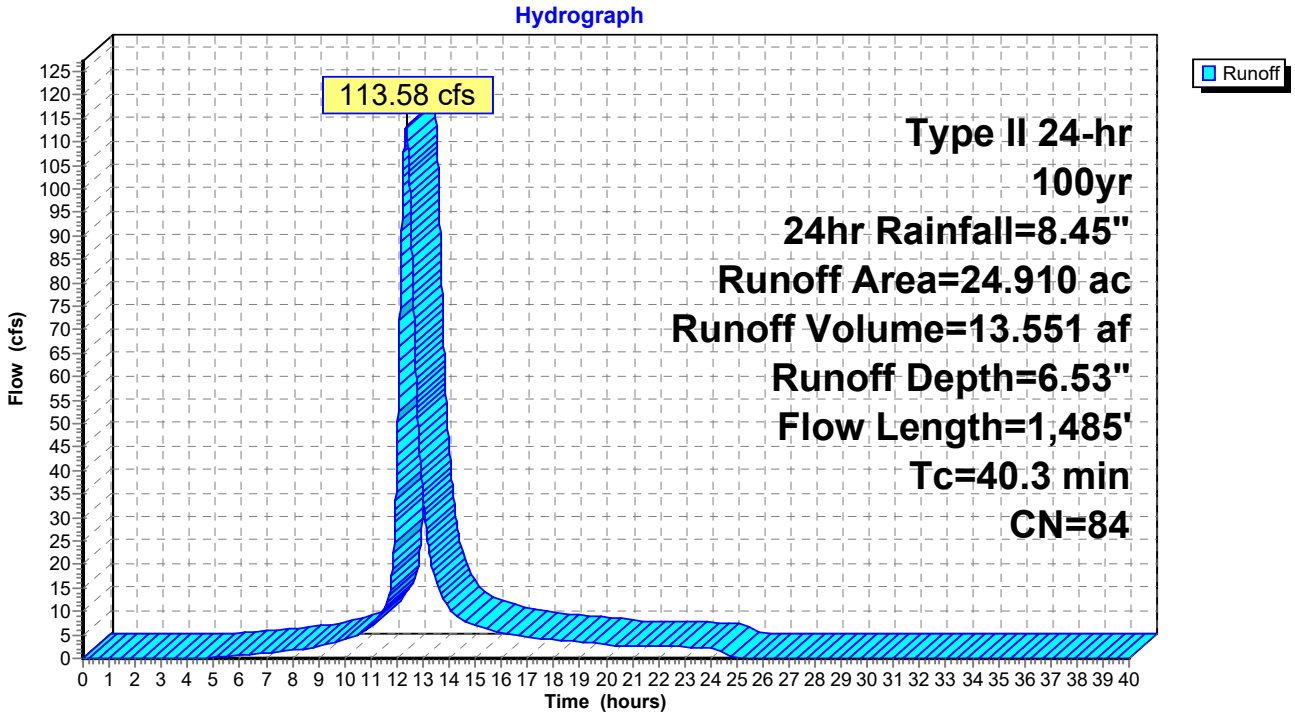
Runoff = 113.58 cfs @ 12.36 hrs, Volume= 13.551 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
24.910	84	50-75% Grass cover, Fair, HSG D
24.910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	665	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.9	670	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.3	1,485	Total			

Subcatchment W2S: DA W2



Summary for Subcatchment W3S: DA W3

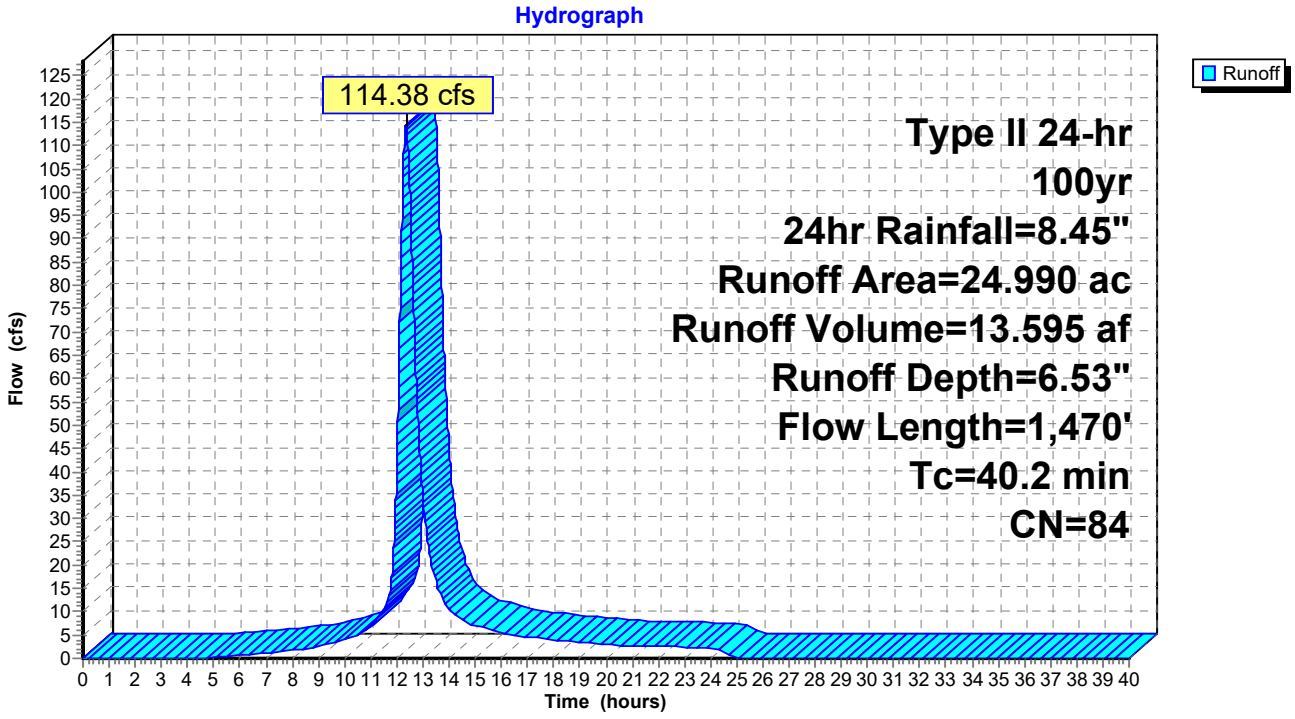
Runoff = 114.38 cfs @ 12.37 hrs, Volume= 13.595 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
24.990	84	50-75% Grass cover, Fair, HSG D
24.990		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
10.4	660	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
6.8	660	0.0117	1.62		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
40.2	1,470	Total			

Subcatchment W3S: DA W3



Summary for Subcatchment W4S: DA W4

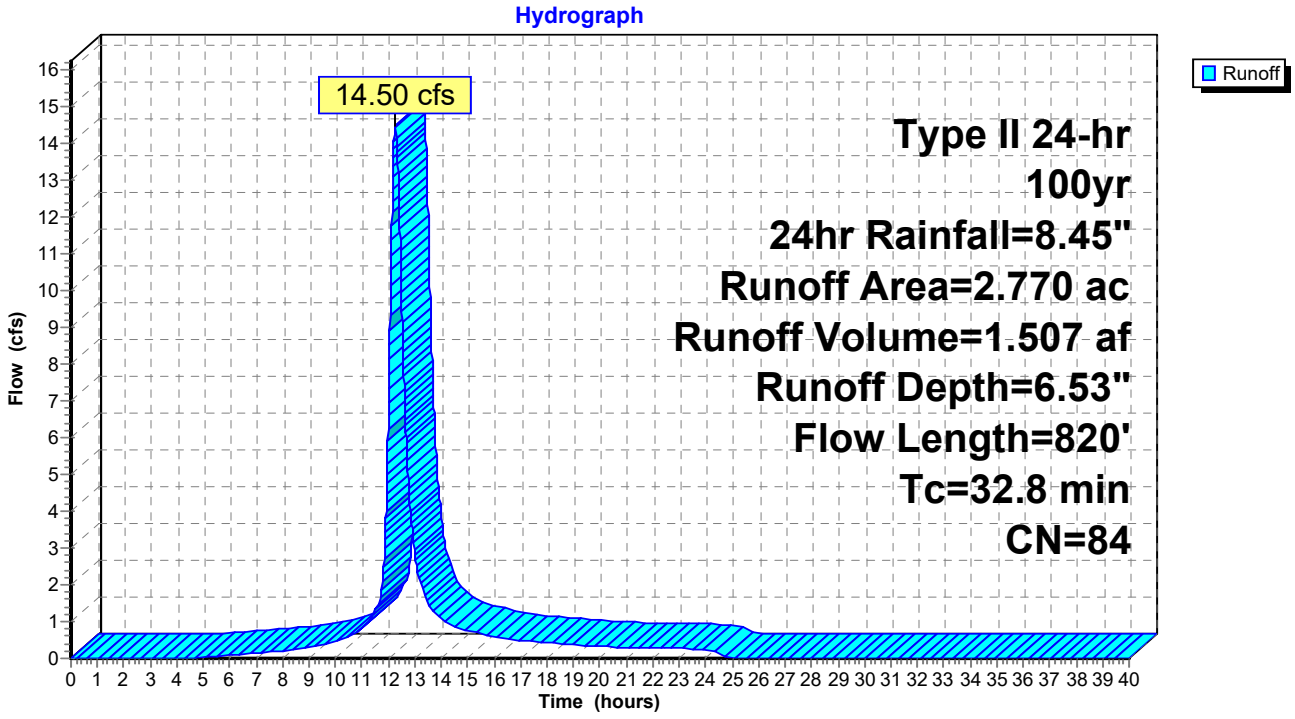
Runoff = 14.50 cfs @ 12.28 hrs, Volume= 1.507 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
2.770	84	50-75% Grass cover, Fair, HSG D
2.770		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.0	150	0.0050	0.11		**Sheet Flow, Sheet** Grass: Short n= 0.150 P2= 3.37"
8.6	550	0.0050	1.06		**Shallow Concentrated Flow, Shallow 1** Grassed Waterway Kv= 15.0 fps
1.2	120	0.0127	1.69		**Shallow Concentrated Flow, Shallow 2** Grassed Waterway Kv= 15.0 fps
32.8	820	Total			

Subcatchment W4S: DA W4



Summary for Subcatchment W5S: DA W5

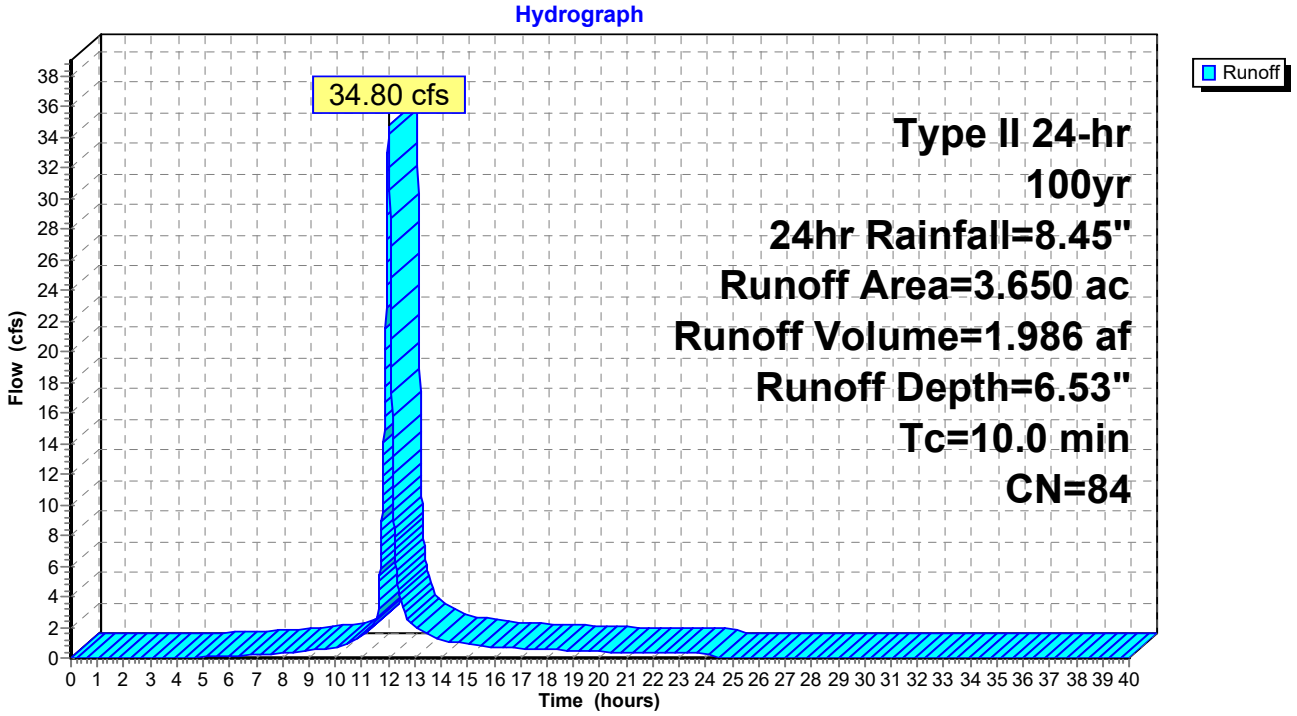
Runoff = 34.80 cfs @ 12.01 hrs, Volume= 1.986 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
3.650	84	50-75% Grass cover, Fair, HSG D
3.650		100.00% Pervious Area

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

Subcatchment W5S: DA W5



Summary for Subcatchment W6S: DA W6

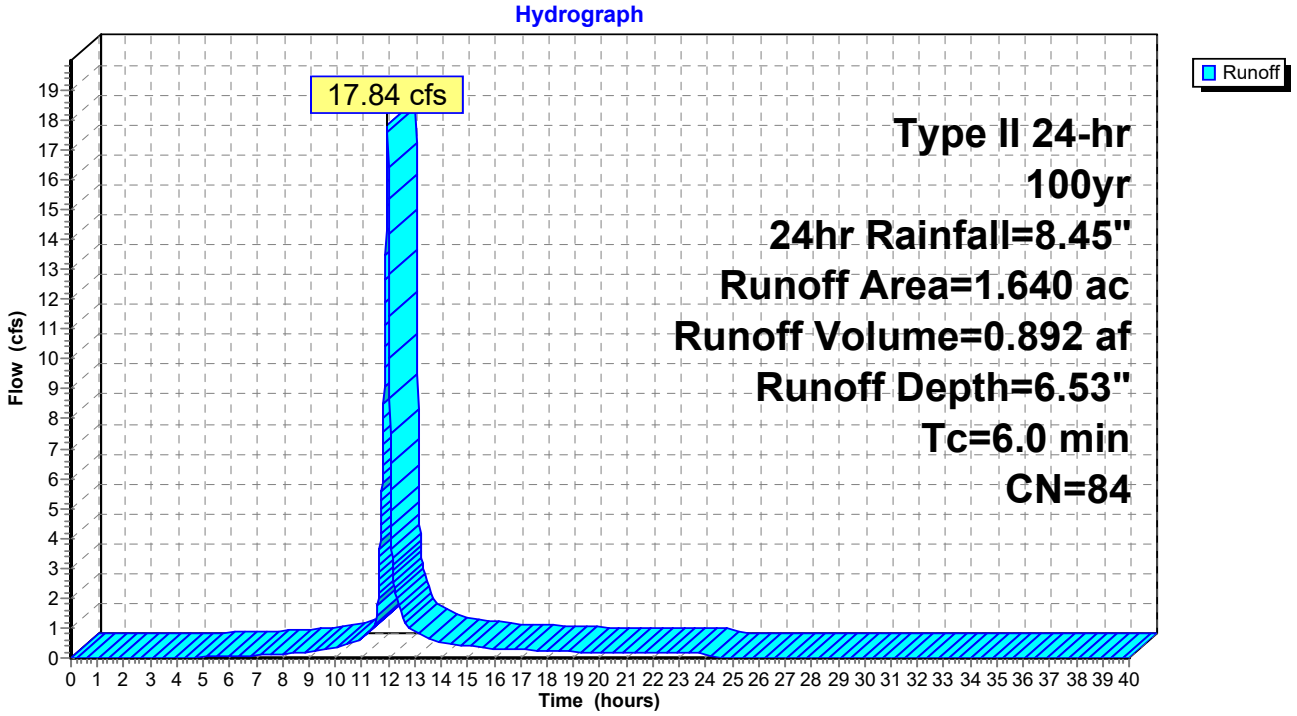
Runoff = 17.84 cfs @ 11.97 hrs, Volume= 0.892 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
1.640	84	50-75% Grass cover, Fair, HSG D
1.640		100.00% Pervious Area

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

Subcatchment W6S: DA W6



Summary for Subcatchment W7S: DA W7

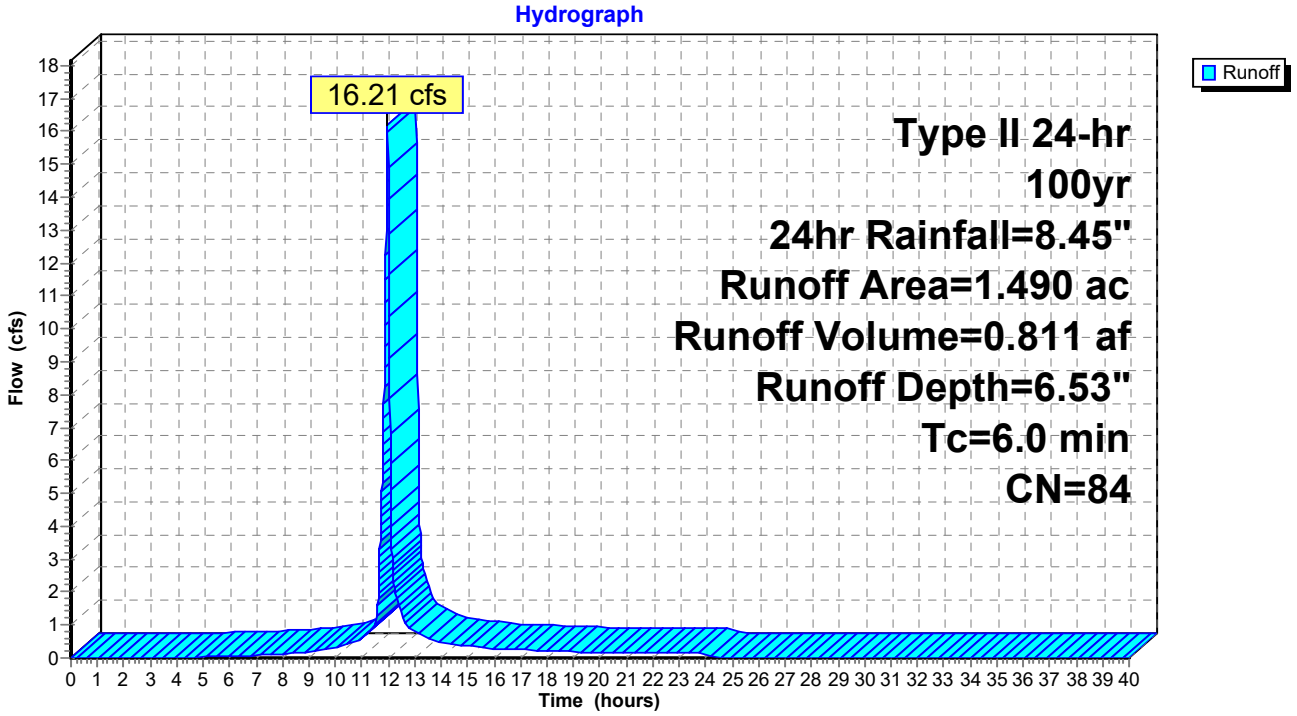
Runoff = 16.21 cfs @ 11.97 hrs, Volume= 0.811 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
1.490	84	50-75% Grass cover, Fair, HSG D
1.490		100.00% Pervious Area

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

Subcatchment W7S: DA W7



Summary for Subcatchment W8S: DA W8

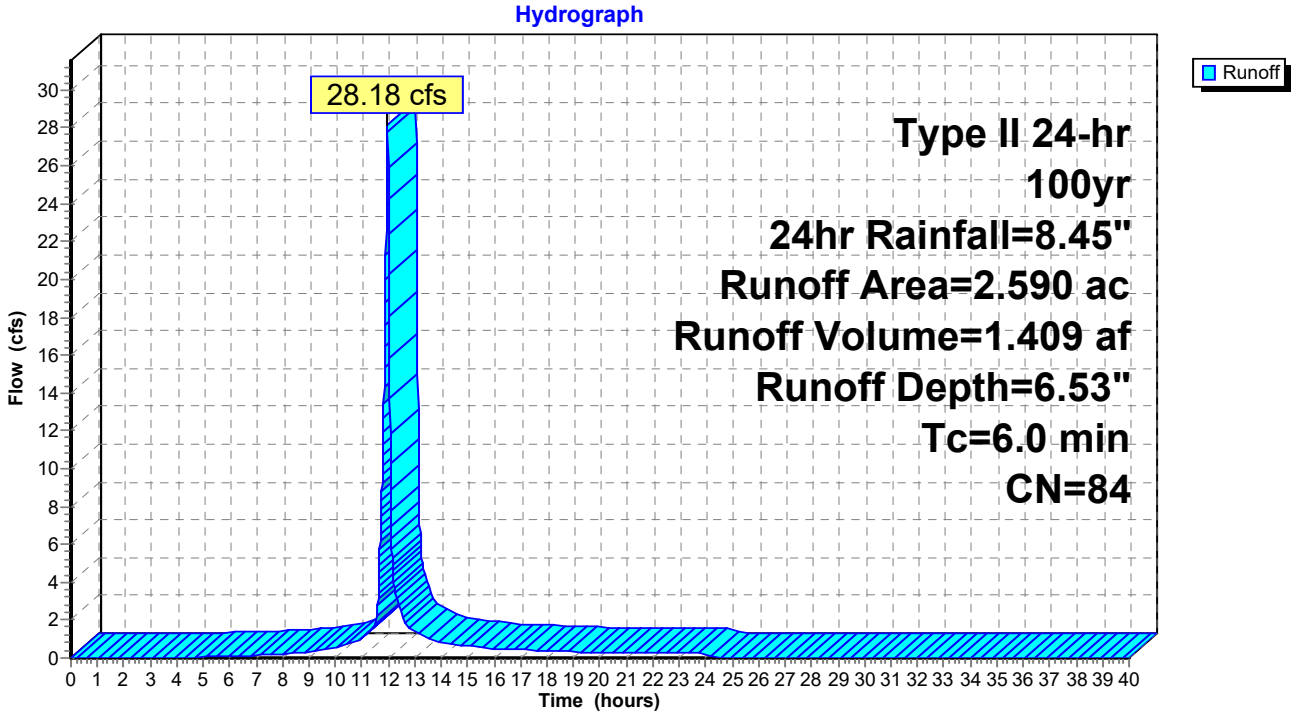
Runoff = 28.18 cfs @ 11.97 hrs, Volume= 1.409 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type II 24-hr 100yr, 24hr Rainfall=8.45"

Area (ac)	CN	Description
2.590	84	50-75% Grass cover, Fair, HSG D
2.590		100.00% Pervious Area

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

Subcatchment W8S: DA W8



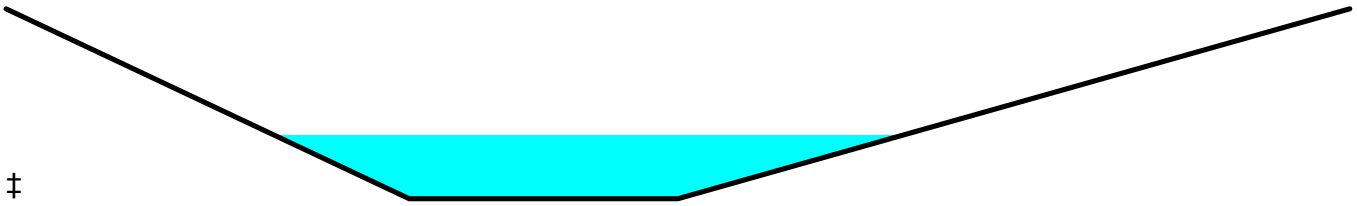
Summary for Reach E1R: Channel E1

Inflow Area = 9.570 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 66.18 cfs @ 12.09 hrs, Volume= 5.206 af
Outflow = 64.79 cfs @ 12.12 hrs, Volume= 5.206 af, Atten= 2%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 6.41 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.79 fps, Avg. Travel Time= 9.3 min

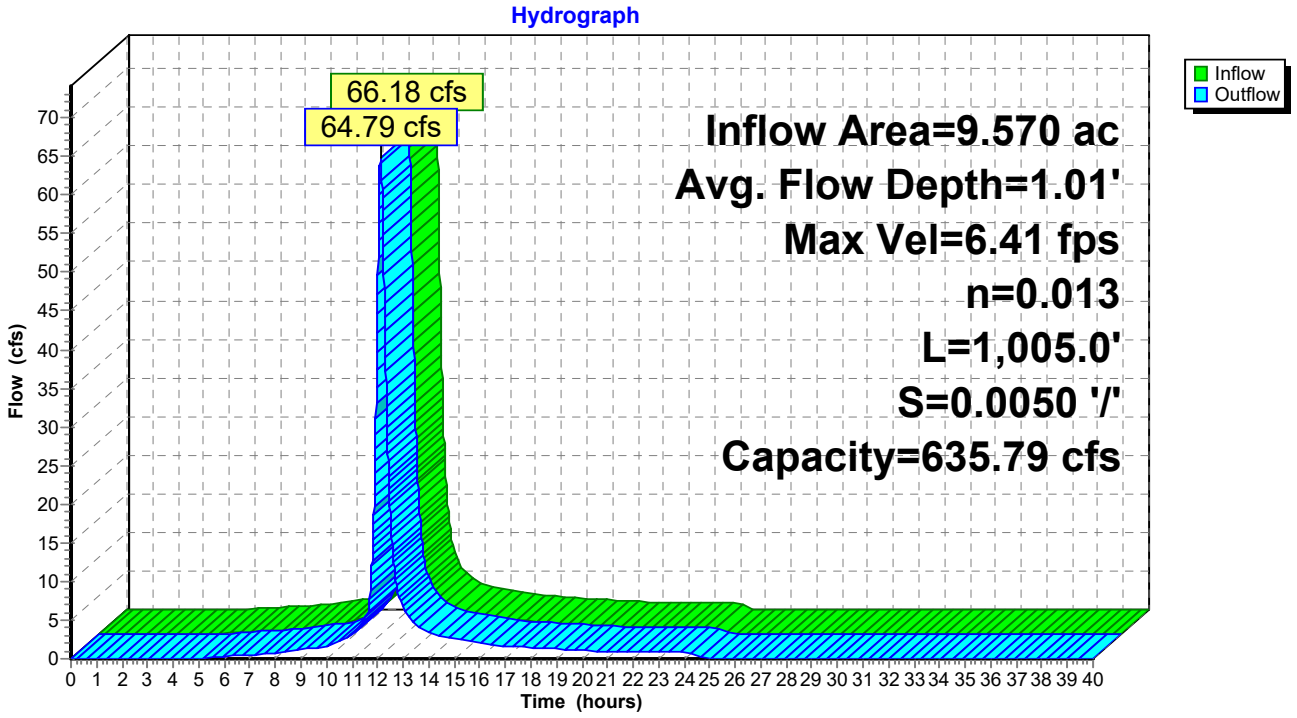
Peak Storage= 10,151 cf @ 12.12 hrs
Average Depth at Peak Storage= 1.01'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 635.79 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,005.0' Slope= 0.0050 '/'
Inlet Invert= 14.32', Outlet Invert= 9.28'



‡

Reach E1R: Channel E1



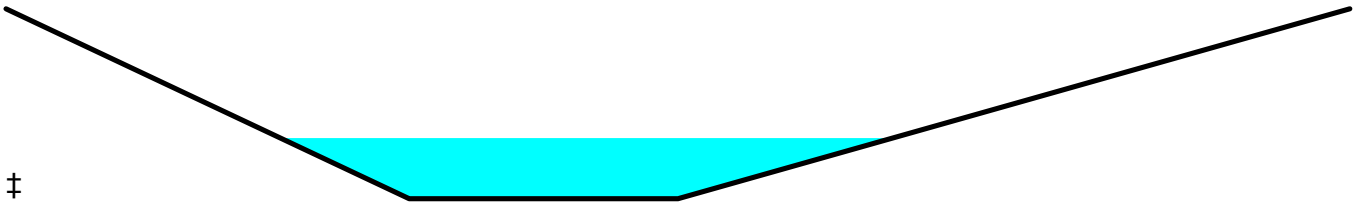
Summary for Reach E2R: Channel E2

Inflow Area = 8.380 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 59.90 cfs @ 12.11 hrs, Volume= 4.559 af
Outflow = 58.85 cfs @ 12.14 hrs, Volume= 4.559 af, Atten= 2%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 6.24 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.74 fps, Avg. Travel Time= 7.7 min

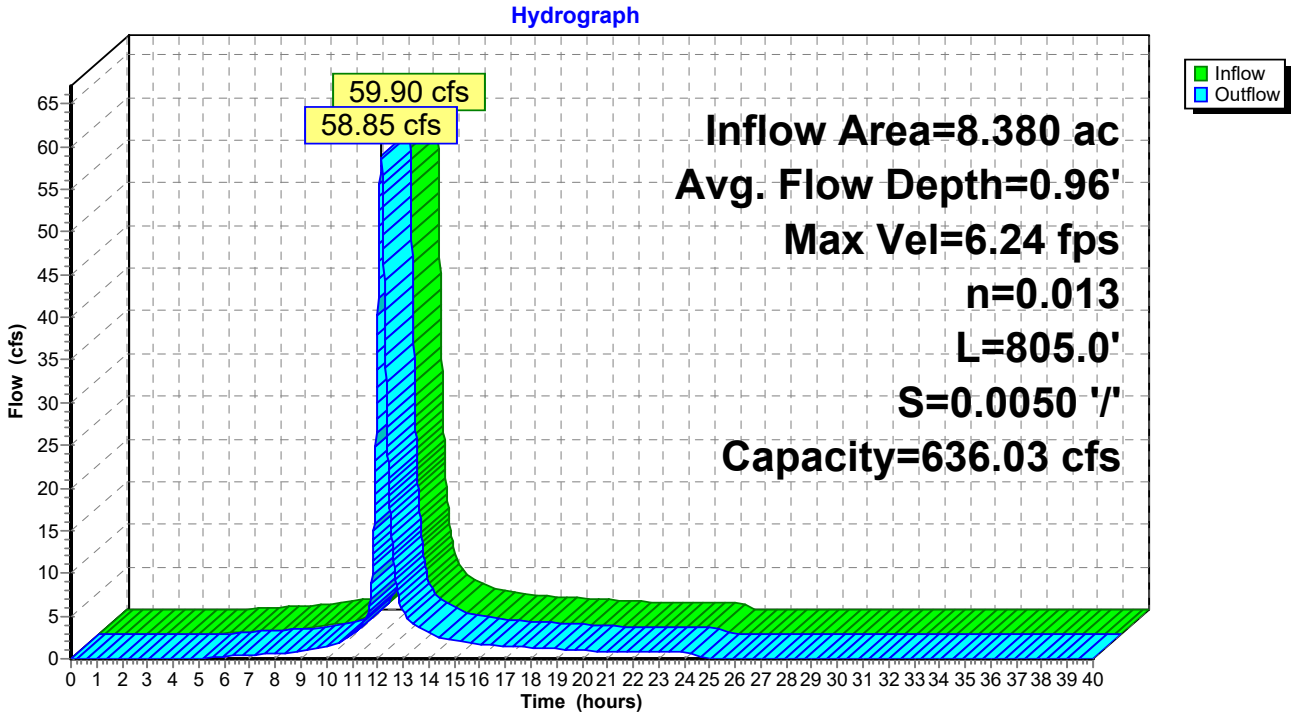
Peak Storage= 7,587 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.96'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 636.03 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 805.0' Slope= 0.0050 '/'
Inlet Invert= 15.27', Outlet Invert= 11.23'



‡

Reach E2R: Channel E2



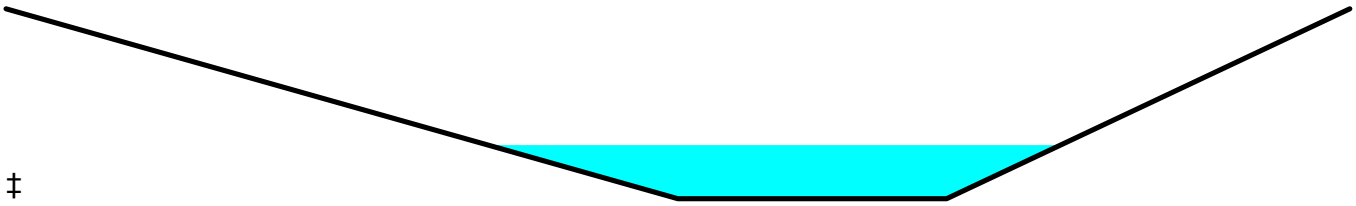
Summary for Reach E3R: Channel E3

Inflow Area = 7.260 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 57.01 cfs @ 12.04 hrs, Volume= 3.949 af
Outflow = 55.84 cfs @ 12.06 hrs, Volume= 3.949 af, Atten= 2%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 7.01 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 1.90 fps, Avg. Travel Time= 7.4 min

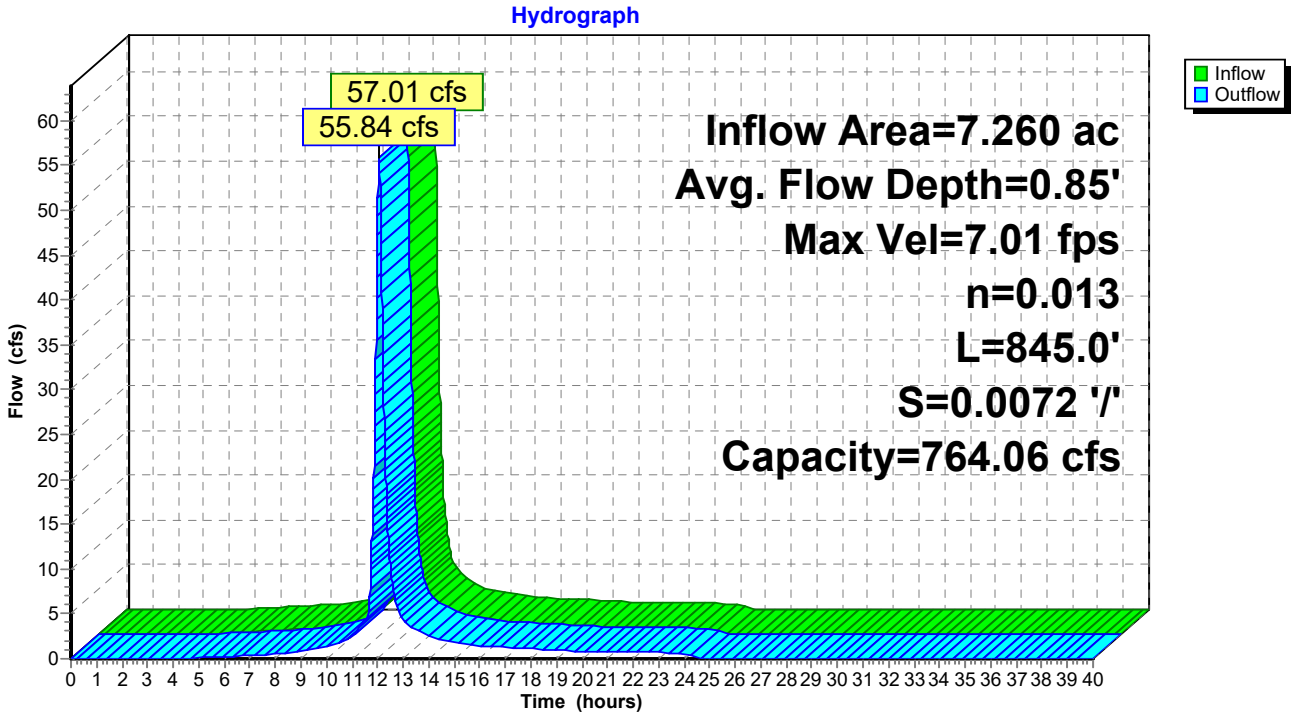
Peak Storage= 6,727 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.85'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 764.06 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 845.0' Slope= 0.0072 '/'
Inlet Invert= 17.35', Outlet Invert= 11.23'



‡

Reach E3R: Channel E3



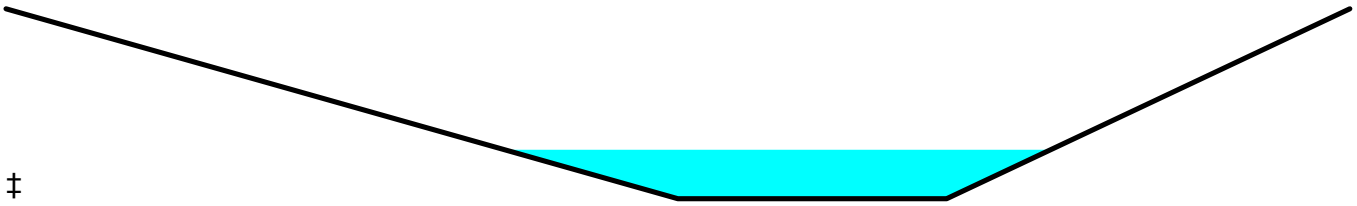
Summary for Reach W1R: Channel W1

Inflow Area = 12.780 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 56.74 cfs @ 12.04 hrs, Volume= 6.952 af
Outflow = 54.83 cfs @ 12.08 hrs, Volume= 6.952 af, Atten= 3%, Lag= 2.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 7.79 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 2.47 fps, Avg. Travel Time= 9.9 min

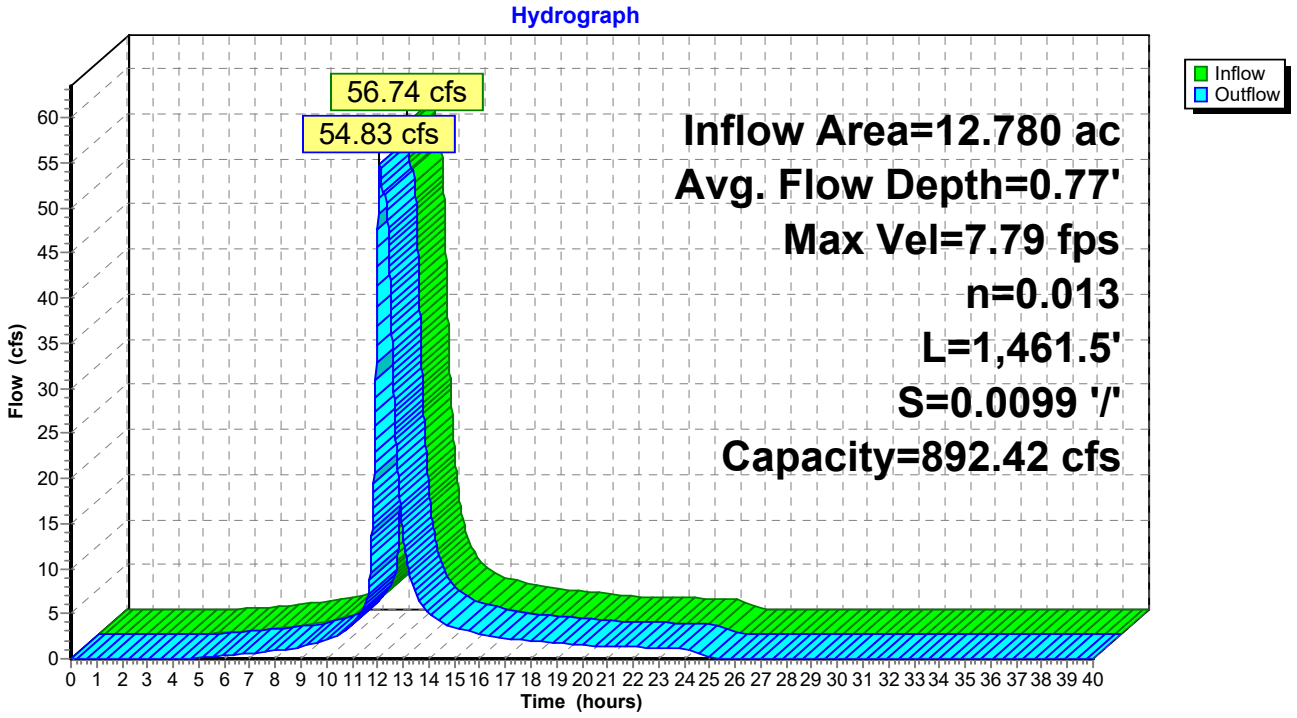
Peak Storage= 10,284 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.77'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 892.42 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 1,461.5' Slope= 0.0099 '/'
Inlet Invert= 20.31', Outlet Invert= 5.87'



‡

Reach W1R: Channel W1



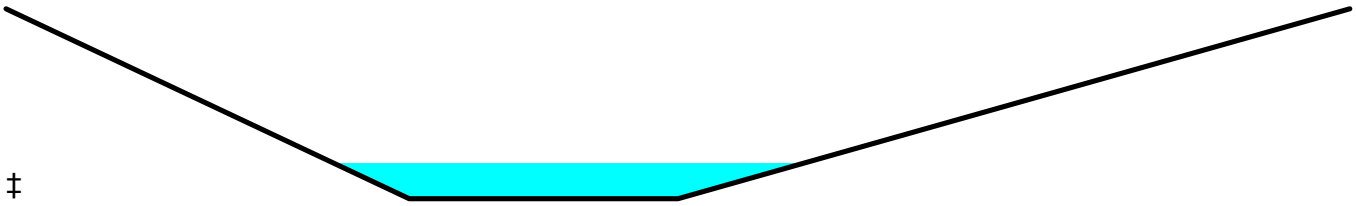
Summary for Reach W2R: Channel W2

Inflow Area = 1.640 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 17.84 cfs @ 11.97 hrs, Volume= 0.892 af
Outflow = 16.63 cfs @ 12.00 hrs, Volume= 0.892 af, Atten= 7%, Lag= 1.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 3.58 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.87 fps, Avg. Travel Time= 12.7 min

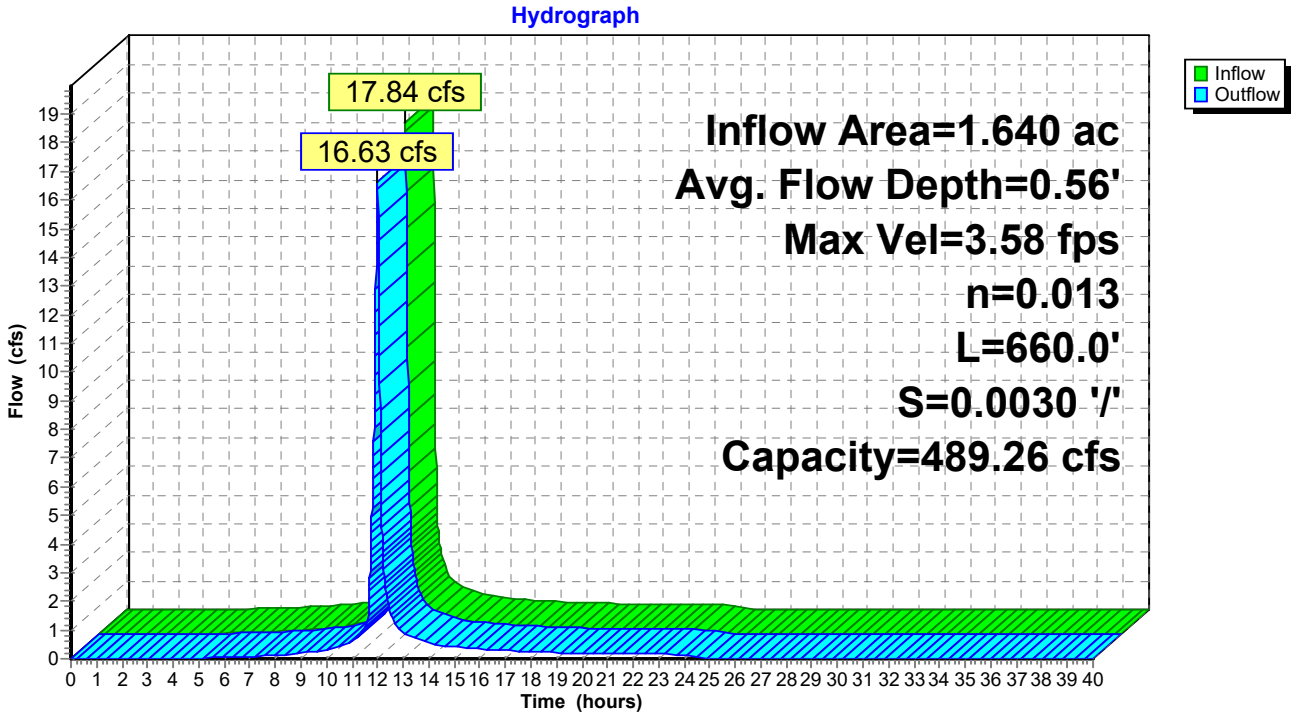
Peak Storage= 3,064 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 489.26 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 660.0' Slope= 0.0030 '/'
Inlet Invert= 7.83', Outlet Invert= 5.87'



‡

Reach W2R: Channel W2



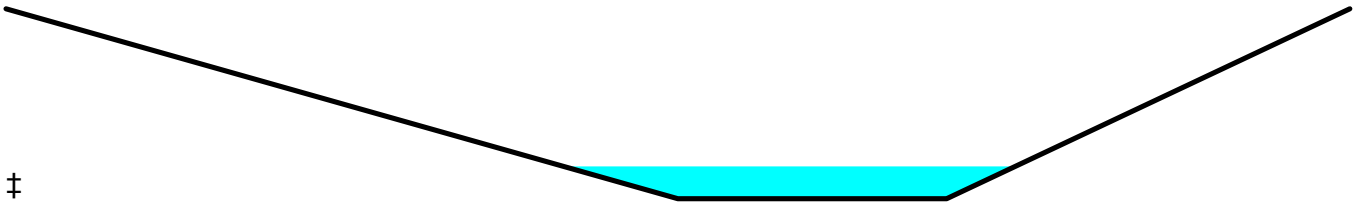
Summary for Reach W3R: Channel W3

Inflow Area = 1.490 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 16.21 cfs @ 11.97 hrs, Volume= 0.811 af
Outflow = 15.22 cfs @ 12.00 hrs, Volume= 0.811 af, Atten= 6%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 3.70 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 11.9 min

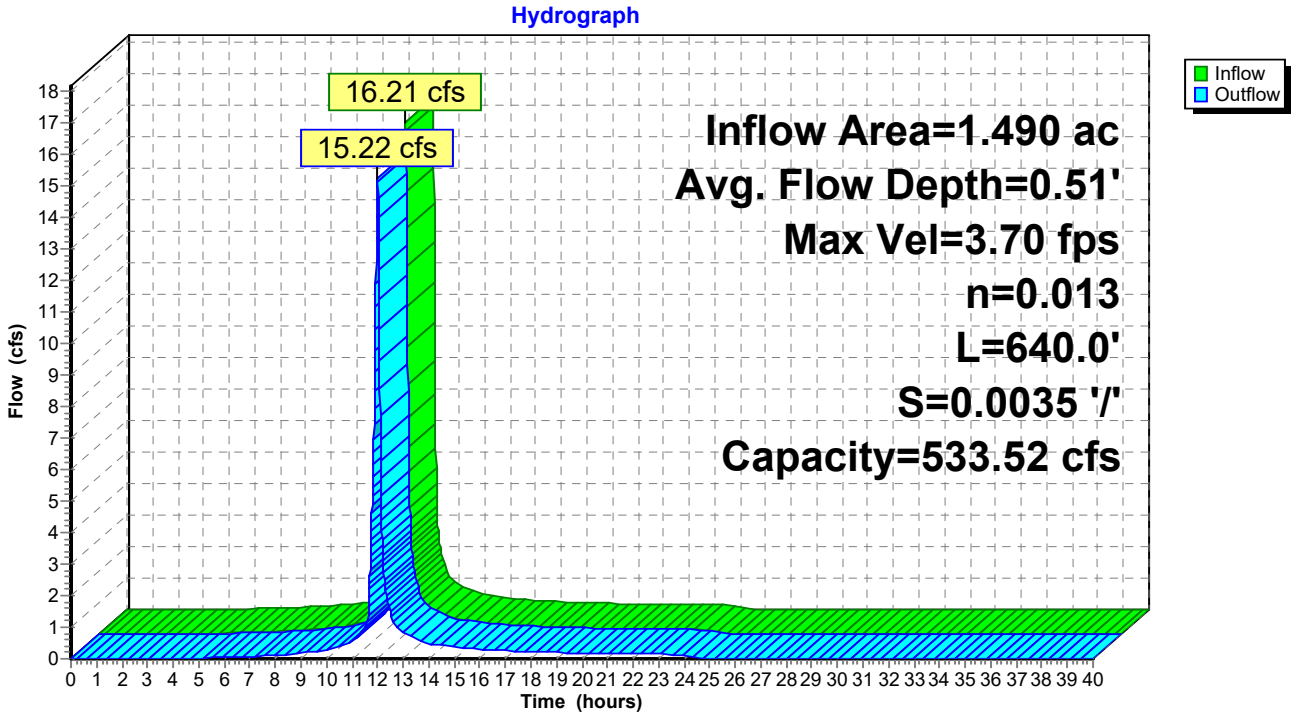
Peak Storage= 2,631 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.51'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 533.52 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 5.0 3.0 '/' Top Width= 30.00'
Length= 640.0' Slope= 0.0035 '/'
Inlet Invert= 7.83', Outlet Invert= 5.57'



‡

Reach W3R: Channel W3



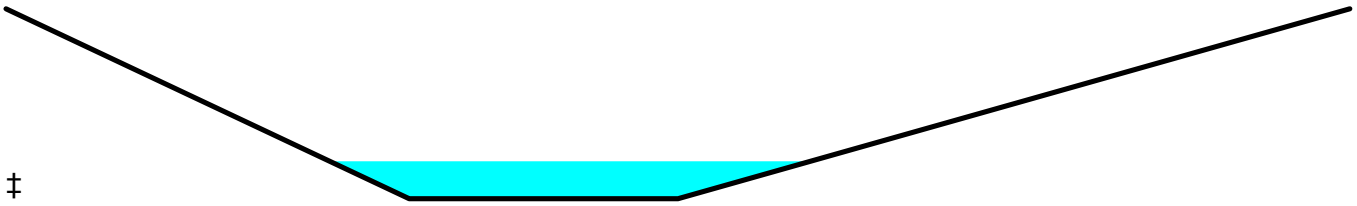
Summary for Reach W4R: Channel W4

Inflow Area = 5.360 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 33.86 cfs @ 11.98 hrs, Volume= 2.916 af
Outflow = 31.27 cfs @ 12.01 hrs, Volume= 2.916 af, Atten= 8%, Lag= 2.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 6.31 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 1.80 fps, Avg. Travel Time= 12.5 min

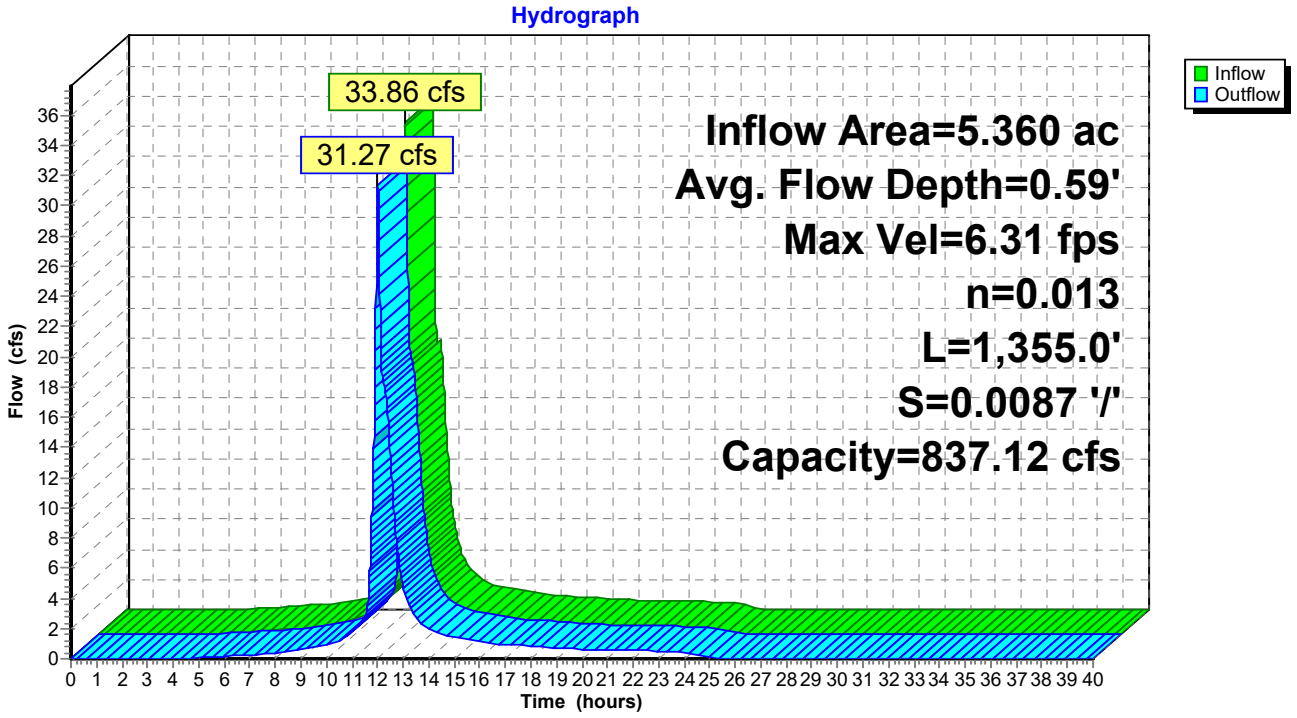
Peak Storage= 6,717 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 3.00' Flow Area= 54.0 sf, Capacity= 837.12 cfs

6.00' x 3.00' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 3.0 5.0 '/' Top Width= 30.00'
Length= 1,355.0' Slope= 0.0087 '/'
Inlet Invert= 17.35', Outlet Invert= 5.57'



‡

Reach W4R: Channel W4



Summary for Pond E1P: Proposed Culvert E1

[62] Hint: Exceeded Reach E1R OUTLET depth by 3.23' @ 12.33 hrs

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 71.22 cfs @ 12.10 hrs, Volume= 5.810 af
Outflow = 47.10 cfs @ 12.22 hrs, Volume= 5.810 af, Atten= 34%, Lag= 7.4 min
Primary = 47.10 cfs @ 12.22 hrs, Volume= 5.810 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 13.29' @ 12.28 hrs Surf.Area= 21,485 sf Storage= 32,843 cf

Plug-Flow detention time= 5.7 min calculated for 5.810 af (100% of inflow)
Center-of-Mass det. time= 5.6 min (809.2 - 803.6)

Volume	Invert	Avail.Storage	Storage Description
#1	9.20'	138,439 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

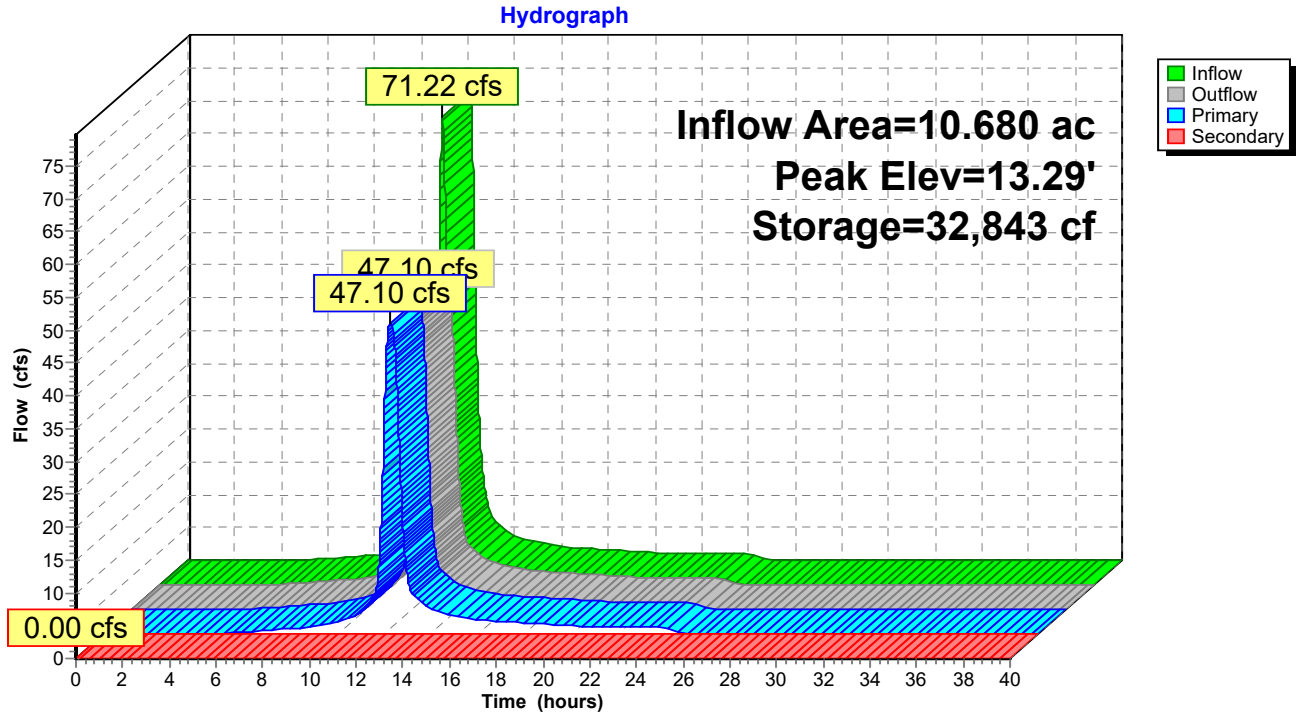
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
9.20	0	0.0	0	0	0
10.00	1,725	385.0	460	460	11,796
11.00	5,530	845.0	3,448	3,908	56,826
12.00	11,180	1,305.0	8,191	12,099	135,535
13.00	18,810	1,770.0	14,831	26,929	249,331
14.00	28,645	2,245.0	23,556	50,485	401,109
15.00	49,400	2,488.0	38,554	89,039	492,663
16.00	49,400	2,488.0	49,400	138,439	495,151

Device	Routing	Invert	Outlet Devices
#1	Primary	9.30'	**36.0" Round 36" Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.30' / 8.70' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=47.10 cfs @ 12.22 hrs HW=13.25' TW=6.00' (Dynamic Tailwater)
↑—**1=36" Culvert** (Barrel Controls 47.10 cfs @ 6.68 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.20' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Proposed Culvert E1



Summary for Pond E2P: Proposed Culvert E2

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 66.86 cfs @ 12.11 hrs, Volume= 5.309 af
Outflow = 41.86 cfs @ 12.27 hrs, Volume= 5.309 af, Atten= 37%, Lag= 9.6 min
Primary = 41.86 cfs @ 12.27 hrs, Volume= 5.309 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 15.09' @ 12.27 hrs Surf.Area= 22,237 sf Storage= 23,990 cf

Plug-Flow detention time= 2.9 min calculated for 5.308 af (100% of inflow)
Center-of-Mass det. time= 2.8 min (802.5 - 799.7)

Volume	Invert	Avail.Storage	Storage Description
#1	11.50'	56,085 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

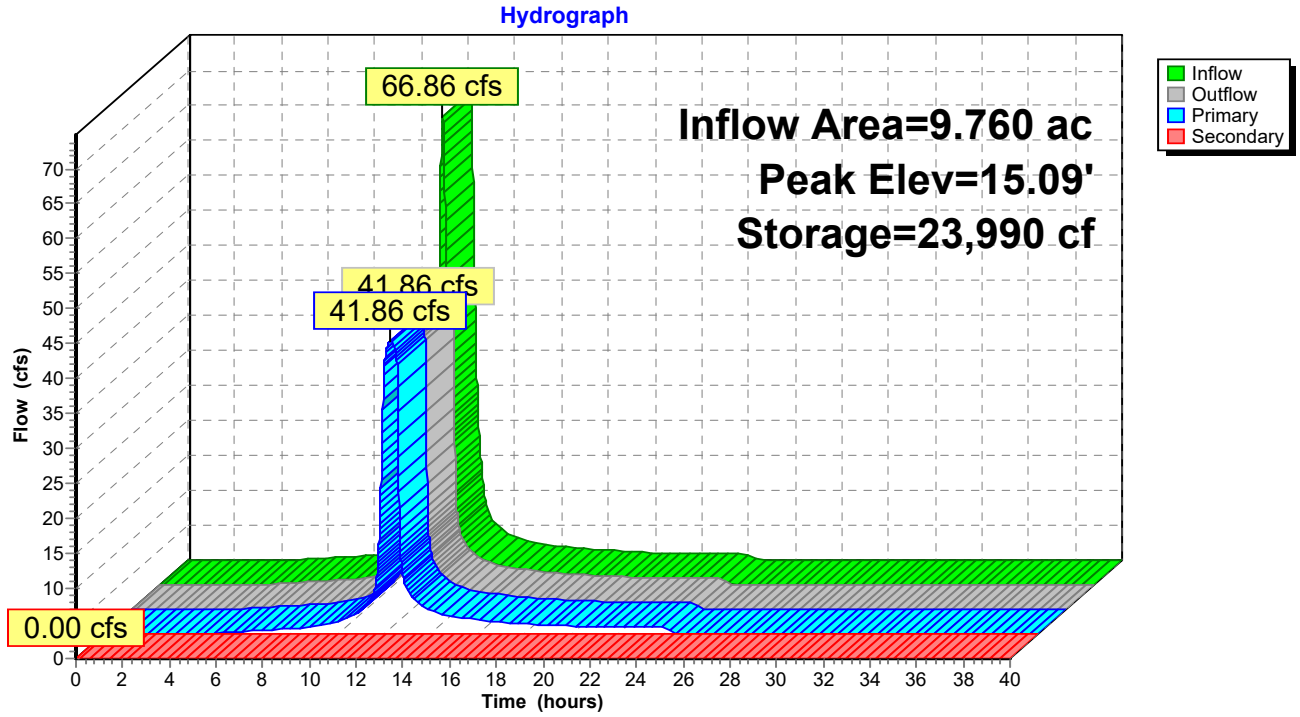
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.50	0	0.0	0	0	0
12.00	765	210.0	128	128	3,510
13.00	3,765	650.0	2,076	2,203	33,625
14.00	8,530	1,095.0	5,987	8,191	95,425
15.00	20,110	1,435.0	13,912	22,103	163,889
16.00	50,095	1,580.0	33,982	56,085	198,711

Device	Routing	Invert	Outlet Devices
#1	Primary	4.12'	**18.0" W x 12.0" H, R=12.0" Elliptical (3) 18x12" Culverts X 3.00** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.12' / 3.60' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 1.17 sf
#2	Device 1	11.50'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=41.86 cfs @ 12.27 hrs HW=15.09' TW=6.00' (Dynamic Tailwater)
└**1=(3) 18x12" Culverts** (Outlet Controls 41.86 cfs @ 11.90 fps)
└**2=Orifice/Grate** (Passes 41.86 cfs of 61.58 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.50' TW=6.00' (Dynamic Tailwater)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E2P: Proposed Culvert E2



Summary for Pond E3P: Proposed Culvert E3

[62] Hint: Exceeded Reach E2R OUTLET depth by 3.26' @ 12.34 hrs
[62] Hint: Exceeded Reach E3R OUTLET depth by 3.48' @ 12.32 hrs

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 109.63 cfs @ 12.09 hrs, Volume= 8.508 af
Outflow = 66.74 cfs @ 12.27 hrs, Volume= 8.508 af, Atten= 39%, Lag= 10.8 min
Primary = 66.74 cfs @ 12.27 hrs, Volume= 8.508 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 15.23' @ 12.27 hrs Surf.Area= 36,458 sf Storage= 50,415 cf

Plug-Flow detention time= 4.7 min calculated for 8.506 af (100% of inflow)
Center-of-Mass det. time= 4.7 min (807.5 - 802.8)

Volume	Invert	Avail.Storage	Storage Description
#1	11.20'	87,995 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

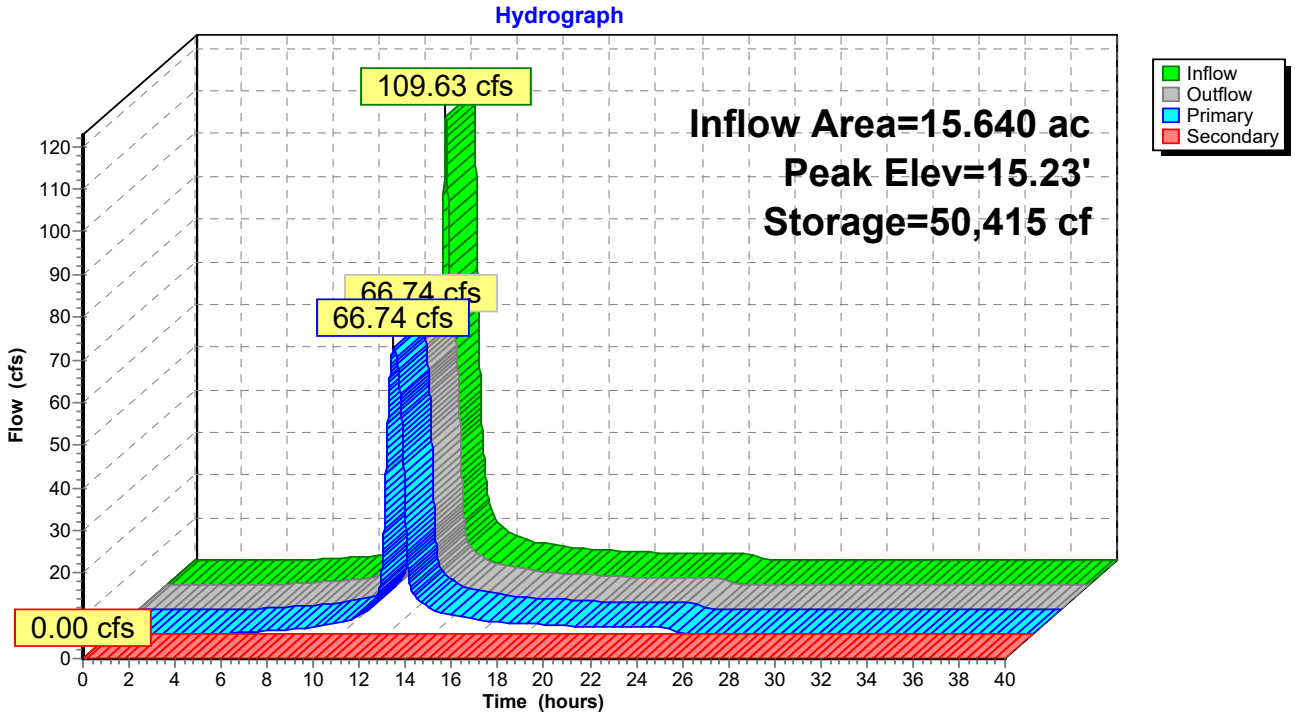
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.20	0	0.0	0	0	0
12.00	2,790	625.0	744	744	31,086
13.00	8,945	1,350.0	5,577	6,321	145,035
14.00	17,465	1,985.0	12,970	19,291	313,567
15.00	30,060	2,655.0	23,479	42,770	560,968
16.00	62,330	3,050.0	45,225	87,995	740,317

Device	Routing	Invert	Outlet Devices
#1	Primary	5.55'	**18.0" Round (3) 18" Culverts X 3.00** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.55' / 5.00' S= 0.0055 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Device 1	11.20'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=66.74 cfs @ 12.27 hrs HW=15.23' TW=6.00' (Dynamic Tailwater)
└**1=(3) 18" Culverts** (Passes 66.74 cfs of 68.90 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 66.74 cfs @ 8.34 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' TW=6.00' (Dynamic Tailwater)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E3P: Proposed Culvert E3



Summary for Pond W1P: Proposed Culvert W1

[62] Hint: Exceeded Reach W1R OUTLET depth by 4.84' @ 12.74 hrs
[63] Warning: Exceeded Reach W2R INLET depth by 3.27' @ 12.67 hrs

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 166.62 cfs @ 12.32 hrs, Volume= 21.396 af
Outflow = 103.50 cfs @ 12.65 hrs, Volume= 21.388 af, Atten= 38%, Lag= 19.8 min
Primary = 103.50 cfs @ 12.65 hrs, Volume= 21.388 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 11.23' @ 12.65 hrs Surf.Area= 117,687 sf Storage= 159,436 cf

Plug-Flow detention time= 15.5 min calculated for 21.388 af (100% of inflow)
Center-of-Mass det. time= 15.2 min (832.2 - 817.0)

Volume	Invert	Avail.Storage	Storage Description
#1	5.80'	501,374 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

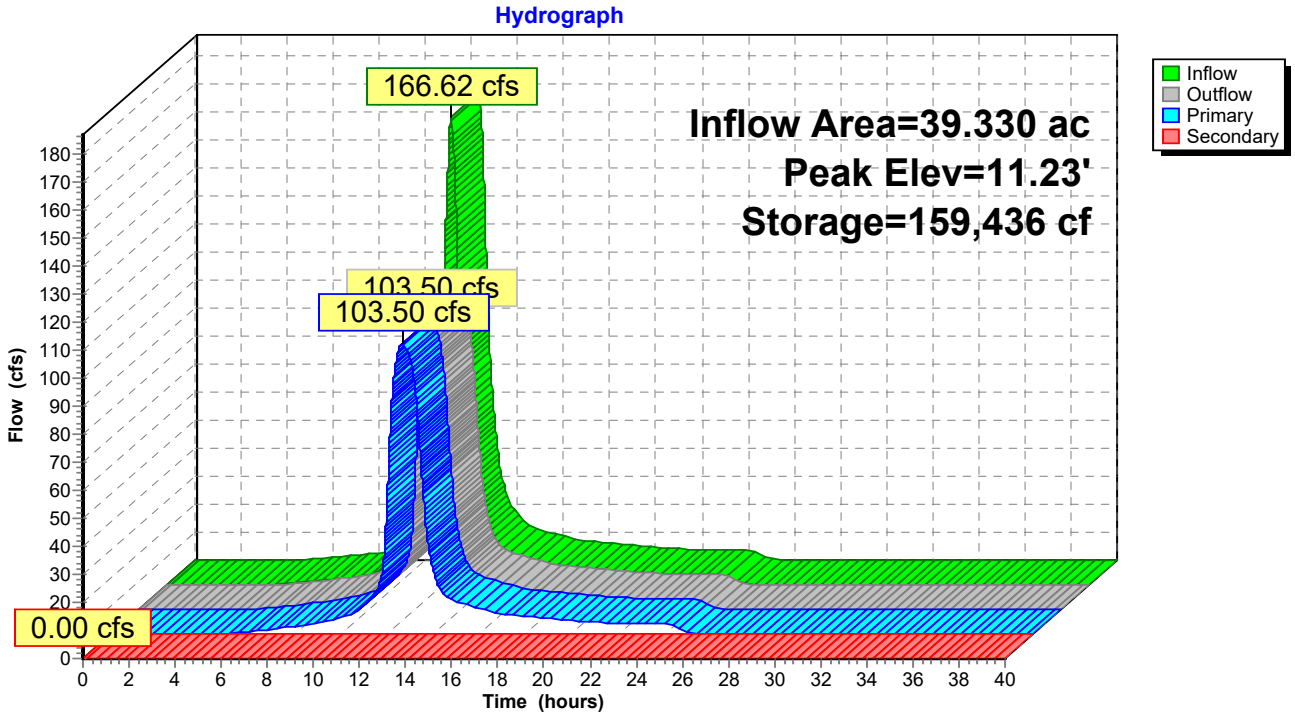
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.80	0	0.0	0	0	0
6.00	475	155.0	32	32	1,912
7.00	5,935	1,130.0	2,696	2,728	101,615
8.00	14,975	2,015.0	10,112	12,840	323,110
9.00	24,795	2,340.0	19,680	32,520	435,763
10.00	41,685	2,720.0	32,876	65,397	588,796
11.00	101,320	3,145.0	69,331	134,728	787,174
12.00	183,080	3,370.0	140,199	274,927	903,870
13.00	272,785	3,650.0	226,447	501,374	1,060,327

Device	Routing	Invert	Outlet Devices
#1	Primary	6.30'	**48.0" Round 48" Culvert** L= 110.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.30' / 5.20' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.25'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=103.50 cfs @ 12.65 hrs HW=11.23' TW=6.00' (Dynamic Tailwater)
↑—**1=48" Culvert** (Inlet Controls 103.50 cfs @ 8.24 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.80' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W1P: Proposed Culvert W1



Summary for Pond W2P: Proposed Culvert W2

[63] Warning: Exceeded Reach W3R INLET depth by 2.71' @ 12.60 hrs
[62] Hint: Exceeded Reach W4R OUTLET depth by 4.77' @ 12.62 hrs

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 133.34 cfs @ 12.33 hrs, Volume= 17.321 af
Outflow = 98.69 cfs @ 12.58 hrs, Volume= 17.317 af, Atten= 26%, Lag= 15.3 min
Primary = 98.69 cfs @ 12.58 hrs, Volume= 17.317 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 10.66' @ 12.58 hrs Surf.Area= 68,058 sf Storage= 94,016 cf

Plug-Flow detention time= 10.7 min calculated for 17.317 af (100% of inflow)
Center-of-Mass det. time= 10.4 min (827.1 - 816.7)

Volume	Invert	Avail.Storage	Storage Description
#1	5.60'	454,263 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

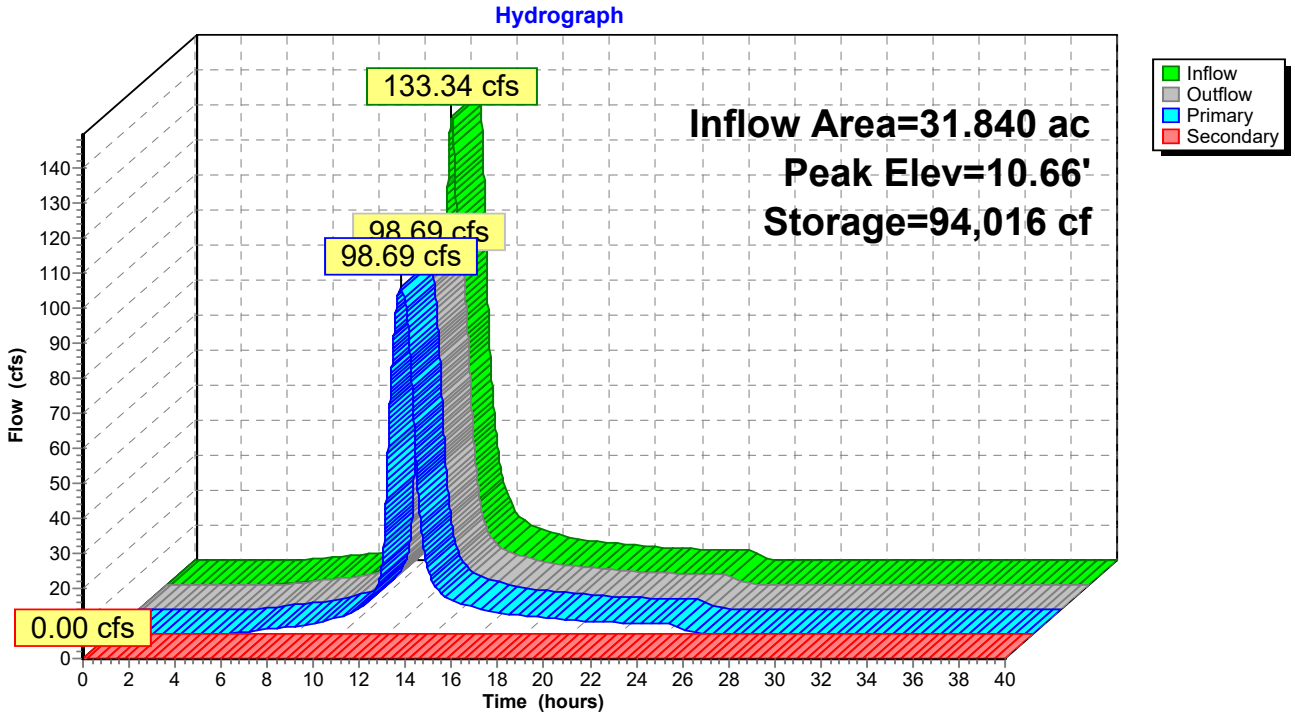
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
5.60	0	0.0	0	0	0
6.00	1,200	320.0	160	160	8,149
7.00	6,000	1,030.0	3,294	3,454	84,427
8.00	13,375	1,650.0	9,444	12,899	216,660
9.00	21,190	1,805.0	17,133	30,032	259,310
10.00	38,310	2,000.0	29,331	59,363	318,386
11.00	86,665	2,220.0	60,865	120,228	392,295
12.00	166,100	2,600.0	124,248	244,476	538,069
13.00	256,750	3,035.0	209,787	454,263	733,152

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**48.0" Round 48" Culvert** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0095 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=98.69 cfs @ 12.58 hrs HW=10.66' TW=6.00' (Dynamic Tailwater)
↑—**1=48" Culvert** (Inlet Controls 98.69 cfs @ 7.85 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=5.60' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond W2P: Proposed Culvert W2



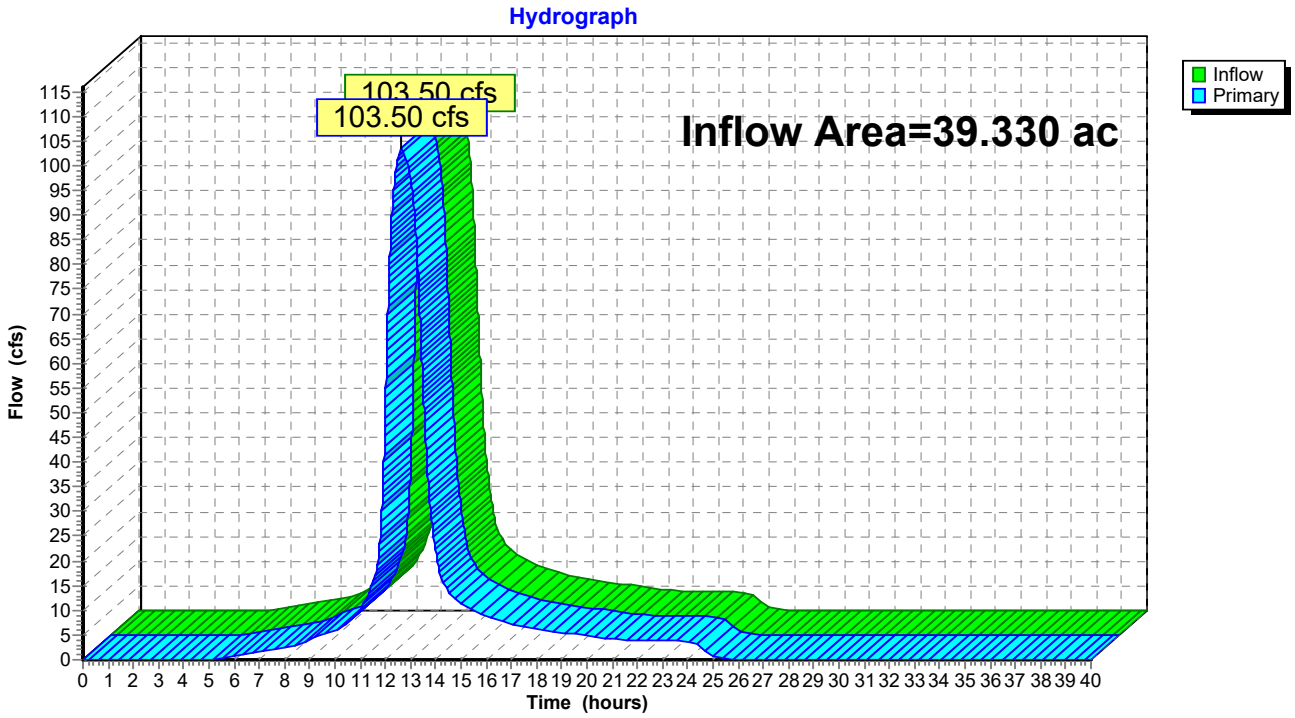
Summary for Link 1L: Thermal Channel

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 103.50 cfs @ 12.65 hrs, Volume= 21.388 af
Primary = 103.50 cfs @ 12.65 hrs, Volume= 21.388 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 1L: Thermal Channel



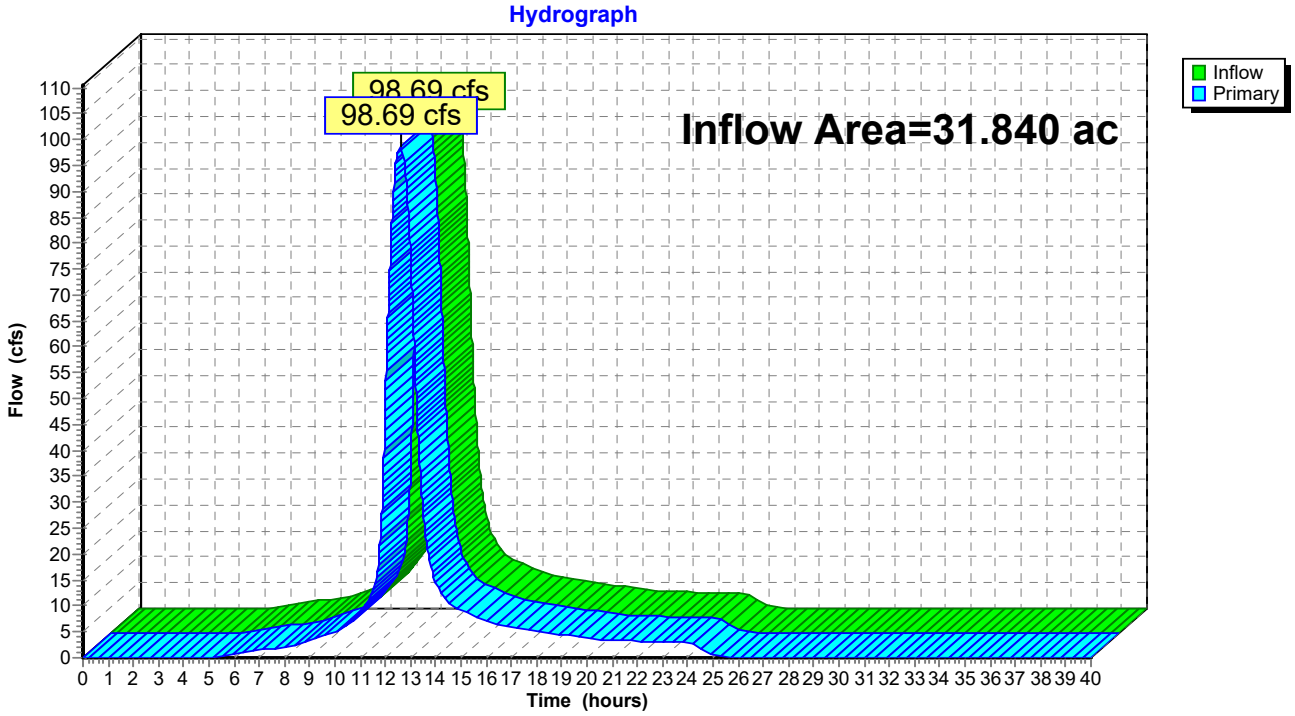
Summary for Link 2L: Thermal Channel

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 98.69 cfs @ 12.58 hrs, Volume= 17.317 af
Primary = 98.69 cfs @ 12.58 hrs, Volume= 17.317 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 2L: Thermal Channel



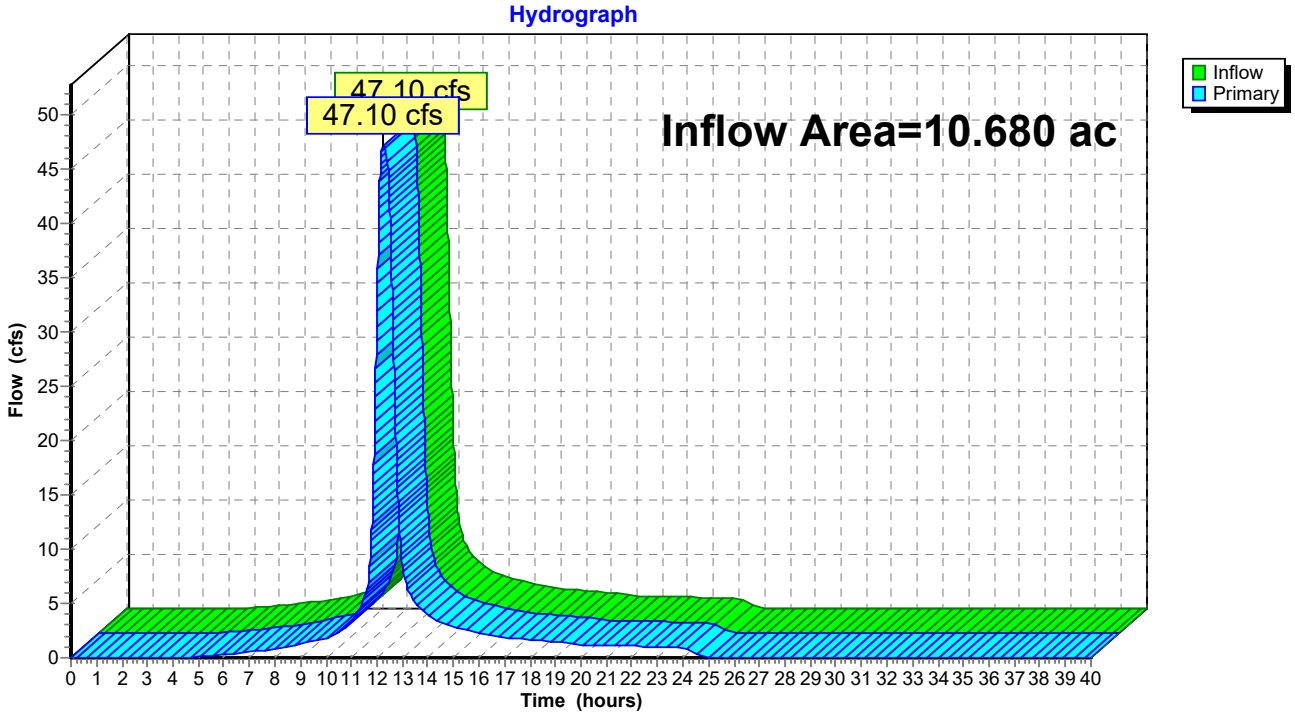
Summary for Link 4L: Ex Channel

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 47.10 cfs @ 12.22 hrs, Volume= 5.810 af
Primary = 47.10 cfs @ 12.22 hrs, Volume= 5.810 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 4L: Ex Channel



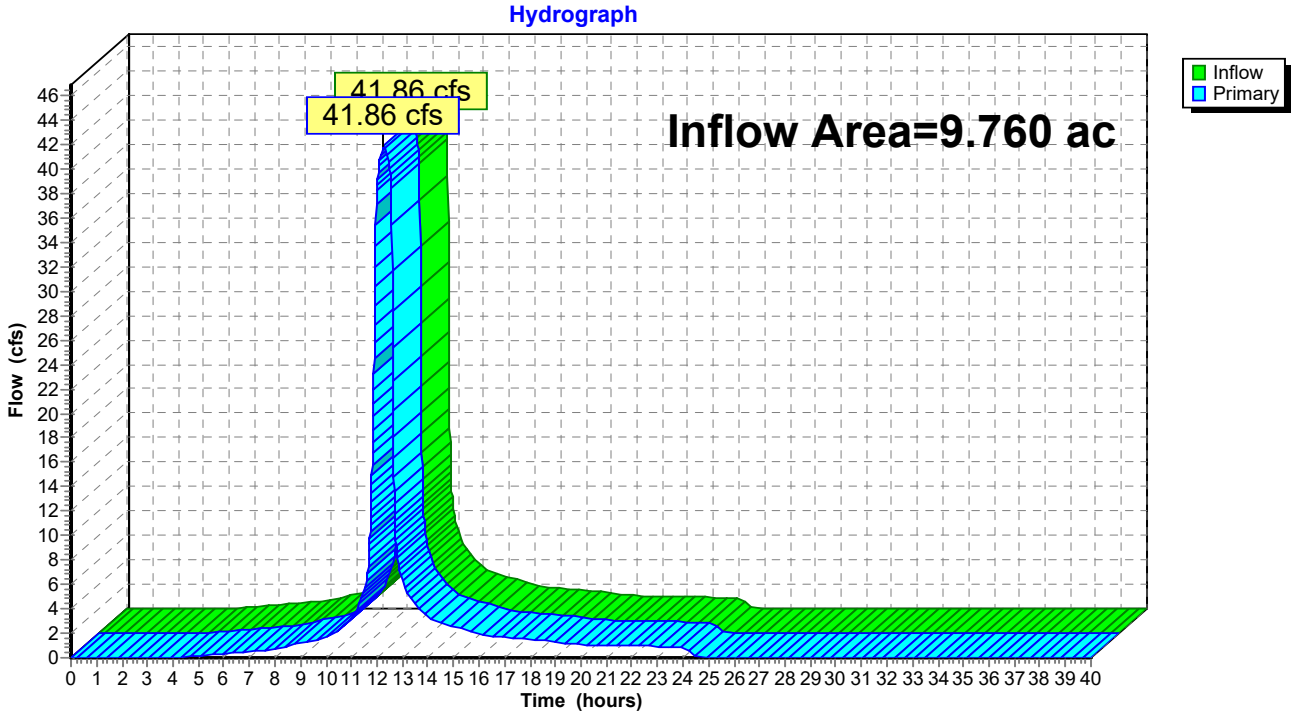
Summary for Link 5L: Swamp

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 41.86 cfs @ 12.27 hrs, Volume= 5.309 af
Primary = 41.86 cfs @ 12.27 hrs, Volume= 5.309 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 5L: Swamp



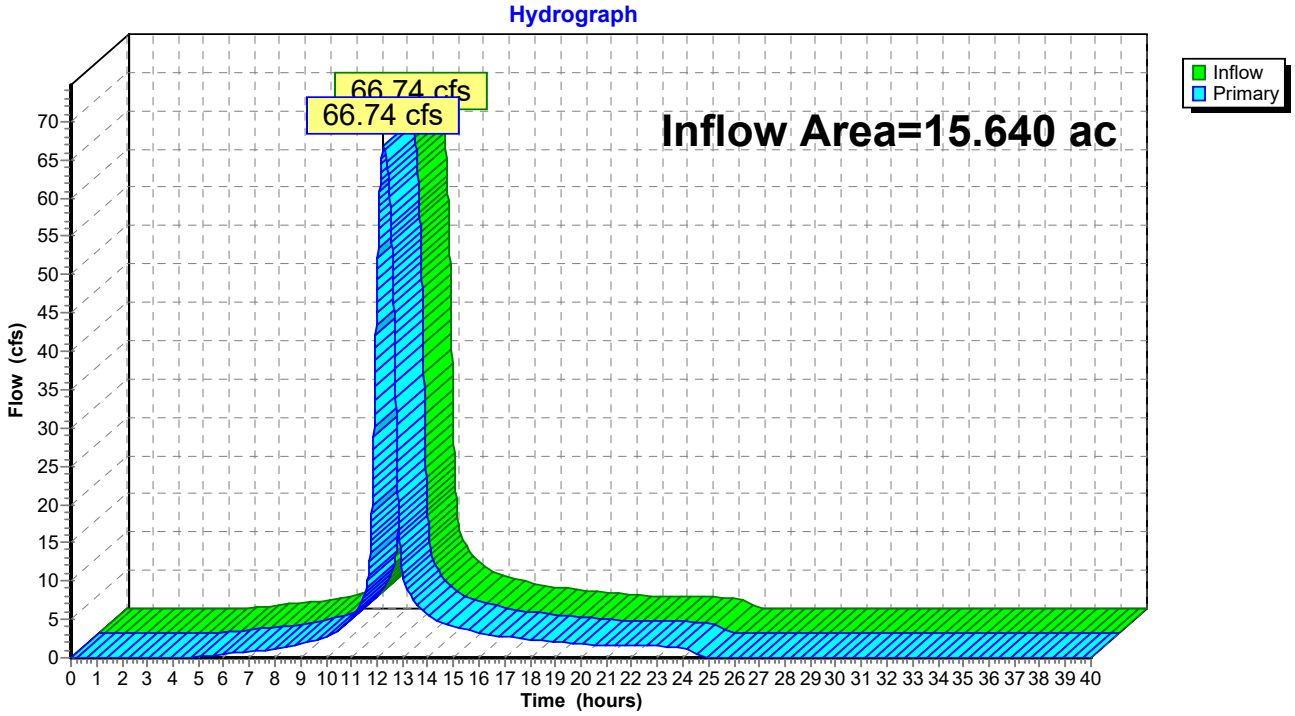
Summary for Link 6L: Swamp

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100yr, 24hr event
Inflow = 66.74 cfs @ 12.27 hrs, Volume= 8.508 af
Primary = 66.74 cfs @ 12.27 hrs, Volume= 8.508 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Fixed water surface Elevation= 6.00'

Link 6L: Swamp



Appendix 3

Sediment Basin Design Calculations

7.3 Sediment Basin Calculations

Sediment Basin Summary																
Sed Basin #	Drainage Area (ac)	Wet Storage		Dry Storage		Bottom Elevation	Dewatering Device Elevation	Dewatering Orifice Diameter (in)	Riser Height (ft)	Riser Diameter (in)	Riser Crest Elevation (ft)	Emergency Spillway Elevation (ft)	Outlet Barrel			
		Vol Required (CY)	Vol Provided (CY)	Vol Required (CY)	Vol Provided (CY)								Pipe Length (ft)	Pipe Diameter (in)	Invert in (ft)	Invert out (ft)
W1	39.3	2,635	3,376	2,635	2,959	6.3	8.8	8	3.7	60	10.0	11.0	110	48	6.3	5.2
W2	31.8	2,133	3,109	2,133	4,797	6.0	8.0	8	4.0	48	10.0	11.0	105	48	6.0	5.0
E1	10.7	716	1,232	716	790	9.3	12.0	4	3.7	36	13.0	15.0	120	36	9.3	8.7
E2	9.8	654	721	654	933	11.5	13.2	4	2.7	120	14.2	15.0	115	(3) 15	4.6	4.0
E3	15.6	1,048	1,716	1,048	1,312	11.2	13.0	6	2.8	36	14.0	15.0	100	36	5.55	5.0

Temporary Basin Design Data Sheet
(with or without an emergency spillway)

Project Chesterfield LAP
Basin # W1 Location 48" RCP
Total area draining to basin: 39.33 acres.

Basin Volume Design

Wet Storage:

1. Minimum required volume = 67 cu. yds. x Total Drainage Area (acres).
   67.00 cu.yds. x 39.33 acres = 2,635 cu. yds. = 71,148 cu. ft

2. Available basin volume = 2,741 cu. yds. at elevation 8.50
   (From storage - elevation curve) * Below dewatering orifice

3. Excavate 0 cu. yds. to obtain required volume*.
   *Elevation corresponding to required volume = invert of the dewatering orifice.

4. Available volume before cleanout required.
   33.00 cu.yds. x 39.33 acres = 1,298 cu. yds. = 35,043 cu. ft

5. Elevation corresponding to cleanout level = 7.80
   (From storage - Elevation Curve)

6. Distance from invert of the dewatering orifice to cleanout level = 1.00 ft. Minimum Dewatering Orifice elev = 8.80
   (Min. = 1.0 ft.) Provided Dewatering Orifice elev = **8.80**

6a. Total Provided Wet Storage (Rounded up)
   Volume at Elevation 8.80 3,376 cu. yds. = 91,164 cu. ft

Dry Storage:

7. Minimum required volume = 67 cu. Yds. X Total Drainage Area (acres).
   67.00 cu.yds. x 39.33 acres = 2,635 cu. yds. = 71,148 cu. ft.

   Total required volume = 134 cu. Yds X Total Drainage Area (acres)
   134.00 cu.yds. x 39.33 acres = 5,270 cu. yds. = 142,296 cu. ft.

   Total provided Volume
   (Wet Storage + Dry Storage) 6,335 cu. yds. = 171,035 cu. ft.

8. Total available basin volume at crest of riser = 6,335 cu. yds. at elevation 10.00
   Elevation rounded up to: 10.00 = 6,335 cu. yds. at elevation **10.00**
   (for constructability)

9. Diameter of dewatering orifice A = 0.22
   d = 6.42 inches (3" min.)
10. Diameter of flexible tubing = 10.00 in. (diameter of dewatering orifice plus 2 inches minimum).

Basin Shape

12. Length of Flow L = 2.00 = 2.00
    Effective Width We 1.00

    If > 2, baffles are not required Yes
    If < 2, baffles are required

Runoff

13. Q_2 = 47.33 cfs (From HydroCAD model)
14. Q_{25} = 115.92 cfs (From HydroCAD model)

Principal Spillway Design

15. With emergency spillway, required spillway capacity $Q_p = Q_2$ = 47.33 cfs.
(riser and barrel)

Without emergency spillway, required spillway capacity $Q_p = Q_{25}$ = 115.92 cfs.
(riser and barrel)

16. With emergency spillway:
Assume available head (h) = 1.00 ft. (Using Q_2)
h = Crest of Emergency Spillway Elevation - Crest of Riser Elevation

Without emergency spillway:
Assume available head (h) = 1.50 ft. (Using Q_{25})
h = Design High Water Elevation - Crest of Riser Elevation

17. Riser diameter (D_r) = 60.0 in.
(From Plate 3.14-8.)
Note: Avoid orifice flow conditions.

18. Barrel length (l) = 110.0 ft.
Head (H) on barrel through embankment = 3.70 ft.
Note: 48" RCP

19. Barrel diameter = 48.0 in.
Note: 48" RCP

20. Trash rack and anti-vortex device
Diameter = 90.0
Height = 29.0
(From Table 3.14-D).

Emergency Spillway Design

21. Required spillway capacity $Q_e = Q_{25} - Q_p$ = 68.59 cfs.

22. Bottom width (b) = 100.00 ft.; the slope of the exit channel (s) = 0.02 ft./foot
and the minimum length of the exit channel (x) = 20.00 ft.
(From LAP / UAP Design).

Anti-Seep Collar Design

23. Depth of water at principal spillway crest (Y) = 3.70 ft.
Slope of upstream face of embankment (Z) = 5.00 :1
Slope of principal spillway barrel (S_b) = 0.005
Length of barrel in saturated zone (L_s) = 33.98 ft.

24. Number of collars required = 2 dimensions = 6' x 6'
(From Plate 3.14-12).

Final Design Elevations

25.

Top of Dam =	12.00
Design High Water =	11.50
Emergency Spillway Crest =	11.00
Principal Spillway Crest =	10.00
Dewatering Orifice Invert =	8.80
Cleanout Elevation =	7.80
Elevation of Upstream Toe of Dam or Excavated Bottom of "Wet Storage Area" (if excavation was performed) =	6.30

Principal Spillway Anchoring

(From Plate 3.14-14 for Embankments Less than 10' High)

Concrete Base:
Diameter ($2D_r$) = 8.00 ft

Depth (bgs) = 1.50 ft

1/4" Steel Base:

Diameter ($2D_r$) = 8.00 ft

Depth (bgs) = 2.50 ft

Temporary Basin Design Data Sheet
(with or without an emergency spillway)

Project Chesterfield LAP
Basin # W2 Location 48" RCP
Total area draining to basin: 31.84 acres.

Basin Volume Design

Wet Storage:

1. Minimum required volume = 67 cu. yds. x Total Drainage Area (acres).
   67.00 cu.yds. x 31.84 acres = 2,133 cu. yds. = 57,599 cu. ft

2. Available basin volume = 2,309 cu. yds. at elevation 7.60
   (From storage - elevation curve) * Below dewatering orifice

3. Excavate 0 cu. yds. to obtain required volume*.
   *Elevation corresponding to required volume = invert of the dewatering orifice.

4. Available volume before cleanout required.
   33.00 cu.yds. x 31.84 acres = 1,051 cu. yds. = 28,369 cu. ft

5. Elevation corresponding to cleanout level = 7.00
   (From storage - Elevation Curve)

6. Distance from invert of the dewatering orifice to cleanout level = 1.00 ft. Minimum Dewatering Orifice elev = **8.00**
   (Min. = 1.0 ft.) Provided Dewatering Orifice elev = **8.00**

6a. Total Provided Wet Storage
   Volume at Elevation 8.00 3,109 cu. yds. = 83,935 cu. ft

Dry Storage:

7. Minimum required volume = 67 cu. Yds. X Total Drainage Area (acres).
   67.00 cu.yds. x 31.84 acres = 2,133 cu. yds. = 57,599 cu. ft.

   Total required volume = 134 cu. Yds X Total Drainage Area (acres)
   134.00 cu.yds. x 31.84 acres = 4,267 cu. yds. = 115,197 cu. ft.

   Total provided Volume
   (Wet Storage + Dry Storage) 5,242 cu. yds. = 141,534 cu. ft.

8. Total available basin volume at crest of riser* = 7,906 cu. yds. at elevation 10.00
   Elevation rounded up to: 10.00 = 7,906 cu. yds. at elevation **10.00**
   (for constructability)

9. Diameter of dewatering orifice A = 0.14
   d = 5.09 inches (3" min.)
10. Diameter of flexible tubing = 10.00 in. (diameter of dewatering orifice plus 2 inches minimum).

Basin Shape

12. Length of Flow L = 2.00 = 2.00
    Effective Width We 1.00

    If > 2, baffles are not required Yes
    If < 2, baffles are required

Runoff

13. Q_2 = 38.04 cfs (From HydroCAD model)
14. Q_{25} = 92.89 cfs (From HydroCAD model)

Principal Spillway Design

15. With emergency spillway, required spillway capacity $Q_p = Q_2$ = 38.04 cfs.
(riser and barrel)

Without emergency spillway, required spillway capacity $Q_p = Q_{25}$ = 92.89 cfs.
(riser and barrel)

16. With emergency spillway:
Assume available head (h) = 1.00 ft. (Using Q_2)
h = Crest of Emergency Spillway Elevation - Crest of Riser Elevation

Without emergency spillway:
Assume available head (h) = 1.50 ft. (Using Q_{25})
h = Design High Water Elevation - Crest of Riser Elevation

17. Riser diameter (D_r) = 48.0 in.
Note: Riser Modeled with HydroCAD

18. Barrel length (l) = 105.00 ft.
Head (H) on barrel through embankment = 4.00 ft.
Note: 48" RCP

19. Barrel diameter = 48.0 in.
Note: 48" RCP

20. Trash rack and anti-vortex device
Diameter = 72.0
Height = 21.0
(From Table 3.14-D).

Emergency Spillway Design (N/A)

21. Required spillway capacity $Q_e = Q_{25} - Q_p$ = 54.85 cfs.

22. Bottom width (b) = 100.00 ft.; the slope of the exit channel (s) = 0.02 ft./foot
and the minimum length of the exit channel (x) = 20.00 ft.
(From LAP / UAP Design).

Anti-Seep Collar Design (N\A)

23. Depth of water at principal spillway crest (Y) = 4.00 ft.
Slope of upstream face of embankment (Z) = 5.00
Slope of principal spillway barrel (S_b) = 0.005
Length of barrel in saturated zone (L_s) = 36.73 ft.

24. Number of collars required = 2 dimensions = 6' x 6'
(From Plate 3.14-12).

Final Design Elevations

25.

Top of Dam =	12.00
Design High Water =	11.50
Emergency Spillway Crest =	11.00
Principal Spillway Crest =	10.00
Dewatering Orifice Invert =	8.00
Cleanout Elevation =	7.00
Elevation of Upstream Toe of Dam or Excavated Bottom of "Wet Storage Area" (if excavation was performed) =	6.00

Principal Spillway Anchoring

(From Plate 3.14-14 for Embankments Less than 10' High)

Concrete Base:
Diameter ($2D_r$) = 8.00 ft
Depth (bgs) = 1.50 ft

1/4" Steel Base:

Diameter ($2D_r$) = 8.00 ft

Depth (bgs) = 2.50 ft

Temporary Basin Design Data Sheet
(with or without an emergency spillway)

Project Chesterfield LAP
Basin # E1 Location 36" RCP
Total area draining to basin: 10.68 acres.

Basin Volume Design

Wet Storage:

1. Minimum required volume = 67 cu. yds. x Total Drainage Area (acres).
   67.00 cu.yds. x 10.68 acres = 716 cu. yds. = 19,320 cu. ft

2. Available basin volume = 764 cu. yds. at elevation 11.20
   (From storage - elevation curve) * Below dewatering orifice

3. Excavate 0 cu. yds. to obtain required volume*.
   *Elevation corresponding to required volume = invert of the dewatering orifice.

4. Available volume before cleanout required.
   33.00 cu.yds. x 10.68 acres = 352 cu. yds. = 9,516 cu. ft

5. Elevation corresponding to cleanout level = 10.40
   (From storage - Elevation Curve)

6. Distance from invert of the dewatering orifice to cleanout level = 1.00 ft. Minimum Dewatering Orifice elev = **11.40**
   (Min. = 1.0 ft.) Provided Dewatering Orifice elev = **12.00**

6a. Total Provided Wet Storage
   Volume at Elevation 12.00 1,232 cu. yds. = 33,271 cu. ft

Dry Storage:

7. Minimum required volume = 67 cu. Yds. X Total Drainage Area (acres).
   67.00 cu.yds. x 10.68 acres = 716 cu. yds. = 19,320 cu. ft.

   Total required volume = 134 cu. Yds X Total Drainage Area (acres)
   134.00 cu.yds. x 10.68 acres = 1,431 cu. yds. = 38,640 cu. ft.

   Total provided Volume
   (Wet Storage + Dry Storage) 1,948 cu. yds. = 52,591 cu. ft.

8. Total available basin volume at crest of riser* = 2,022 cu. yds. at elevation 13.00
   Elevation rounded up to: 13.00 = 2,022 cu. yds. at elevation **13.00**
   (for constructability)

9. Diameter of dewatering orifice A = 0.07
   d = 3.50 inches (3" min.)
10. Diameter of flexible tubing = 6.00 in. (diameter of dewatering orifice plus 2 inches minimum).

Basin Shape

12. Length of Flow L = 2.00 = 2.00
    Effective Width We 1.00

    If > 2, baffles are not required Yes
    If < 2, baffles are required

Runoff

13. Q_2 = 19.77 cfs (From HydroCAD model)
14. Q_{25} = 49.35 cfs (From HydroCAD model)

Principal Spillway Design

15. With emergency spillway, required spillway capacity $Q_p = Q_2$ = 19.77 cfs.
(riser and barrel)

Without emergency spillway, required spillway capacity $Q_p = Q_{25}$ = 49.35 cfs.
(riser and barrel)

16. With emergency spillway:
Assume available head (h) = 2.00 ft. (Using Q_2)
h = Crest of Emergency Spillway Elevation - Crest of Riser Elevation

Without emergency spillway:
Assume available head (h) = 2.50 ft. (Using Q_{25})
h = Design High Water Elevation - Crest of Riser Elevation

17. Riser diameter (D_r) = 36.0 in.
Note: Riser Modeled with HydroCAD

18. Barrel length (l) = 120.00 ft.
Head (H) on barrel through embankment = 3.70 ft.
Note: 36" RCP

19. Barrel diameter = 36.0 in.
Note: 36" RCP

20. Trash rack and anti-vortex device
Diameter = 54.0
Height = 17.0
(From Table 3.14-D).

Emergency Spillway Design (N/A)

21. Required spillway capacity $Q_e = Q_{25} - Q_p$ = 29.58 cfs.

22. Bottom width (b) = 100.00 ft.; the slope of the exit channel (s) = 0.02 ft./foot
and the minimum length of the exit channel (x) = 20.00 ft.
(From LAP / UAP Design).

Anti-Seep Collar Design (N\A)

23. Depth of water at principal spillway crest (Y) = 3.70 ft.
Slope of upstream face of embankment (Z) = 5.00
Slope of principal spillway barrel (S_b) = 0.005
Length of barrel in saturated zone (L_s) = 33.98 ft.

24. Number of collars required = 2 dimensions = 5' x 5'
(From Plate 3.14-12).

Final Design Elevations

25.

Top of Dam =	16.00
Design High Water =	15.50
Emergency Spillway Crest =	15.00
Principal Spillway Crest =	13.00
Dewatering Orifice Invert =	12.00
Cleanout Elevation =	11.00
Elevation of Upstream Toe of Dam or Excavated Bottom of "Wet Storage Area" (if excavation was performed) =	9.30

Principal Spillway Anchoring

(From Plate 3.14-14 for Embankments Less than 10' High)

Concrete Base:
Diameter ($2D_r$) = 6.00 ft
Depth (bgs) = 1.50 ft

1/4" Steel Base:

Diameter ($2D_r$) =	6.00	ft
Depth (bgs) =	2.50	ft

Temporary Basin Design Data Sheet
(with or without an emergency spillway)

Project Chesterfield LAP
Basin # E2 Location (3) 15" RCP
Total area draining to basin: 9.76 acres.

Basin Volume Design

Wet Storage:

1. Minimum required volume = 67 cu. yds. x Total Drainage Area (acres).
   67.00 cu.yds. x 9.76 acres = 654 cu. yds. = 17,656 cu. ft

2. Available basin volume = 721 cu. yds. at elevation 13.20
   (From storage - elevation curve) * Below dewatering orifice

3. Excavate 0 cu. yds. to obtain required volume*.
   *Elevation corresponding to required volume = invert of the dewatering orifice.

4. Available volume before cleanout required.
   33.00 cu.yds. x 9.76 acres = 322 cu. yds. = 8,696 cu. ft

5. Elevation corresponding to cleanout level = 12.70
   (From storage - Elevation Curve)

6. Distance from invert of the dewatering orifice to cleanout level = 0.50 ft. Minimum Dewatering Orifice elev = **13.20**
   (Min. = 1.0 ft.) Provided Dewatering Orifice elev = **13.20**

6a. Total Provided Wet Storage
   Volume at Elevation 13.20 721 cu. yds. = 19,462 cu. ft

Dry Storage:

7. Minimum required volume = 67 cu. Yds. X Total Drainage Area (acres).
   67.00 cu.yds. x 9.76 acres = 654 cu. yds. = 17,656 cu. ft.

   Total required volume = 134 cu. Yds X Total Drainage Area (acres)
   134.00 cu.yds. x 9.76 acres = 1,308 cu. yds. = 35,312 cu. ft.

   Total provided Volume
   (Wet Storage + Dry Storage) 1,375 cu. yds. = 37,118 cu. ft.

8. Total available basin volume at crest of riser* = 1,654 cu. yds. at elevation 14.20
   Elevation rounded up to: 14.20 = 1,654 cu. yds. at elevation **14.20**
   (for constructability)

9. Diameter of dewatering orifice A = 0.06
   d = 3.35 inches (3" min.)
10. Diameter of flexible tubing = 6.00 in. (diameter of dewatering orifice plus 2 inches minimum).

Basin Shape

12. Length of Flow L = 2.00 = 2.00
    Effective Width We 1.00

    If > 2, baffles are not required Yes
    If < 2, baffles are required

Runoff

13. Q_2 = 19.22 cfs (From HydroCAD model)
14. Q_{25} = 46.71 cfs (From HydroCAD model)

Principal Spillway Design

15. With emergency spillway, required spillway capacity $Q_p = Q_2$ = 19.22 cfs.
(riser and barrel)

Without emergency spillway, required spillway capacity $Q_p = Q_{25}$ = 46.71 cfs.
(riser and barrel)

16. With emergency spillway:
Assume available head (h) = 0.80 ft. (Using Q_2)
h = Crest of Emergency Spillway Elevation - Crest of Riser Elevation

Without emergency spillway:
Assume available head (h) = 1.30 ft. (Using Q_{25})
h = Design High Water Elevation - Crest of Riser Elevation

17. Riser diameter (D_r) = 120.0 in.
Note: Riser Modeled with HydroCAD

18. Barrel length (l) = 115.00 ft.
Head (H) on barrel through embankment = 2.70 ft.
Note: (3) 15" RCP

19. Barrel diameter = 15.0 in.
Note: (3) 15" RCP

20. Trash rack and anti-vortex device
Diameter = 54.0
Height = 17.0
(From Table 3.14-D).

Emergency Spillway Design (N/A)

21. Required spillway capacity $Q_e = Q_{25} - Q_p$ = 27.49 cfs.

22. Bottom width (b) = 100.00 ft.; the slope of the exit channel (s) = 0.02 ft./foot
and the minimum length of the exit channel (x) = 20.00 ft.
(From LAP / UAP Design).

Anti-Seep Collar Design (N\A)

23. Depth of water at principal spillway crest (Y) = 2.70 ft.
Slope of upstream face of embankment (Z) = 5.00
Slope of principal spillway barrel (S_b) = 0.005
Length of barrel in saturated zone (L_s) = 24.80 ft.

24. Number of collars required = 1.00 dimensions = 7.5' W x 4' H
(From Plate 3.14-12).

Final Design Elevations

25.

Top of Dam =	16.00
Design High Water =	15.50
Emergency Spillway Crest =	15.00
Principal Spillway Crest =	14.20
Dewatering Orifice Invert =	13.20
Cleanout Elevation =	12.70
Elevation of Upstream Toe of Dam or Excavated Bottom of "Wet Storage Area" (if excavation was performed) =	11.50

Principal Spillway Anchoring

(From Plate 3.14-14 for Embankments Less than 10' High)

Concrete Base:
Diameter ($2D_r$) = 2.50 ft
Depth (bgs) = 1.50 ft

1/4" Steel Base:

Diameter ($2D_r$) = 2.50 ft

Depth (bgs) = 2.50 ft

Temporary Basin Design Data Sheet
(with or without an emergency spillway)

Project Chesterfield LAP
Basin # E3 Location 36" RCP
Total area draining to basin: 15.64 acres.

Basin Volume Design

Wet Storage:

1. Minimum required volume = 67 cu. yds. x Total Drainage Area (acres).
   67.00 cu.yds. x 15.64 acres = 1,048 cu. yds. = 28,293 cu. ft

2. Available basin volume = 1,062 cu. yds. at elevation 12.40
   (From storage - elevation curve) * Below dewatering orifice

3. Excavate 0 cu. yds. to obtain required volume*.
   *Elevation corresponding to required volume = invert of the dewatering orifice.

4. Available volume before cleanout required.
   33.00 cu.yds. x 15.64 acres = 516 cu. yds. = 13,935 cu. ft

5. Elevation corresponding to cleanout level = 12.00
   (From storage - Elevation Curve)

6. Distance from invert of the dewatering orifice to cleanout level = 1.00 ft. Minimum Dewatering Orifice elev = **13.00**
   (Min. = 1.0 ft.) Provided Dewatering Orifice elev = **13.00**

6a. Total Provided Wet Storage
   Volume at Elevation 13.00 1,716 cu. yds. = 46,335 cu. ft

Dry Storage:

7. Minimum required volume = 67 cu. Yds. X Total Drainage Area (acres).
   67.00 cu.yds. x 15.64 acres = 1,048 cu. yds. = 28,293 cu. ft.

   Total required volume = 134 cu. Yds X Total Drainage Area (acres)
   134.00 cu.yds. x 15.64 acres = 2,096 cu. yds. = 56,586 cu. ft.

   Total provided Volume
   (Wet Storage + Dry Storage) 2,764 cu. yds. = 74,628 cu. ft.

8. Total available basin volume at crest of riser* = 3,028 cu. yds. at elevation 14.00
   Elevation rounded up to: 14.00 = 3,028 cu. yds. at elevation **14.00**
   (for constructability)

9. Diameter of dewatering orifice A = 0.10
   d = 4.24 inches (3" min.)
10. Diameter of flexible tubing = 8.00 in. (diameter of dewatering orifice plus 2 inches minimum).

Basin Shape

12. Length of Flow L = 2.00 = 2.00
    Effective Width We 1.00

    If > 2, baffles are not required Yes
    If < 2, baffles are required

Runoff

13. Q_2 = 30.92 cfs (From HydroCAD model)
14. Q_{25} = 76.25 cfs (From HydroCAD model)

Principal Spillway Design

15. With emergency spillway, required spillway capacity $Q_p = Q_2$ = 30.92 cfs.
(riser and barrel)

Without emergency spillway, required spillway capacity $Q_p = Q_{25}$ = 76.25 cfs.
(riser and barrel)

16. With emergency spillway:
Assume available head (h) = 1.00 ft. (Using Q_2)
h = Crest of Emergency Spillway Elevation - Crest of Riser Elevation

Without emergency spillway:
Assume available head (h) = 1.50 ft. (Using Q_{25})
h = Design High Water Elevation - Crest of Riser Elevation

17. Riser diameter (D_r) = 36.0 in.
Note: Riser Modeled with HydroCAD

18. Barrel length (l) = 100.00 ft.
Head (H) on barrel through embankment = 2.80 ft.
Note: 36" RCP

19. Barrel diameter = 36.0 in.
Note: 36" RCP

20. Trash rack and anti-vortex device
Diameter = 54.0
Height = 17.0
(From Table 3.14-D).

Emergency Spillway Design (N/A)

21. Required spillway capacity $Q_e = Q_{25} - Q_p$ = 45.33 cfs.

22. Bottom width (b) = 100.00 ft.; the slope of the exit channel (s) = 0.02 ft./foot
and the minimum length of the exit channel (x) = 20.00 ft.
(From LAP / UAP Design).

Anti-Seep Collar Design (N\A)

23. Depth of water at principal spillway crest (Y) = 2.80 ft.
Slope of upstream face of embankment (Z) = 5.00
Slope of principal spillway barrel (S_b) = 0.005
Length of barrel in saturated zone (L_s) = 25.71 ft.

24. Number of collars required = 2 dimensions = 4.25' x 4.25'
(From Plate 3.14-12).

Final Design Elevations

25. Top of Dam = 16.00
Design High Water = 15.50
Emergency Spillway Crest = 15.00
Principal Spillway Crest = 14.00
Dewatering Orifice Invert = 13.00
Cleanout Elevation = 12.50
Elevation of Upstream Toe of Dam or Excavated Bottom of "Wet Storage Area" (if excavation was performed) = 11.20

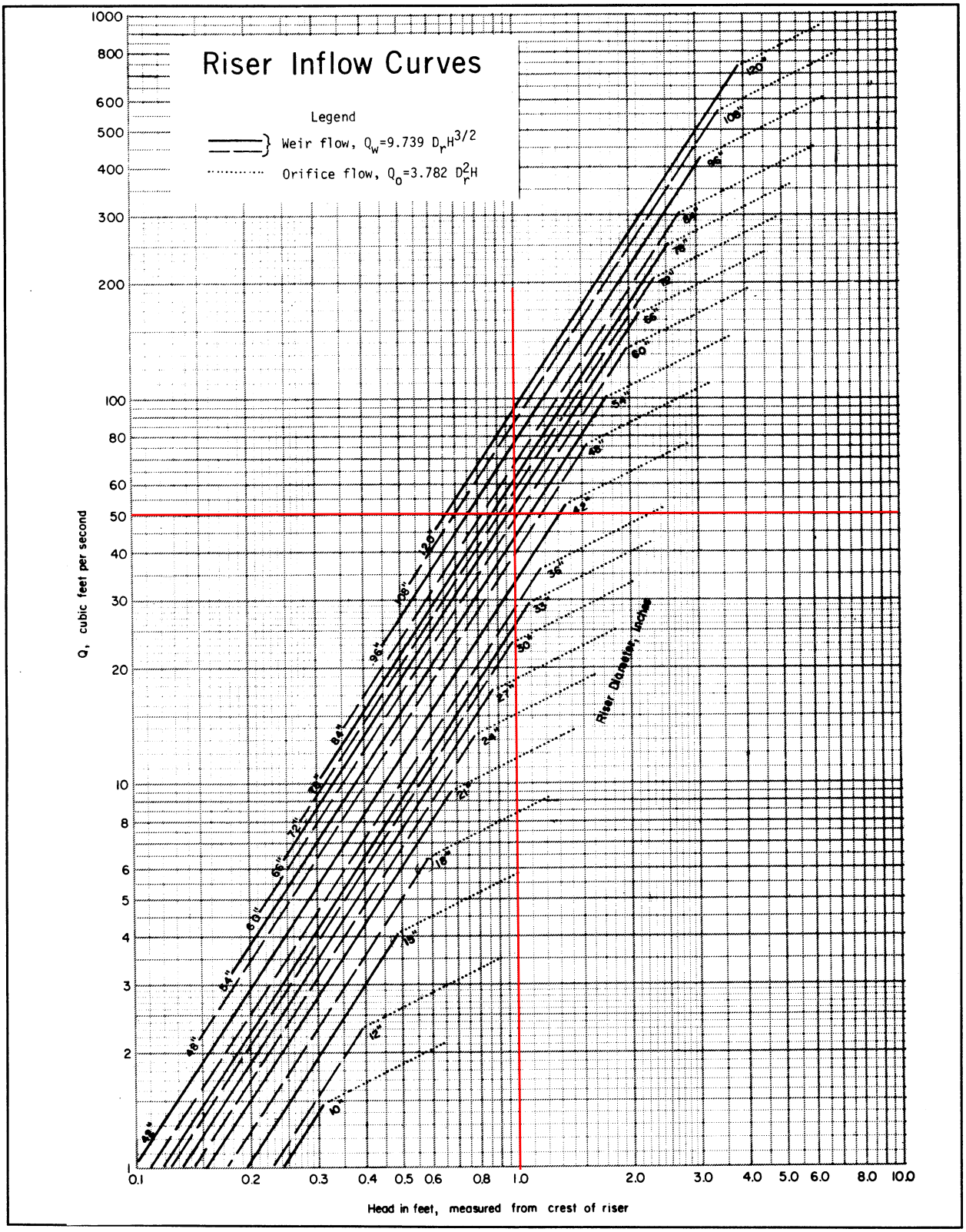
Principal Spillway Anchoring

(From Plate 3.14-14 for Embankments Less than 10' High)

Concrete Base:
Diameter ($2D_r$) = 6.00 ft
Depth (bgs) = 1.50 ft

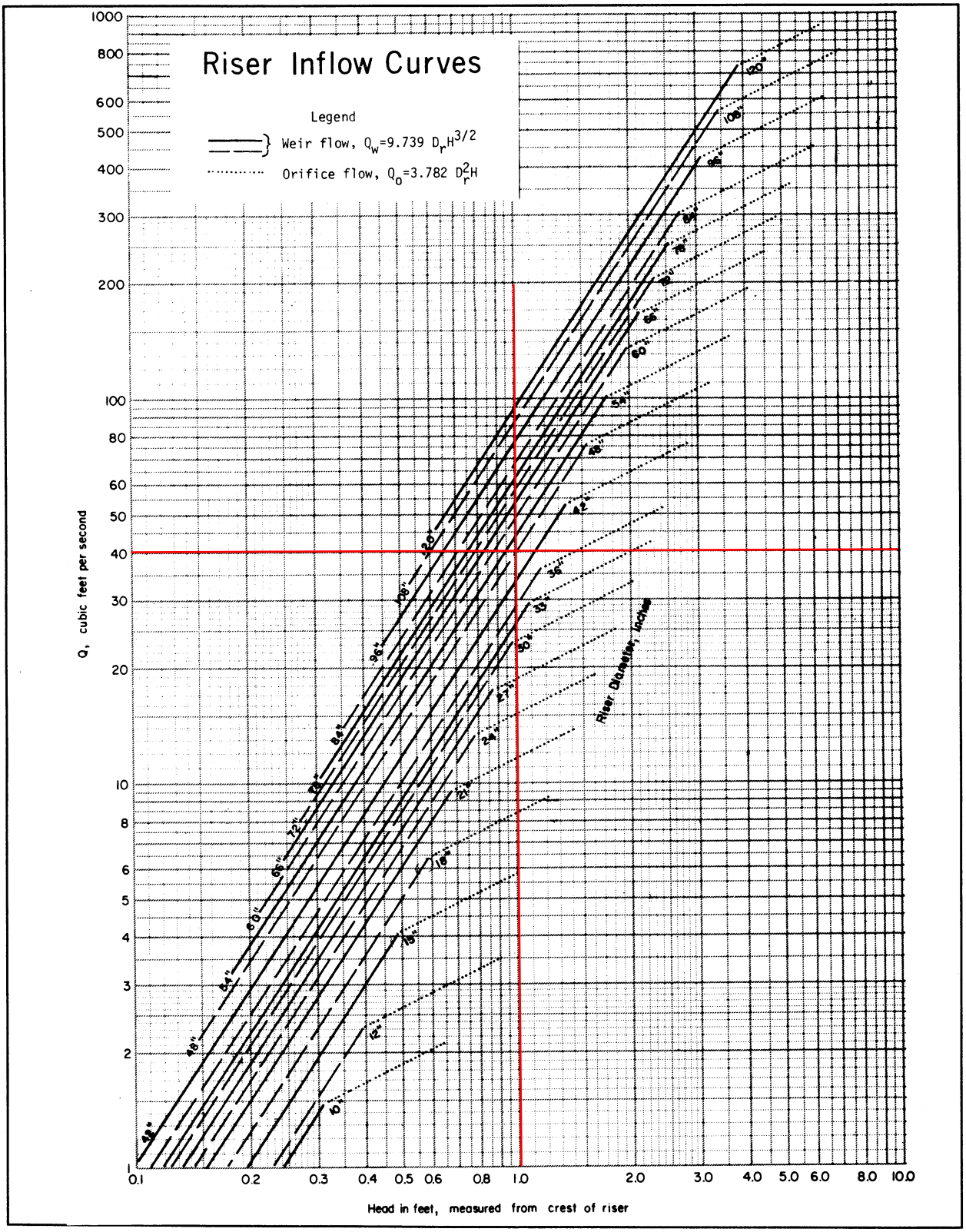
1/4" Steel Base:

Diameter ($2D_r$) =	6.00	ft
Depth (bgs) =	2.50	ft



Source: USDA-SCS Plate 3.14-8

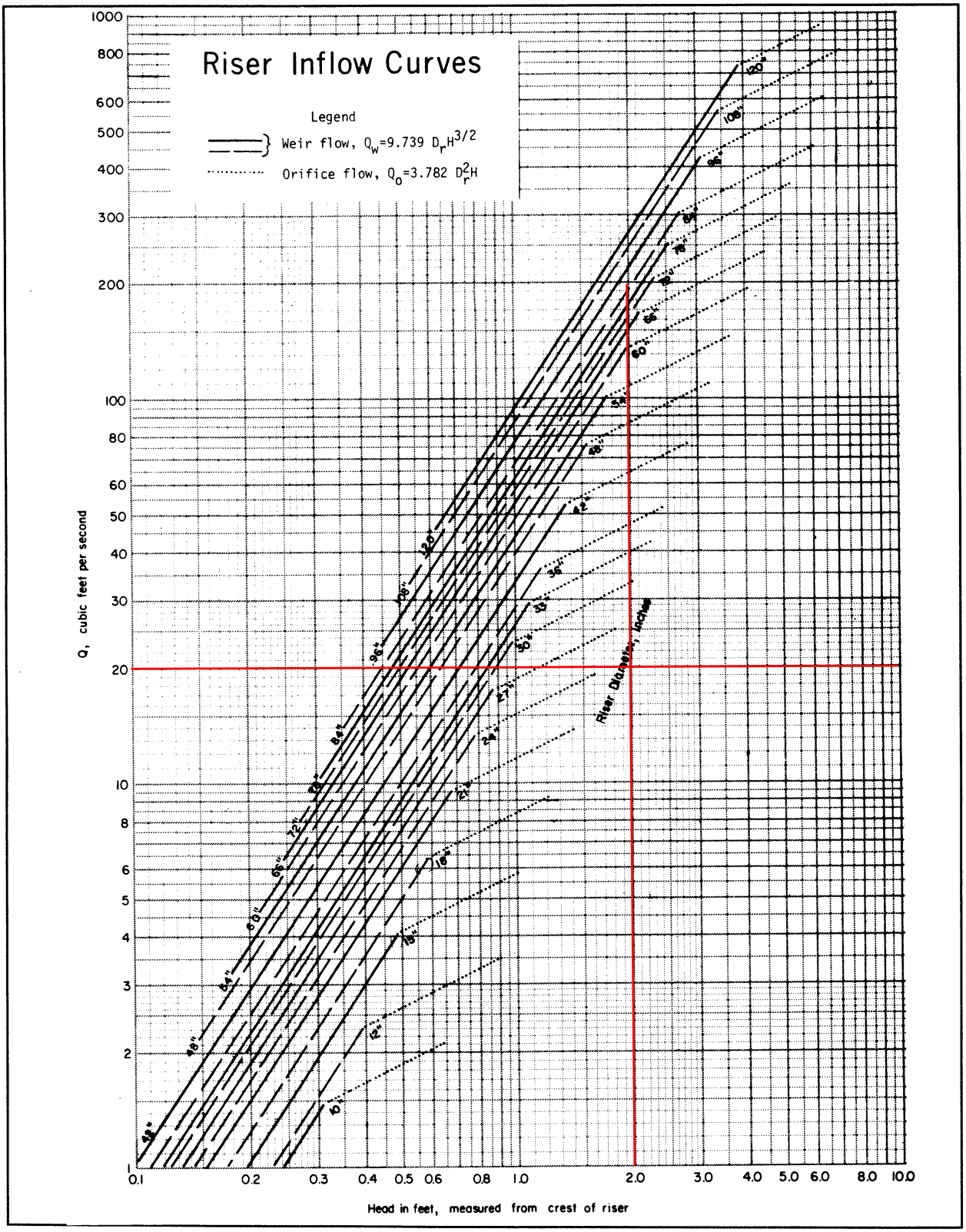
Outlet W2 - 48" RCP



Source: USDA-SCS

Plate 3.14-8

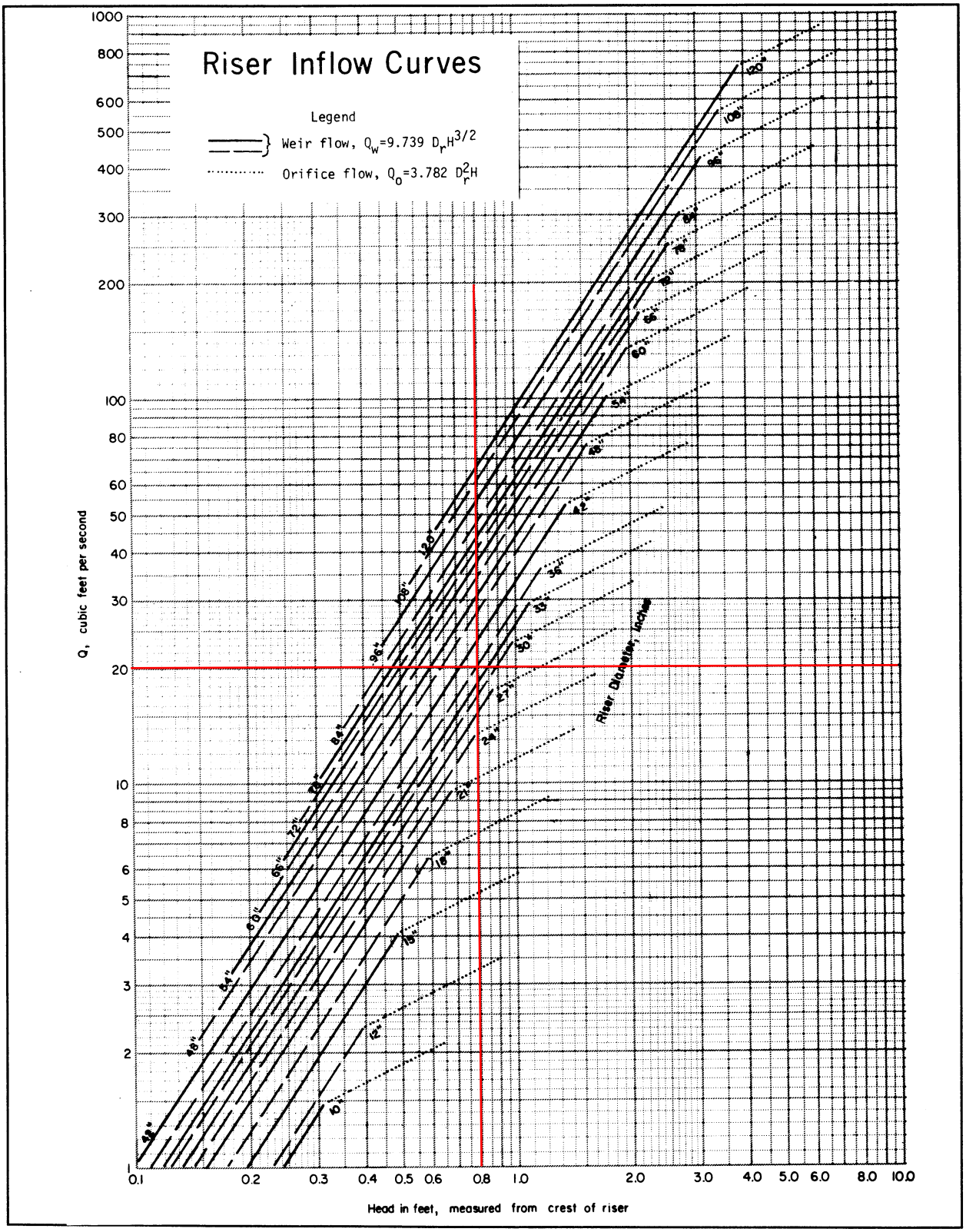
Outlet E1 - 36" RCP



Source: USDA-SCS

Plate 3.14-8

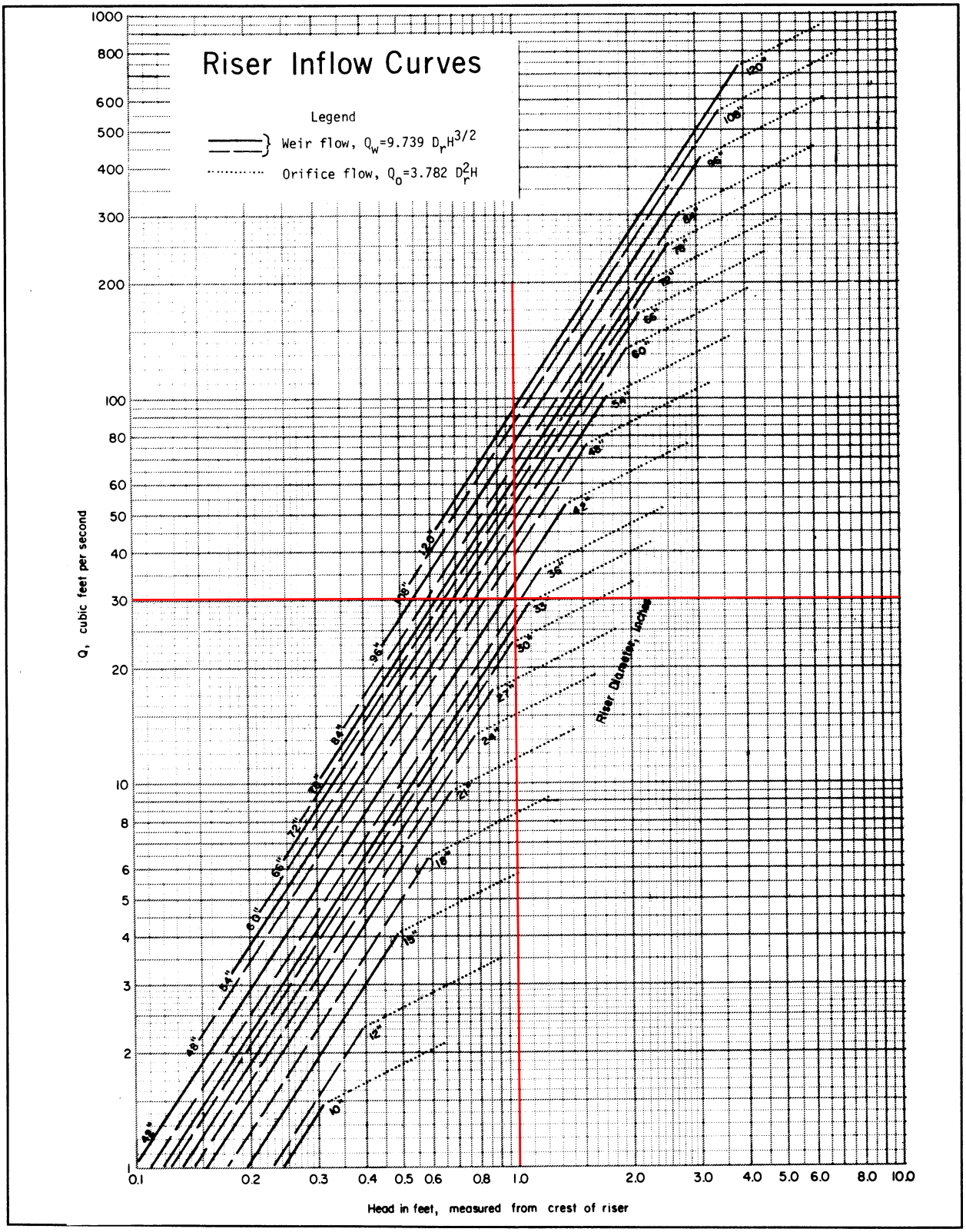
Outlet E2 - (3) 15" RCP



Source: USDA-SCS

Plate 3.14-8

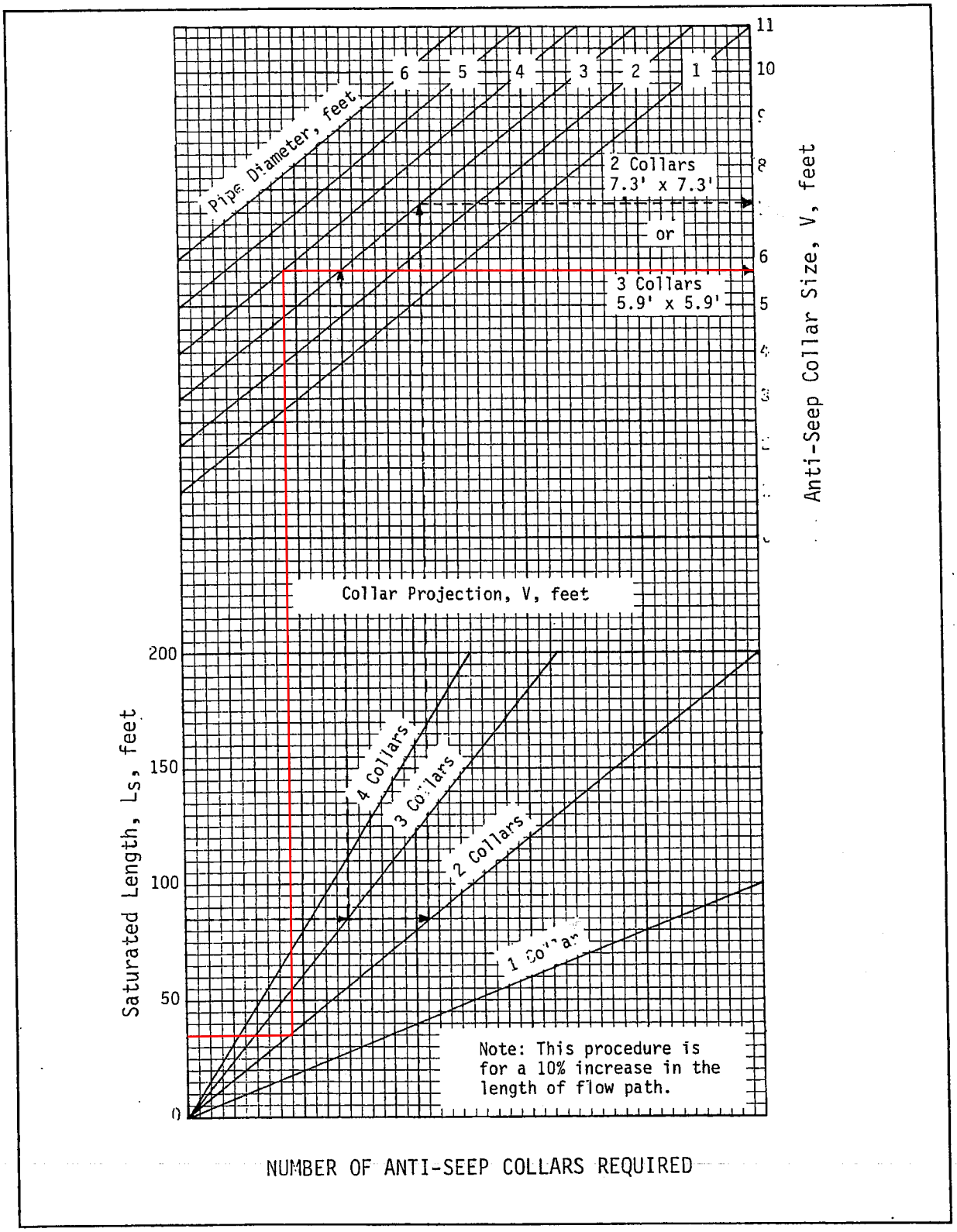
Outlet E3 - 36" RCP



Source: USDA-SCS

Plate 3.14-8

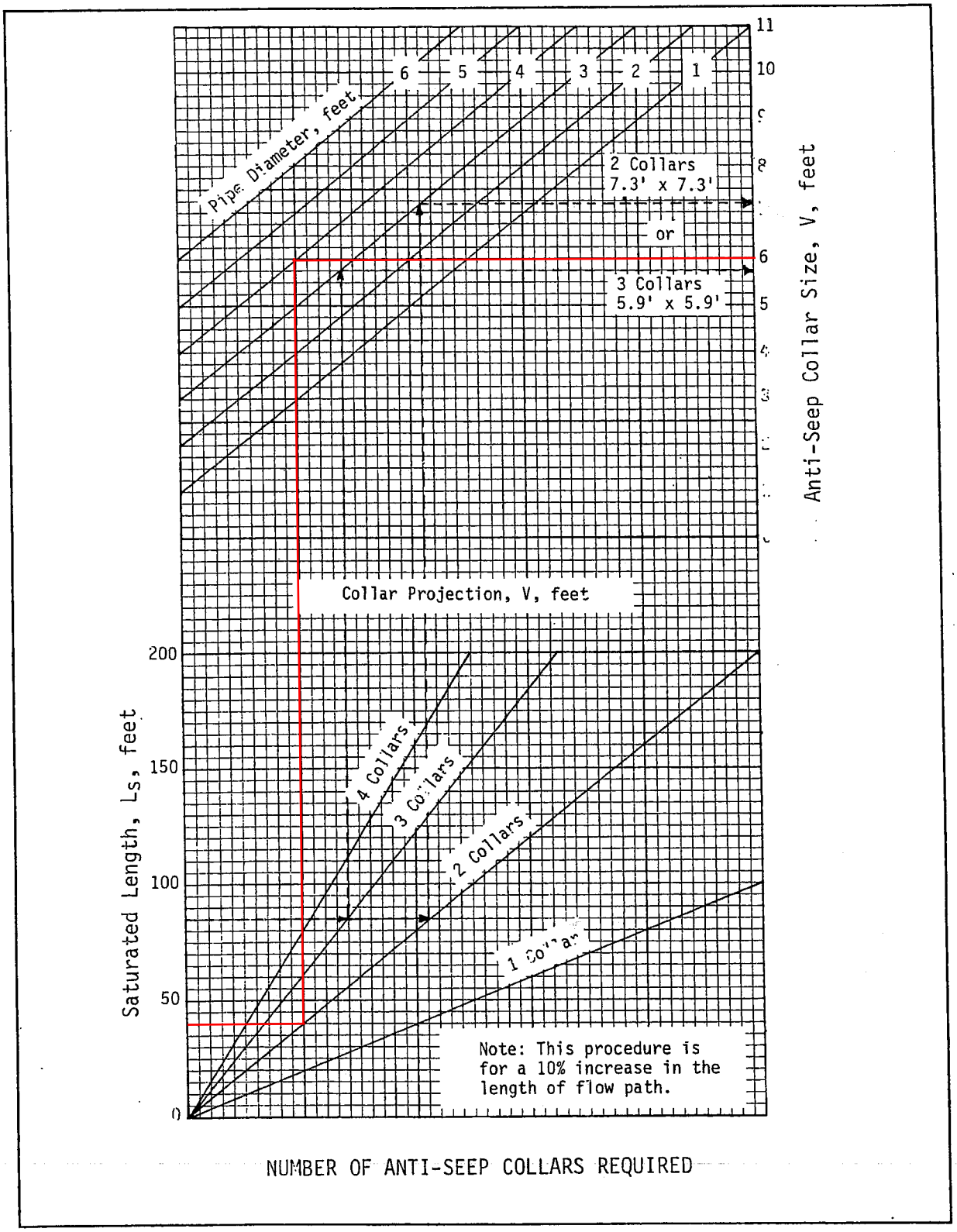
Outlet W1 - 48" RCP



Source: USDA-SCS

Plate 3.14-12

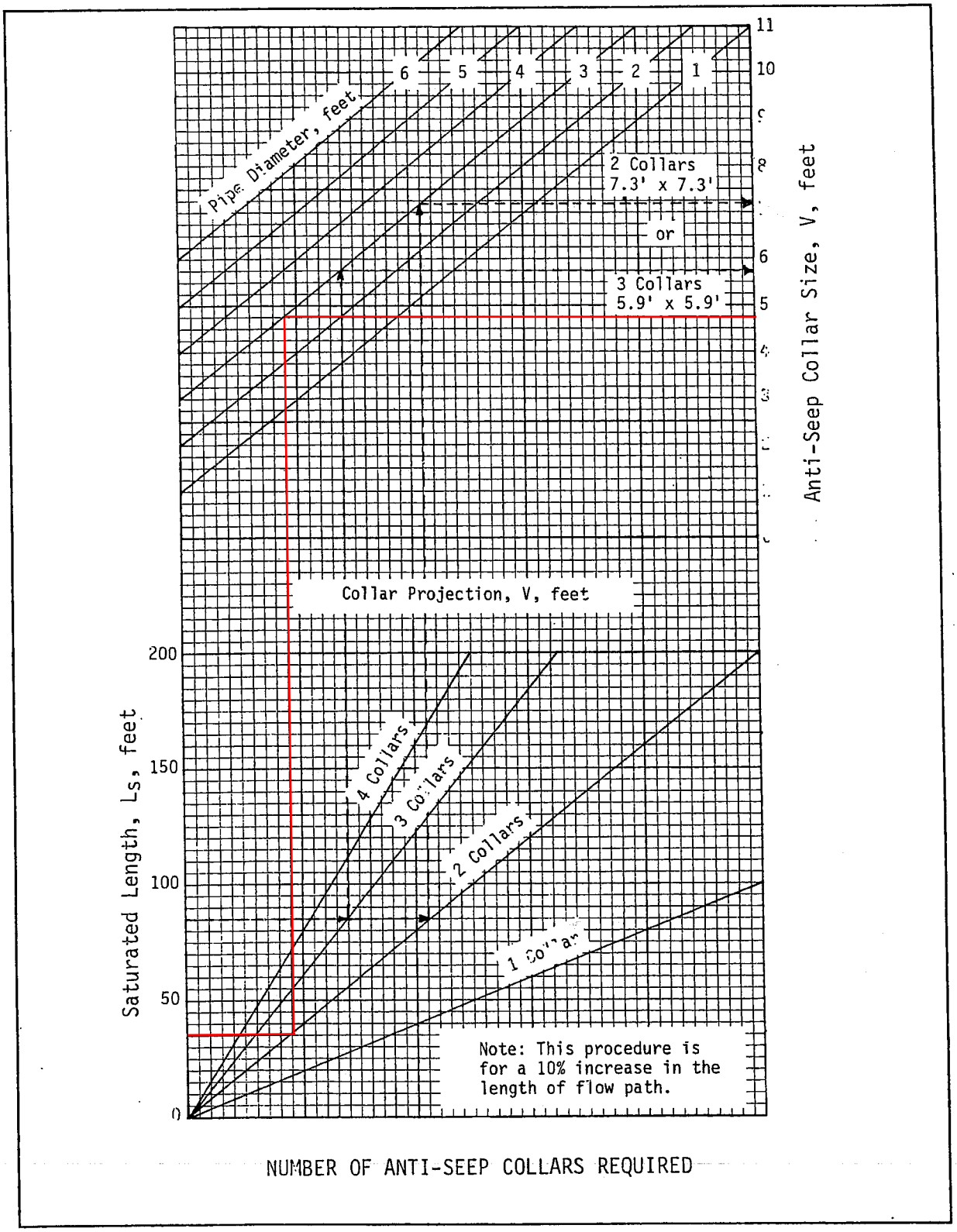
Outlet W2 - 48" RCP



Source: USDA-SCS

Plate 3.14-12

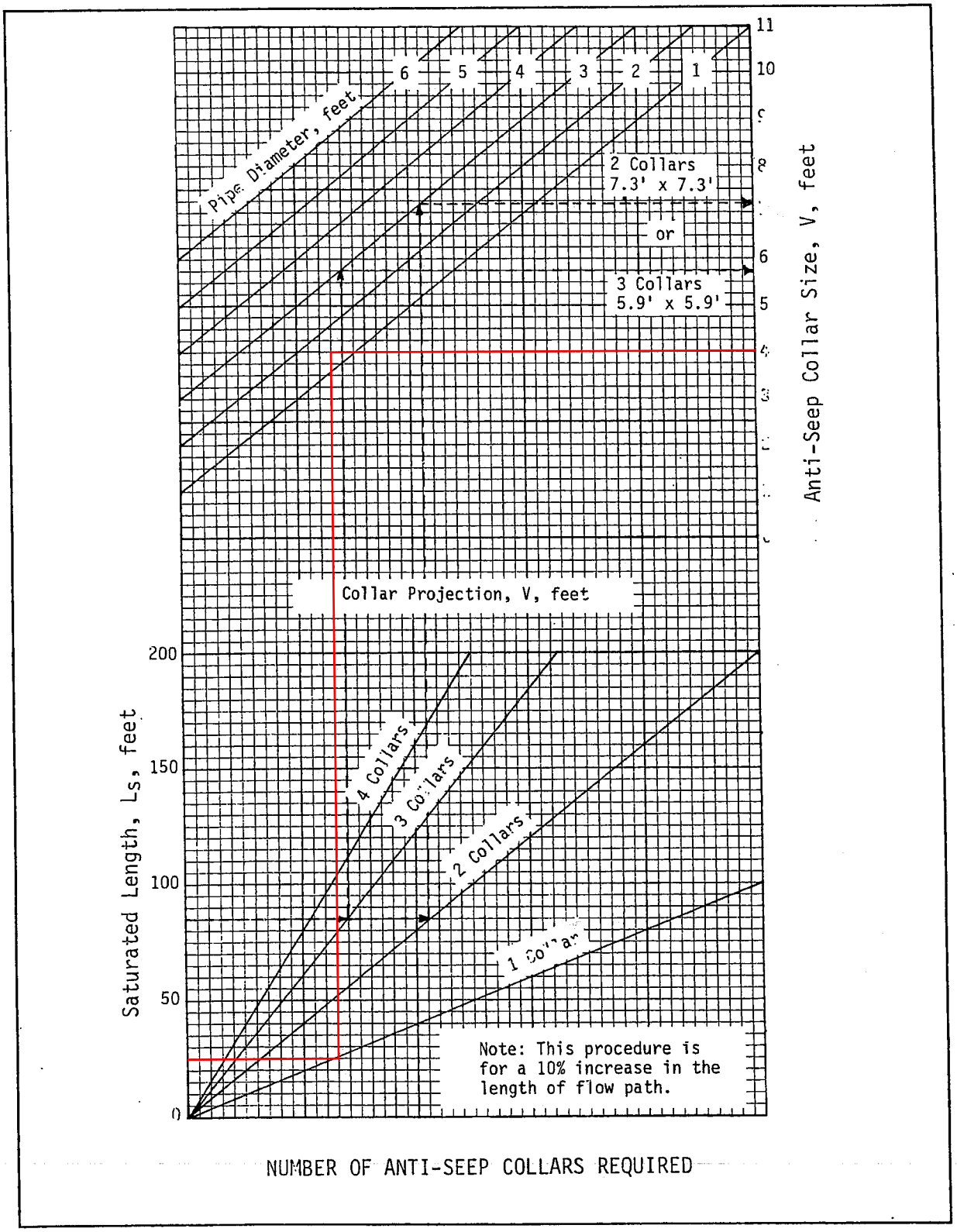
Outlet E1 - 36" RCP



Source: USDA-SCS

Plate 3.14-12

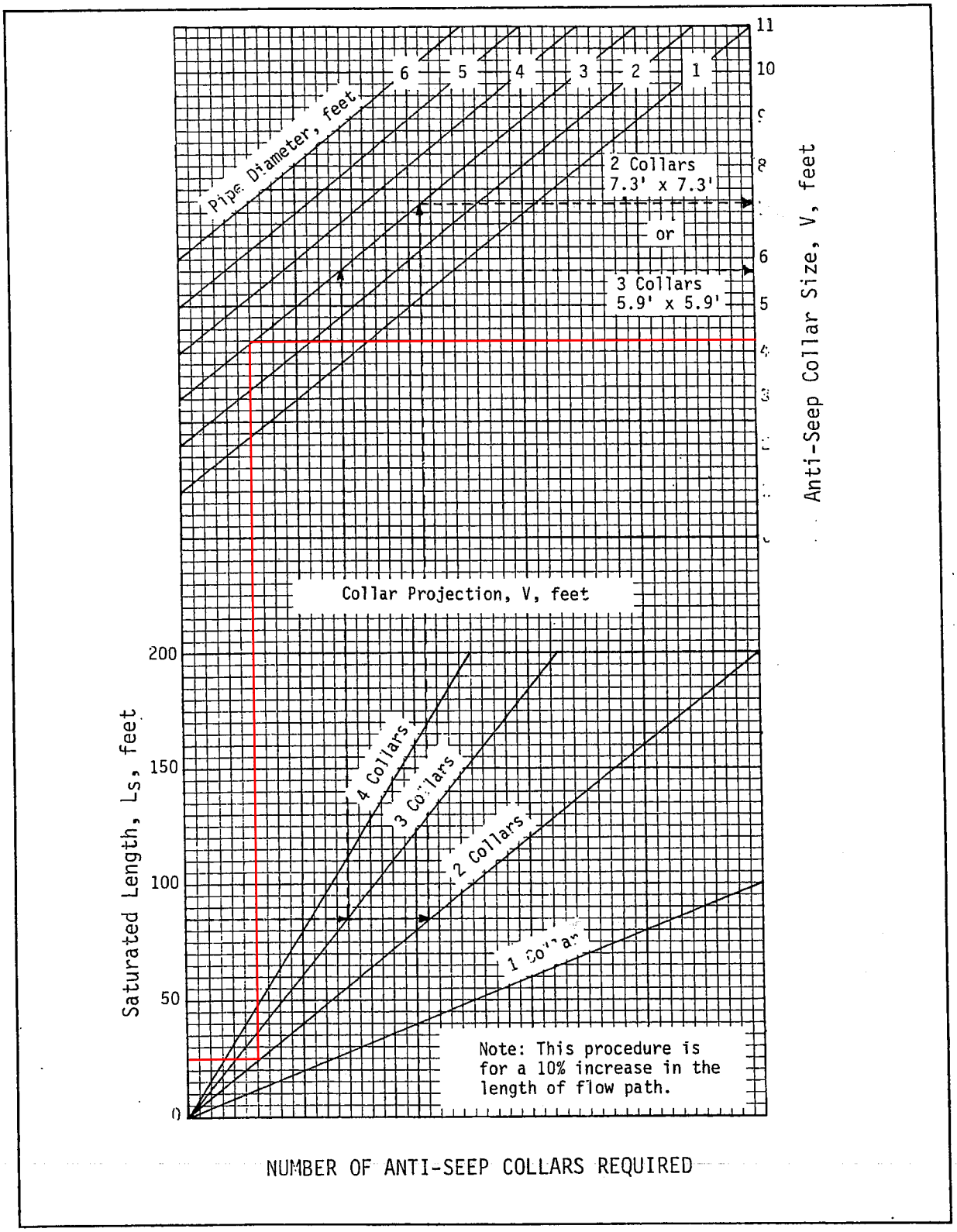
Outlet E2 - (3) 15" RCP



Source: USDA-SCS

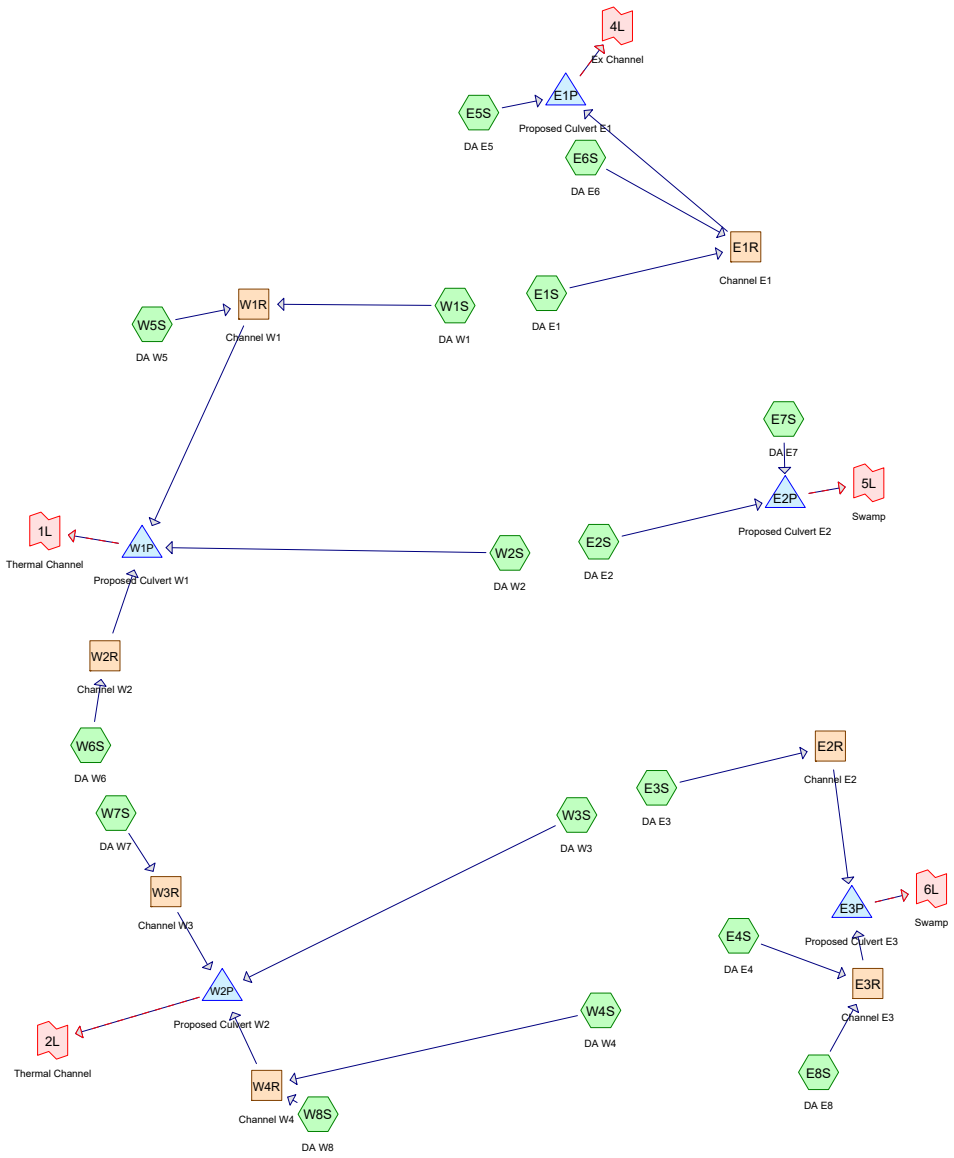
Plate 3.14-12

Outlet E3 - 36" RCP



Source: USDA-SCS

Plate 3.14-12



Subcat Reach Pond Link

Routing Diagram for Chesterfield LAP - Sed Basin Calcs Rev3
Prepared by AECOM, Printed 4/16/2020
HydroCAD® 10.00-12 s/n 00537 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
107.250	84	50-75% Grass cover, Fair, HSG D (E1S, E2S, E3S, E4S, E5S, E6S, E7S, E8S, W1S, W2S, W3S, W4S, W5S, W6S, W7S, W8S)
107.250	**84**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
107.250	HSG D	E1S, E2S, E3S, E4S, E5S, E6S, E7S, E8S, W1S, W2S, W3S, W4S, W5S, W6S, W7S, W8S
0.000	Other	
107.250		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	107.250	0.000	107.250	50-75% Grass cover, Fair	E1S, E2S, E3S, E4S, E5S, E6S, E7S, E8S, W1S, W2S, W3S, W4S, W5S, W6S, W7S, W8S
0.000	**0.000**	**0.000**	**107.250**	**0.000**	**107.250**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	E1P	9.30	8.70	120.0	0.0050	0.013	36.0	0.0	0.0
2	E2P	4.60	4.00	115.0	0.0052	0.013	15.0	0.0	0.0
3	E3P	5.55	5.00	100.0	0.0055	0.013	36.0	0.0	0.0
4	W1P	6.30	5.20	110.0	0.0100	0.013	48.0	0.0	0.0
5	W2P	6.00	5.00	105.0	0.0095	0.013	48.0	0.0	0.0

Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Pond E1P: Proposed Culvert E1 Peak Elev=10.90' Storage=16,749 cf Inflow=19.77 cfs 1.617 af
Primary=13.26 cfs 1.593 af Secondary=0.00 cfs 0.000 af Outflow=13.26 cfs 1.593 af

Pond E2P: Proposed Culvert E2 Peak Elev=12.59' Storage=7,623 cf Inflow=19.22 cfs 1.478 af
Primary=14.61 cfs 1.478 af Secondary=0.00 cfs 0.000 af Outflow=14.61 cfs 1.478 af

Pond E3P: Proposed Culvert E3 Peak Elev=12.36' Storage=27,671 cf Inflow=30.92 cfs 2.368 af
Primary=16.12 cfs 2.368 af Secondary=0.00 cfs 0.000 af Outflow=16.12 cfs 2.368 af

Pond W1P: Proposed Culvert W1 Peak Elev=8.29' Storage=62,435 cf Inflow=47.33 cfs 5.956 af
Primary=29.11 cfs 5.941 af Secondary=0.00 cfs 0.000 af Outflow=29.11 cfs 5.941 af

Pond W2P: Proposed Culvert W2 Peak Elev=7.65' Storage=65,012 cf Inflow=38.04 cfs 4.822 af
Primary=20.68 cfs 4.776 af Secondary=0.00 cfs 0.000 af Outflow=20.68 cfs 4.776 af

Summary for Pond E1P: Proposed Culvert E1

[62] Hint: Exceeded Reach E1R OUTLET depth by 1.23' @ 12.37 hrs

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 19.77 cfs @ 12.12 hrs, Volume= 1.617 af
Outflow = 13.26 cfs @ 12.30 hrs, Volume= 1.593 af, Atten= 33%, Lag= 10.8 min
Primary = 13.26 cfs @ 12.30 hrs, Volume= 1.593 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 10.90' @ 12.30 hrs Surf.Area= 12,430 sf Storage= 16,749 cf

Plug-Flow detention time= 57.1 min calculated for 1.593 af (98% of inflow)
Center-of-Mass det. time= 47.8 min (890.0 - 842.1)

Volume	Invert	Avail.Storage	Storage Description
#1	9.20'	182,417 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

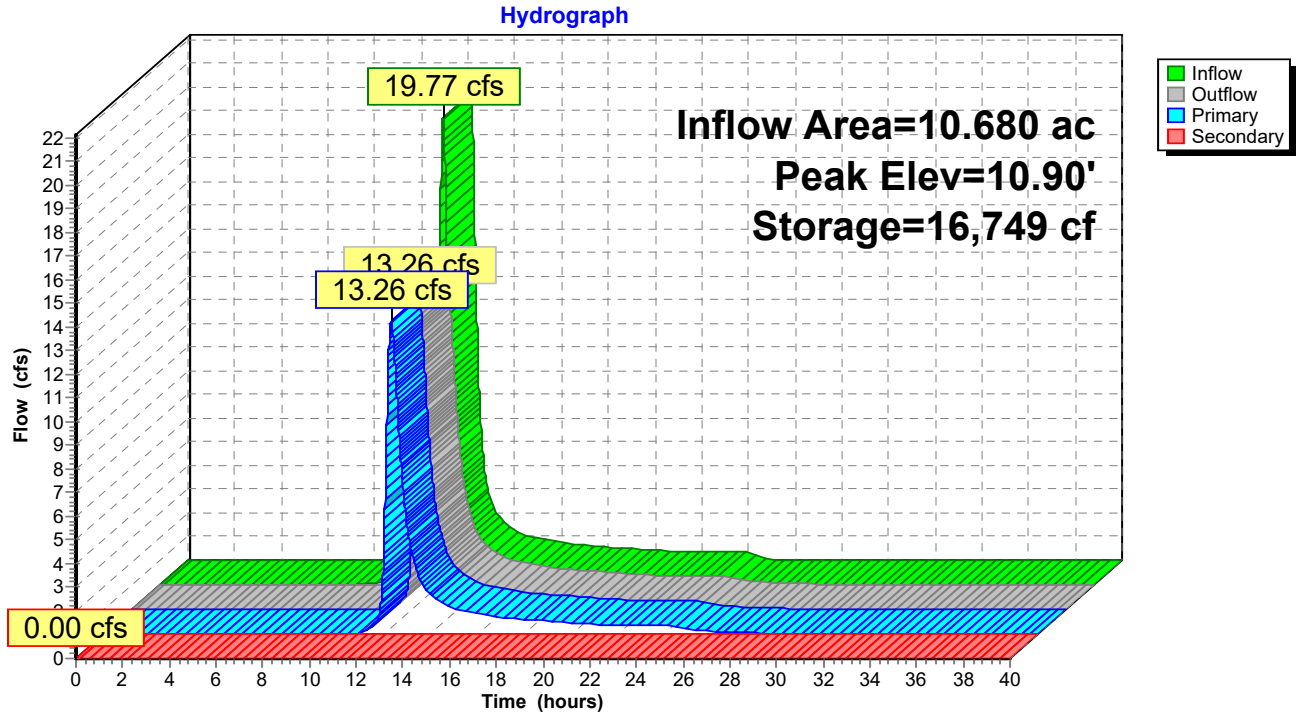
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
9.20	8,160	495.0	0	0	8,160
10.00	9,294	512.0	6,977	6,977	9,581
11.00	12,795	923.0	10,998	17,975	56,520
12.00	17,943	1,335.0	15,297	33,271	130,559
13.00	24,884	1,748.0	21,319	54,590	231,895
14.00	34,118	2,225.0	29,380	83,970	382,717
15.00	54,276	2,470.0	43,809	127,779	474,283
16.00	55,000	2,500.0	54,638	182,417	486,405

Device	Routing	Invert	Outlet Devices
#1	Primary	9.30'	**36.0" Round 36" Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.30' / 8.70' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

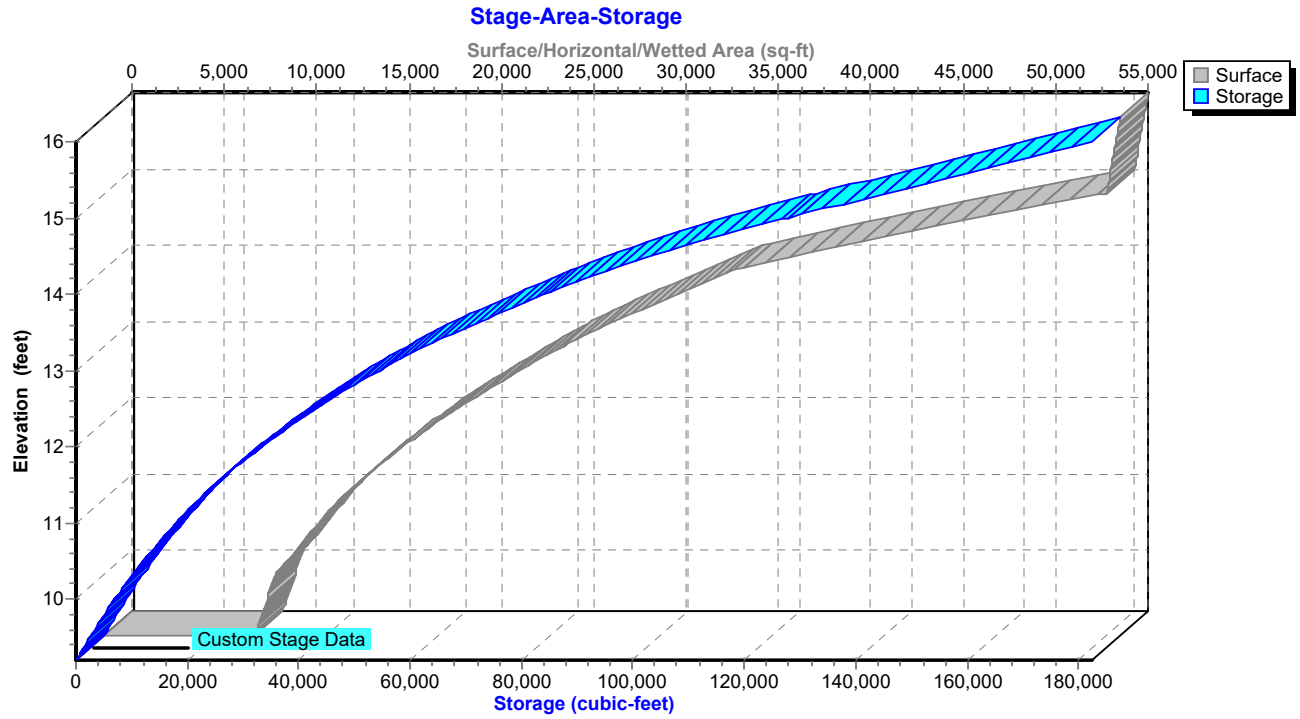
Primary OutFlow Max=13.26 cfs @ 12.30 hrs HW=10.90' TW=6.00' (Dynamic Tailwater)
↑—**1=36" Culvert** (Barrel Controls 13.26 cfs @ 5.01 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.20' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Proposed Culvert E1



Pond E1P: Proposed Culvert E1



Summary for Pond E2P: Proposed Culvert E2

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 19.22 cfs @ 12.11 hrs, Volume= 1.478 af
Outflow = 14.61 cfs @ 12.23 hrs, Volume= 1.478 af, Atten= 24%, Lag= 7.3 min
Primary = 14.61 cfs @ 12.23 hrs, Volume= 1.478 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 12.59' @ 12.23 hrs Surf.Area= 14,979 sf Storage= 7,623 cf

Plug-Flow detention time= 3.9 min calculated for 1.478 af (100% of inflow)
Center-of-Mass det. time= 3.9 min (839.8 - 835.9)

Volume	Invert	Avail.Storage	Storage Description
#1	11.50'	103,576 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

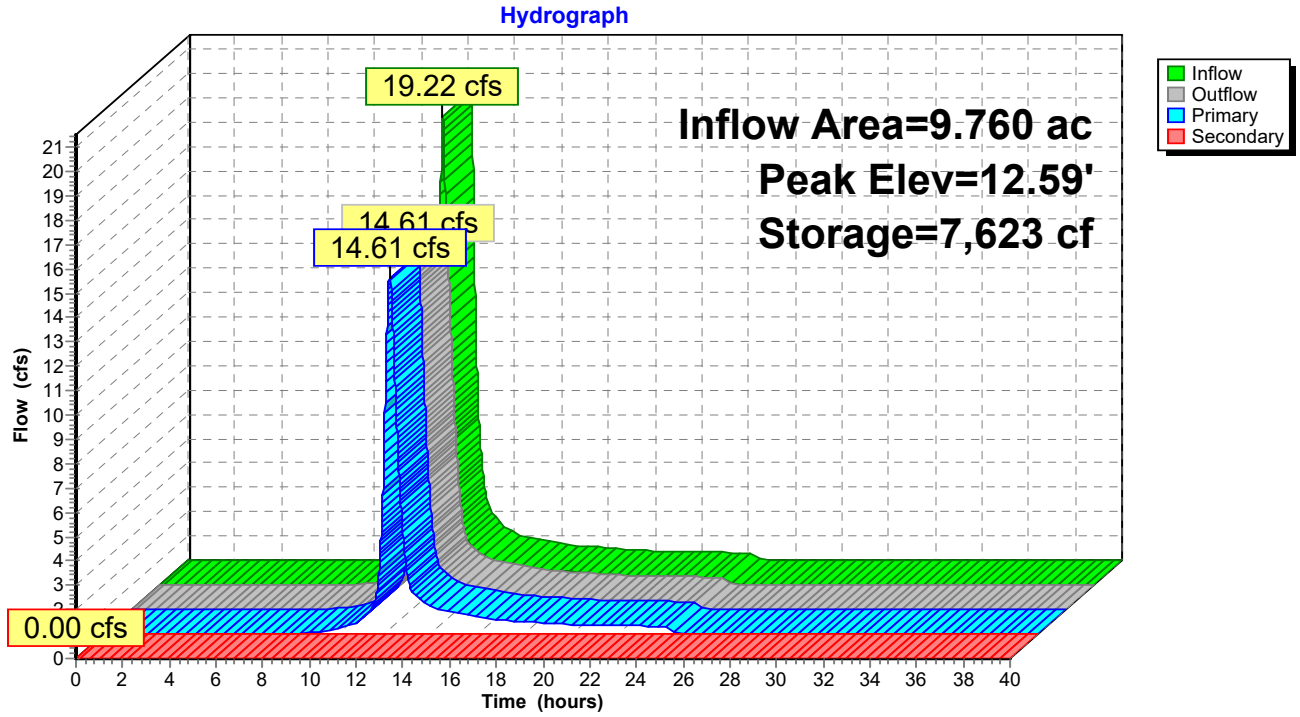
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.50	0	0.0	0	0	0
11.60	28	27.0	1	1	58
11.80	2,042	205.0	154	155	3,344
12.00	7,656	383.0	910	1,065	11,673
13.00	21,500	920.0	13,995	15,060	67,358
14.00	26,830	1,345.0	24,116	39,176	143,970
15.00	33,550	1,610.0	30,127	69,304	206,303
16.00	35,000	1,750.0	34,272	103,576	243,774

Device	Routing	Invert	Outlet Devices
#1	Primary	4.60'	**15.0" Round (3) 15" Culvert X 3.00** L= 115.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.60' / 4.00' S= 0.0052 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	11.50'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

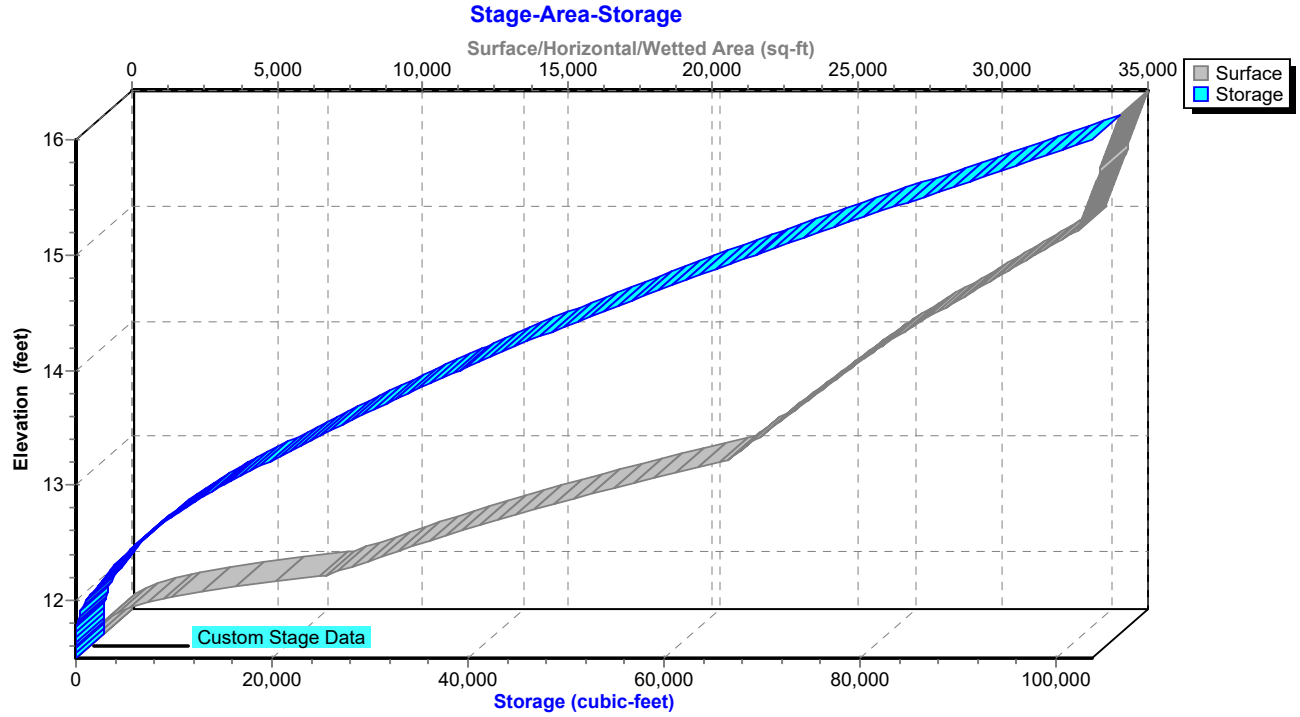
Primary OutFlow Max=14.61 cfs @ 12.23 hrs HW=12.59' TW=6.00' (Dynamic Tailwater)
↑**1=(3) 15" Culvert** (Passes 14.61 cfs of 37.09 cfs potential flow)
↑**2=Orifice/Grate** (Orifice Controls 14.61 cfs @ 3.35 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.50' TW=6.00' (Dynamic Tailwater)
↑**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E2P: Proposed Culvert E2



Pond E2P: Proposed Culvert E2



Summary for Pond E3P: Proposed Culvert E3

[62] Hint: Exceeded Reach E2R OUTLET depth by 0.81' @ 12.44 hrs
[62] Hint: Exceeded Reach E3R OUTLET depth by 0.90' @ 12.40 hrs

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 30.92 cfs @ 12.11 hrs, Volume= 2.368 af
Outflow = 16.12 cfs @ 12.34 hrs, Volume= 2.368 af, Atten= 48%, Lag= 13.3 min
Primary = 16.12 cfs @ 12.34 hrs, Volume= 2.368 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 12.36' @ 12.34 hrs Surf.Area= 27,435 sf Storage= 27,671 cf

Plug-Flow detention time= 41.4 min calculated for 2.368 af (100% of inflow)
Center-of-Mass det. time= 41.4 min (882.6 - 841.2)

Volume	Invert	Avail.Storage	Storage Description
#1	11.20'	181,215 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

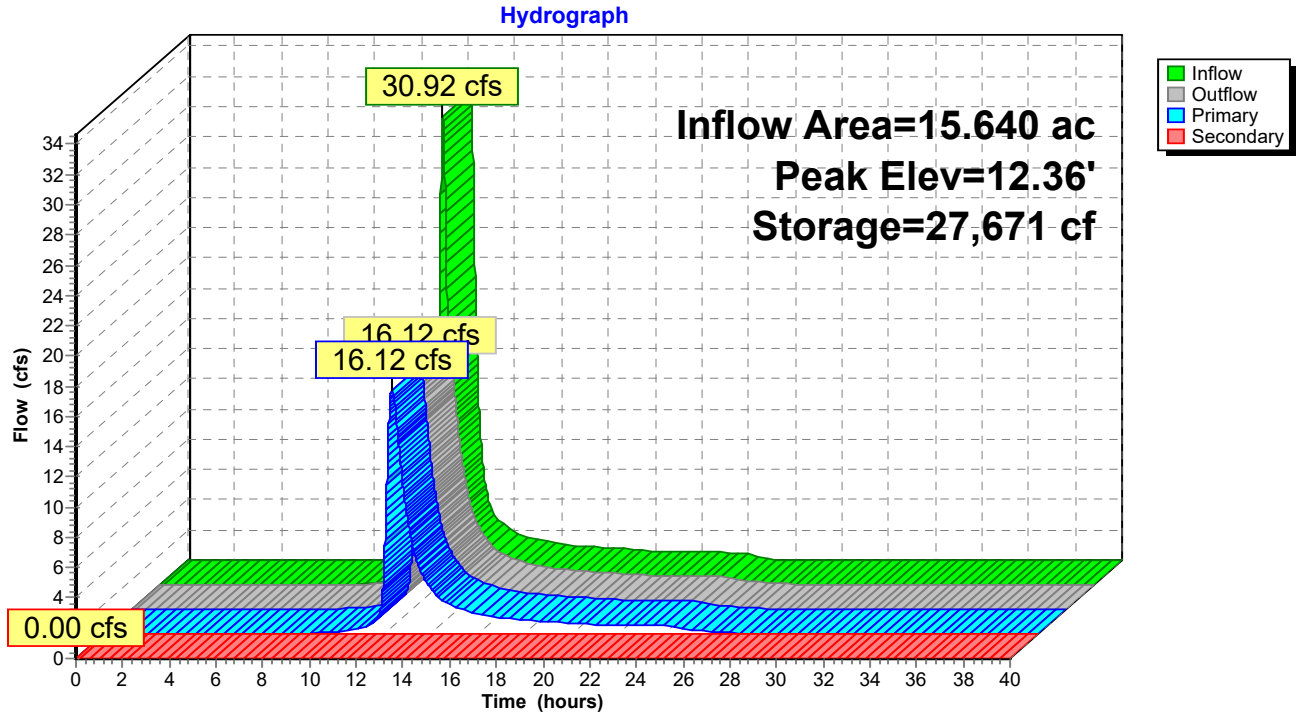
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.20	0	0.0	0	0	0
11.25	21,913	735.0	365	365	42,990
12.00	25,341	765.0	17,705	18,070	46,615
13.00	31,293	1,493.0	28,265	46,335	177,431
14.00	39,712	2,135.0	35,419	81,754	362,790
15.00	52,254	2,805.0	45,840	127,593	626,187
16.00	55,000	3,000.0	53,621	181,215	716,313

Device	Routing	Invert	Outlet Devices
#1	Primary	5.55'	**36.0" Round 36" Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.55' / 5.00' S= 0.0055 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	11.20'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

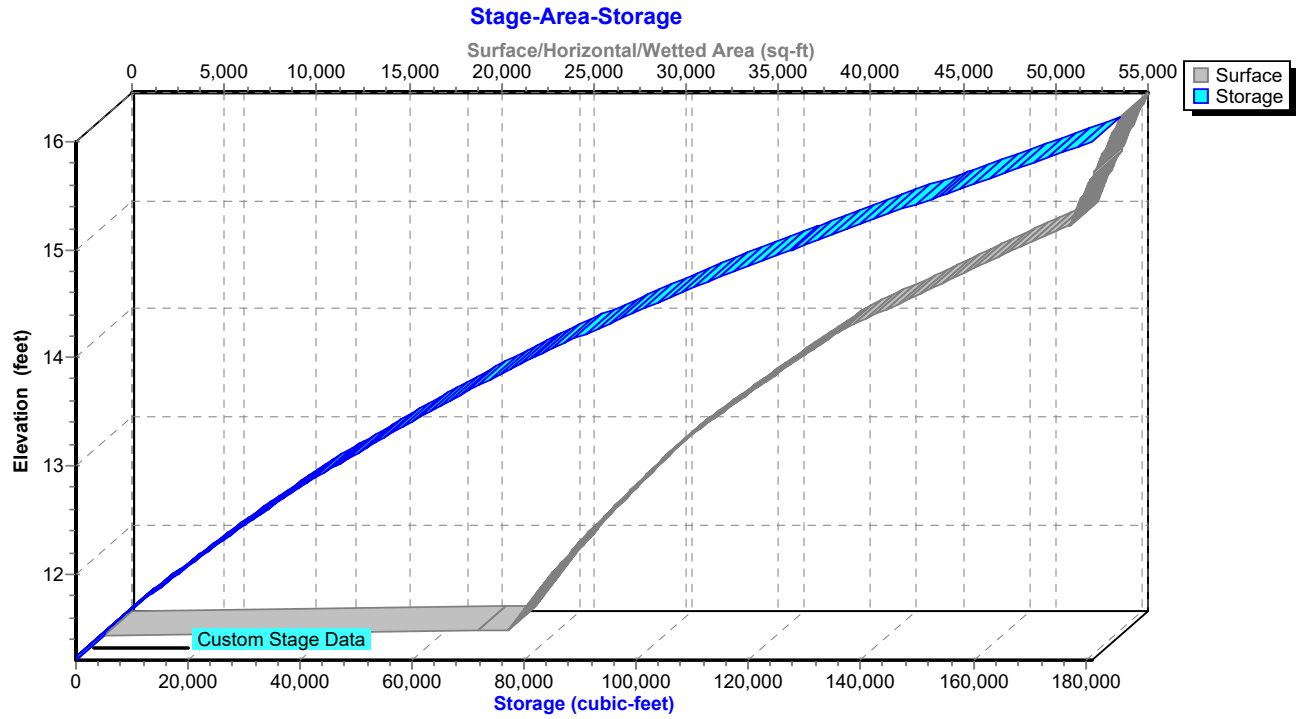
Primary OutFlow Max=16.12 cfs @ 12.34 hrs HW=12.36' TW=6.00' (Dynamic Tailwater)
↑—**1=36" Culvert** (Passes 16.12 cfs of 78.46 cfs potential flow)
↑—**2=Orifice/Grate** (Orifice Controls 16.12 cfs @ 3.46 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' TW=6.00' (Dynamic Tailwater)
↑—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E3P: Proposed Culvert E3



Pond E3P: Proposed Culvert E3



Summary for Pond W1P: Proposed Culvert W1

[62] Hint: Exceeded Reach W1R OUTLET depth by 2.16' @ 12.76 hrs
[63] Warning: Exceeded Reach W2R INLET depth by 0.39' @ 12.69 hrs

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 47.33 cfs @ 12.36 hrs, Volume= 5.956 af
Outflow = 29.11 cfs @ 12.68 hrs, Volume= 5.941 af, Atten= 38%, Lag= 19.6 min
Primary = 29.11 cfs @ 12.68 hrs, Volume= 5.941 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 8.29' @ 12.68 hrs Surf.Area= 53,657 sf Storage= 62,435 cf

Plug-Flow detention time= 40.4 min calculated for 5.939 af (100% of inflow)
Center-of-Mass det. time= 39.0 min (893.2 - 854.3)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	389,586 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

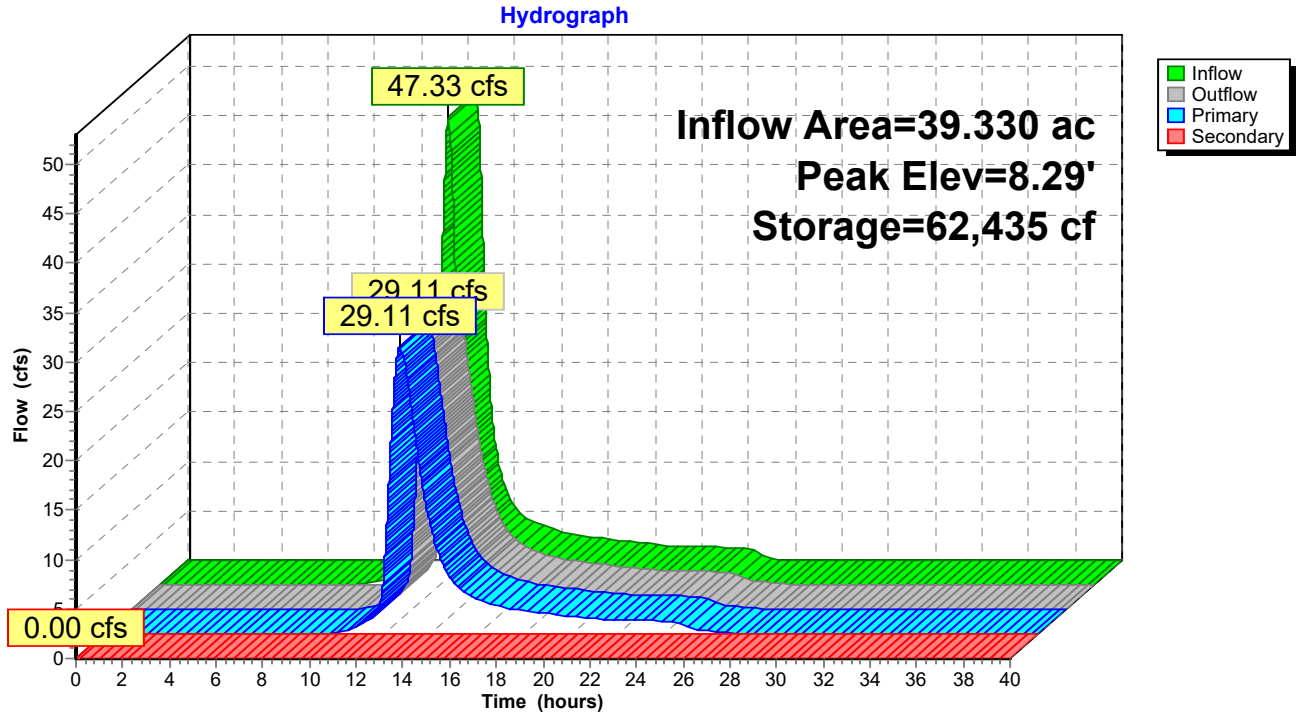
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	451	157.0	0	0	451
7.00	25,631	1,283.0	9,827	9,827	129,483
8.00	50,776	2,315.0	37,494	47,321	424,971
9.00	61,066	2,638.0	55,842	103,163	552,304
10.00	74,913	2,980.0	67,872	171,035	705,227
11.00	119,467	3,282.0	96,327	267,363	855,750
12.00	125,000	3,500.0	122,223	389,586	973,452

Device	Routing	Invert	Outlet Devices
#1	Primary	6.30'	**48.0" Round 48" Culvert** L= 110.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.30' / 5.20' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

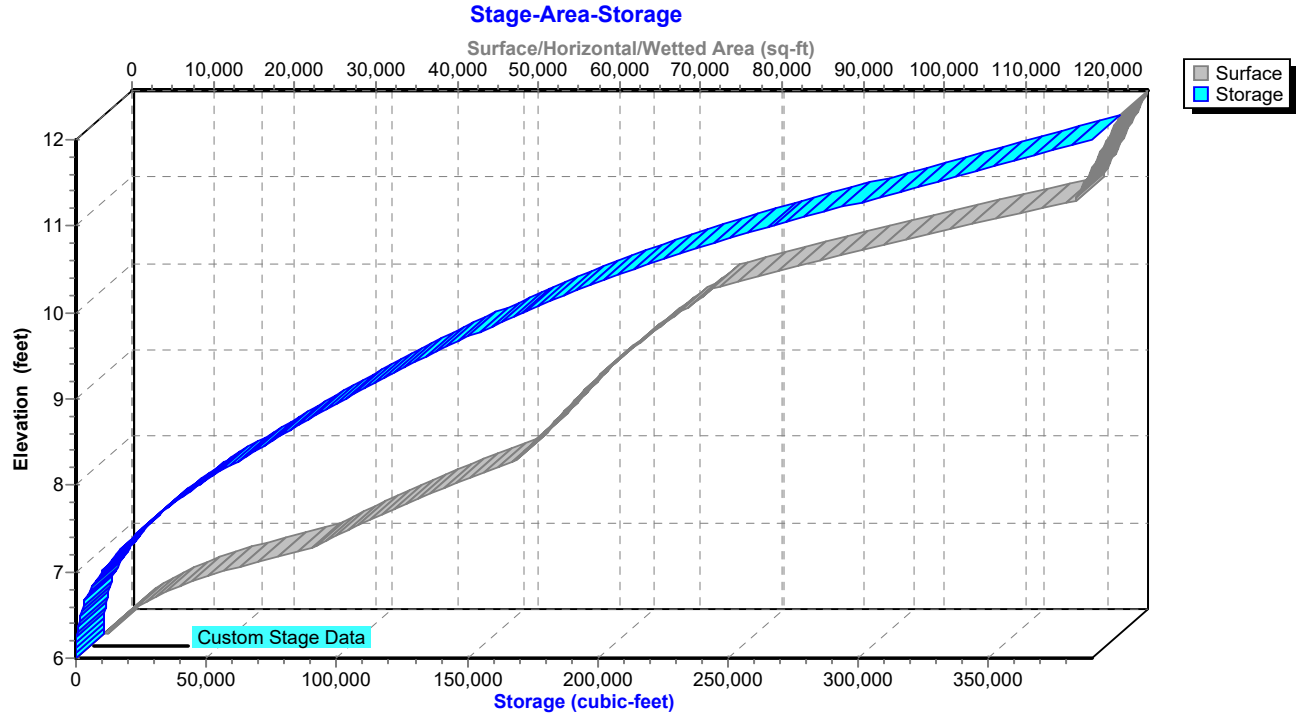
Primary OutFlow Max=29.11 cfs @ 12.68 hrs HW=8.29' TW=6.00' (Dynamic Tailwater)
1=48" Culvert (Barrel Controls 29.11 cfs @ 6.81 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=6.00' TW=6.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond W1P: Proposed Culvert W1



Pond W1P: Proposed Culvert W1



Summary for Pond W2P: Proposed Culvert W2

[62] Hint: Exceeded Reach W3R OUTLET depth by 2.02' @ 12.75 hrs
[62] Hint: Exceeded Reach W4R OUTLET depth by 1.94' @ 12.80 hrs

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2yr, 24hr event
Inflow = 38.04 cfs @ 12.37 hrs, Volume= 4.822 af
Outflow = 20.68 cfs @ 12.74 hrs, Volume= 4.776 af, Atten= 46%, Lag= 22.4 min
Primary = 20.68 cfs @ 12.74 hrs, Volume= 4.776 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 7.65' @ 12.74 hrs Surf.Area= 52,763 sf Storage= 65,012 cf

Plug-Flow detention time= 88.0 min calculated for 4.775 af (99% of inflow)
Center-of-Mass det. time= 82.4 min (936.1 - 853.7)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	411,060 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

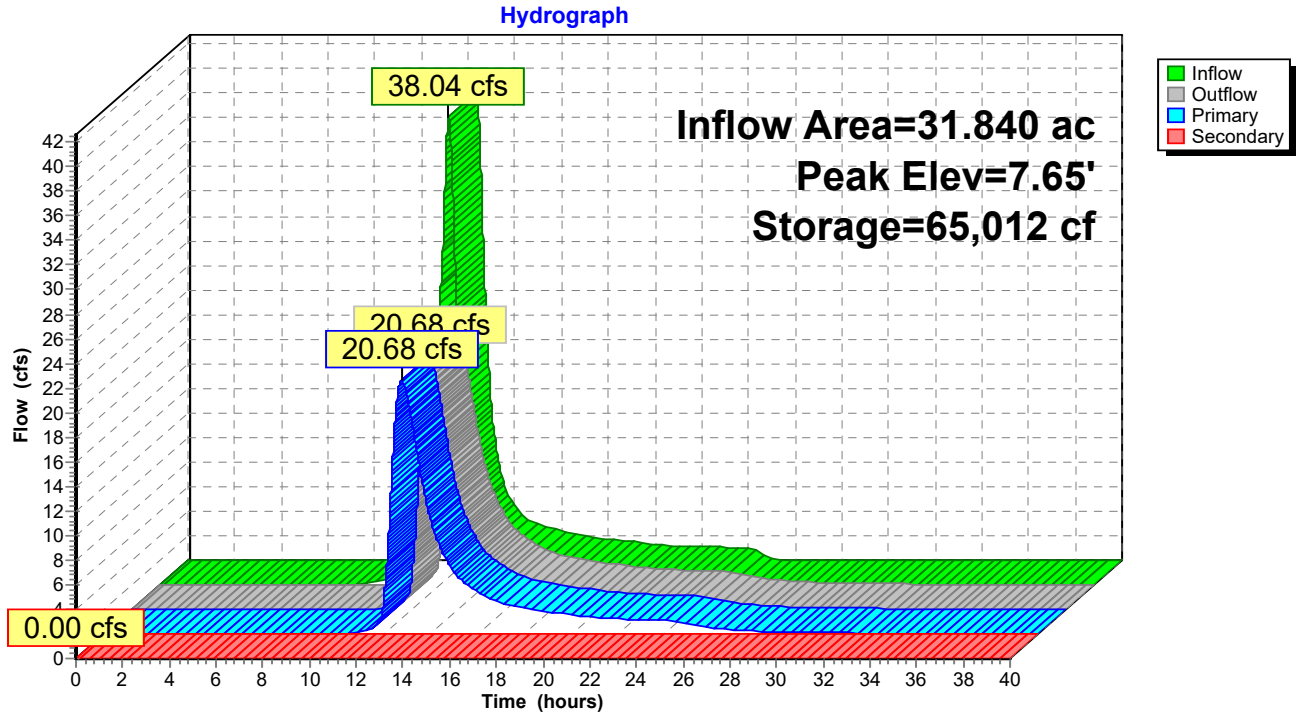
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	19,280	630.0	0	0	19,280
7.00	47,562	1,436.0	32,375	32,375	151,796
8.00	55,664	2,057.0	51,560	83,935	324,421
9.00	64,212	2,211.5	59,887	143,822	376,944
10.00	75,224	2,346.0	69,645	213,467	425,777
11.00	105,412	2,407.0	89,895	303,362	448,971
12.00	110,000	2,500.0	107,698	411,060	485,369

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**48.0" Round 48" Culvert** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0095 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

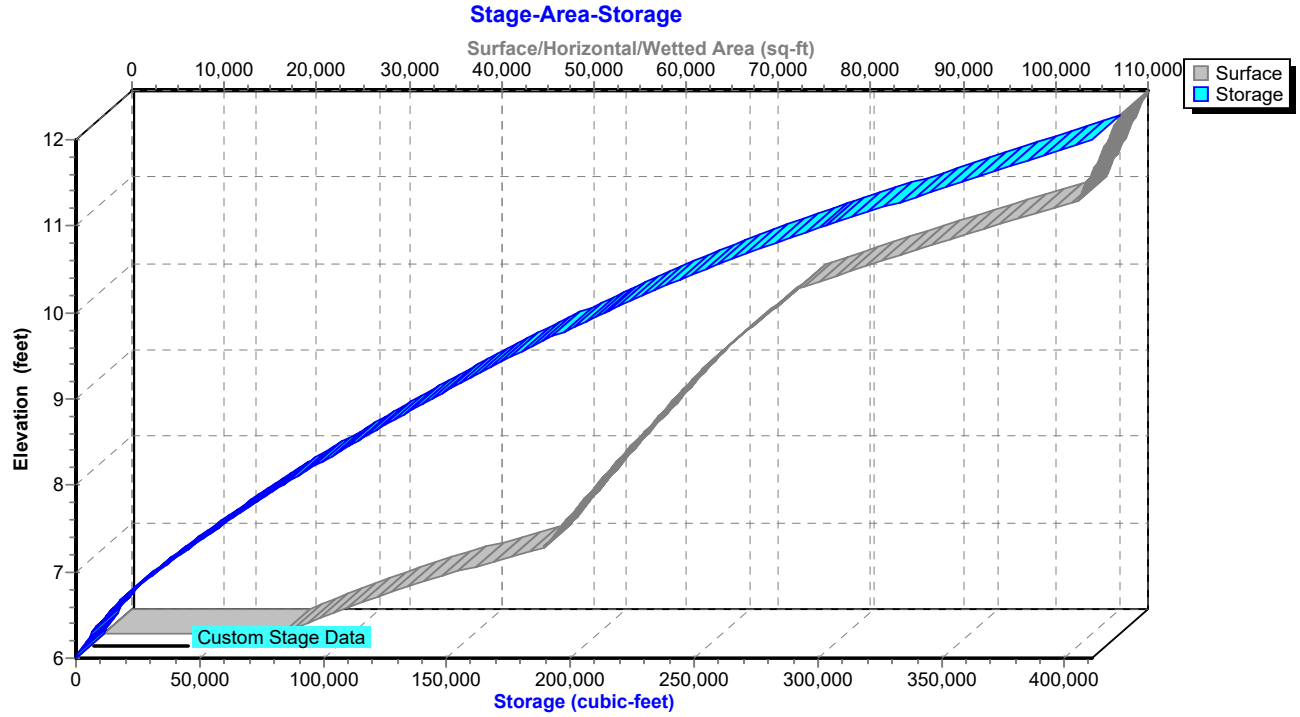
Primary OutFlow Max=20.68 cfs @ 12.74 hrs HW=7.65' TW=6.00' (Dynamic Tailwater)
1=48" Culvert (Barrel Controls 20.68 cfs @ 6.24 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=6.00' TW=6.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond W2P: Proposed Culvert W2



Pond W2P: Proposed Culvert W2



Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Pond E1P: Proposed Culvert E1 Peak Elev=12.14' Storage=35,882 cf Inflow=49.35 cfs 3.994 af
Primary=33.34 cfs 3.969 af Secondary=0.00 cfs 0.000 af Outflow=33.34 cfs 3.969 af

Pond E2P: Proposed Culvert E2 Peak Elev=13.38' Storage=23,597 cf Inflow=46.71 cfs 3.650 af
Primary=33.10 cfs 3.650 af Secondary=0.00 cfs 0.000 af Outflow=33.10 cfs 3.650 af

Pond E3P: Proposed Culvert E3 Peak Elev=13.50' Storage=63,127 cf Inflow=76.25 cfs 5.849 af
Primary=42.75 cfs 5.849 af Secondary=0.00 cfs 0.000 af Outflow=42.75 cfs 5.849 af

Pond W1P: Proposed Culvert W1 Peak Elev=9.80' Storage=156,495 cf Inflow=115.92 cfs 14.708 af
Primary=70.70 cfs 14.692 af Secondary=0.00 cfs 0.000 af Outflow=70.70 cfs 14.692 af

Pond W2P: Proposed Culvert W2 Peak Elev=9.03' Storage=145,558 cf Inflow=92.89 cfs 11.907 af
Primary=55.79 cfs 11.860 af Secondary=0.00 cfs 0.000 af Outflow=55.79 cfs 11.860 af

Summary for Pond E1P: Proposed Culvert E1

[62] Hint: Exceeded Reach E1R OUTLET depth by 2.21' @ 12.34 hrs

Inflow Area = 10.680 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 49.35 cfs @ 12.10 hrs, Volume= 3.994 af
Outflow = 33.34 cfs @ 12.28 hrs, Volume= 3.969 af, Atten= 32%, Lag= 10.4 min
Primary = 33.34 cfs @ 12.28 hrs, Volume= 3.969 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 12.14' @ 12.28 hrs Surf.Area= 18,859 sf Storage= 35,882 cf

Plug-Flow detention time= 38.1 min calculated for 3.968 af (99% of inflow)
Center-of-Mass det. time= 34.3 min (849.0 - 814.7)

Volume	Invert	Avail.Storage	Storage Description
#1	9.20'	182,417 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

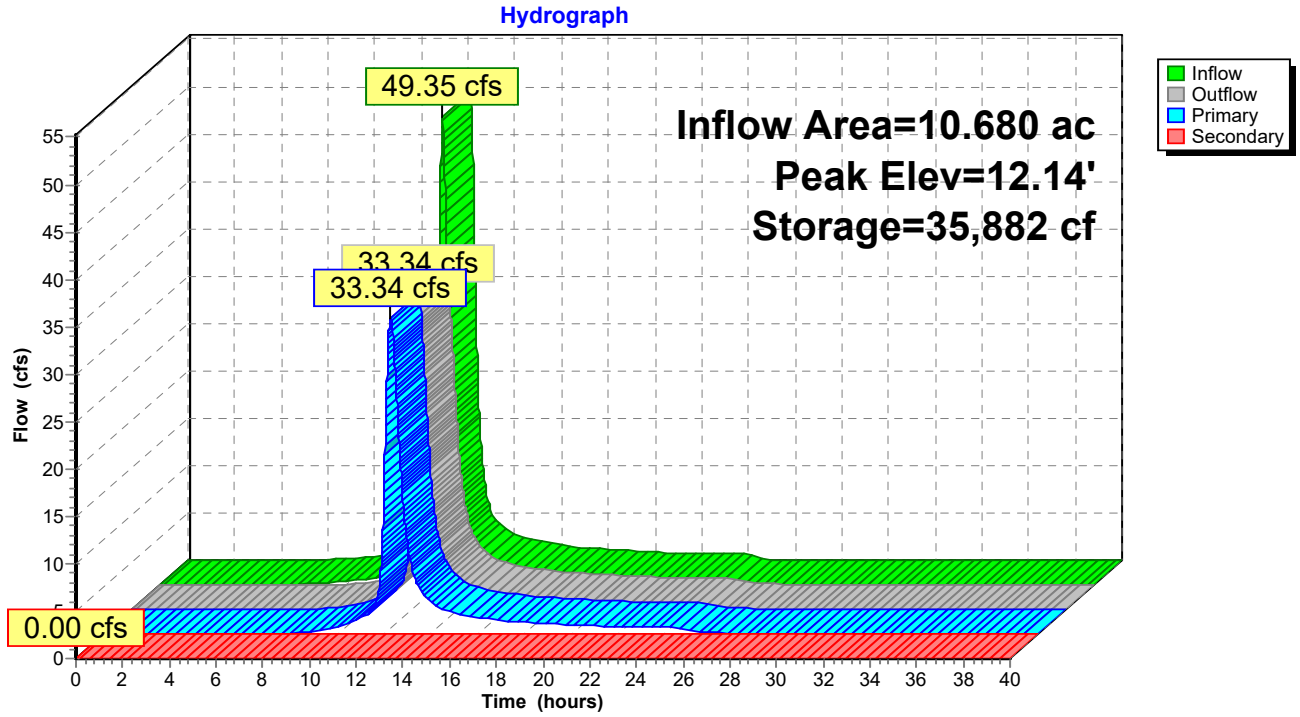
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
9.20	8,160	495.0	0	0	8,160
10.00	9,294	512.0	6,977	6,977	9,581
11.00	12,795	923.0	10,998	17,975	56,520
12.00	17,943	1,335.0	15,297	33,271	130,559
13.00	24,884	1,748.0	21,319	54,590	231,895
14.00	34,118	2,225.0	29,380	83,970	382,717
15.00	54,276	2,470.0	43,809	127,779	474,283
16.00	55,000	2,500.0	54,638	182,417	486,405

Device	Routing	Invert	Outlet Devices
#1	Primary	9.30'	**36.0" Round 36" Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.30' / 8.70' S= 0.0050 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

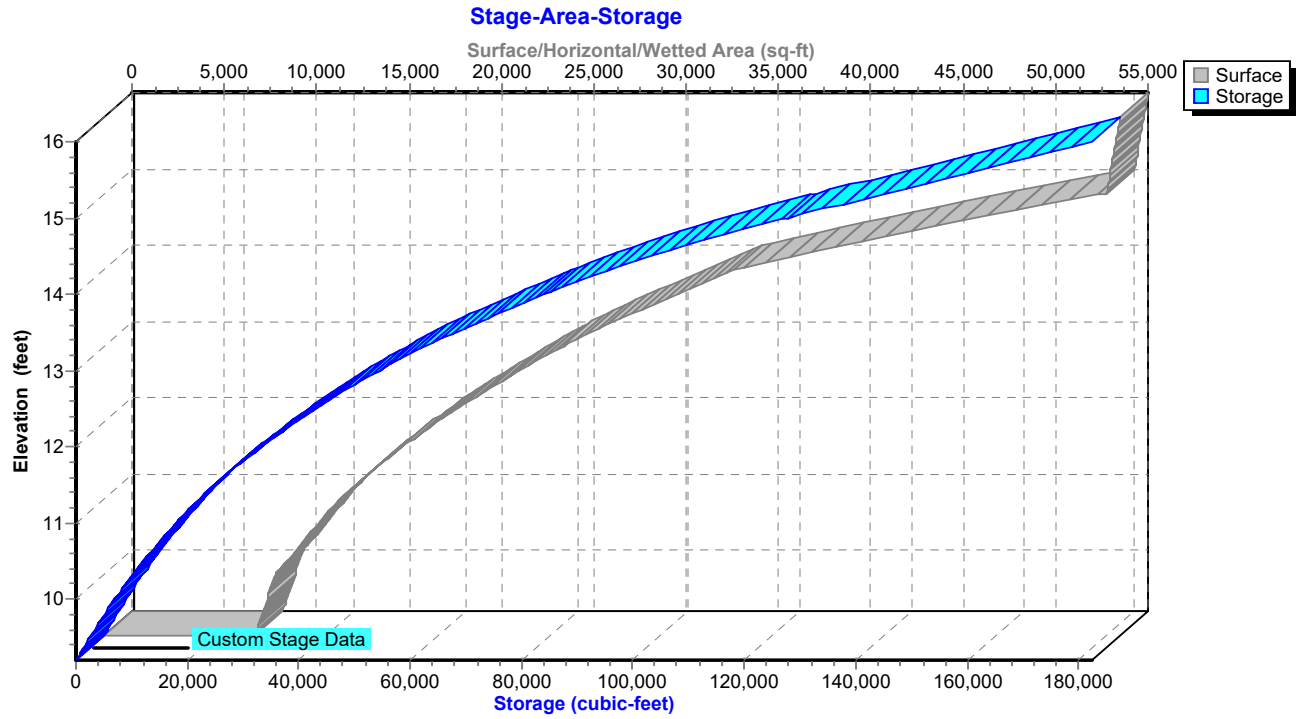
Primary OutFlow Max=33.33 cfs @ 12.28 hrs HW=12.14' TW=6.00' (Dynamic Tailwater)
↑—**1=36" Culvert** (Barrel Controls 33.33 cfs @ 6.21 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=9.20' TW=6.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E1P: Proposed Culvert E1



Pond E1P: Proposed Culvert E1



Summary for Pond E2P: Proposed Culvert E2

Inflow Area = 9.760 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 46.71 cfs @ 12.11 hrs, Volume= 3.650 af
Outflow = 33.10 cfs @ 12.24 hrs, Volume= 3.650 af, Atten= 29%, Lag= 8.1 min
Primary = 33.10 cfs @ 12.24 hrs, Volume= 3.650 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 13.38' @ 12.24 hrs Surf.Area= 23,455 sf Storage= 23,597 cf

Plug-Flow detention time= 6.0 min calculated for 3.649 af (100% of inflow)
Center-of-Mass det. time= 6.0 min (816.2 - 810.2)

Volume	Invert	Avail.Storage	Storage Description
#1	11.50'	103,576 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

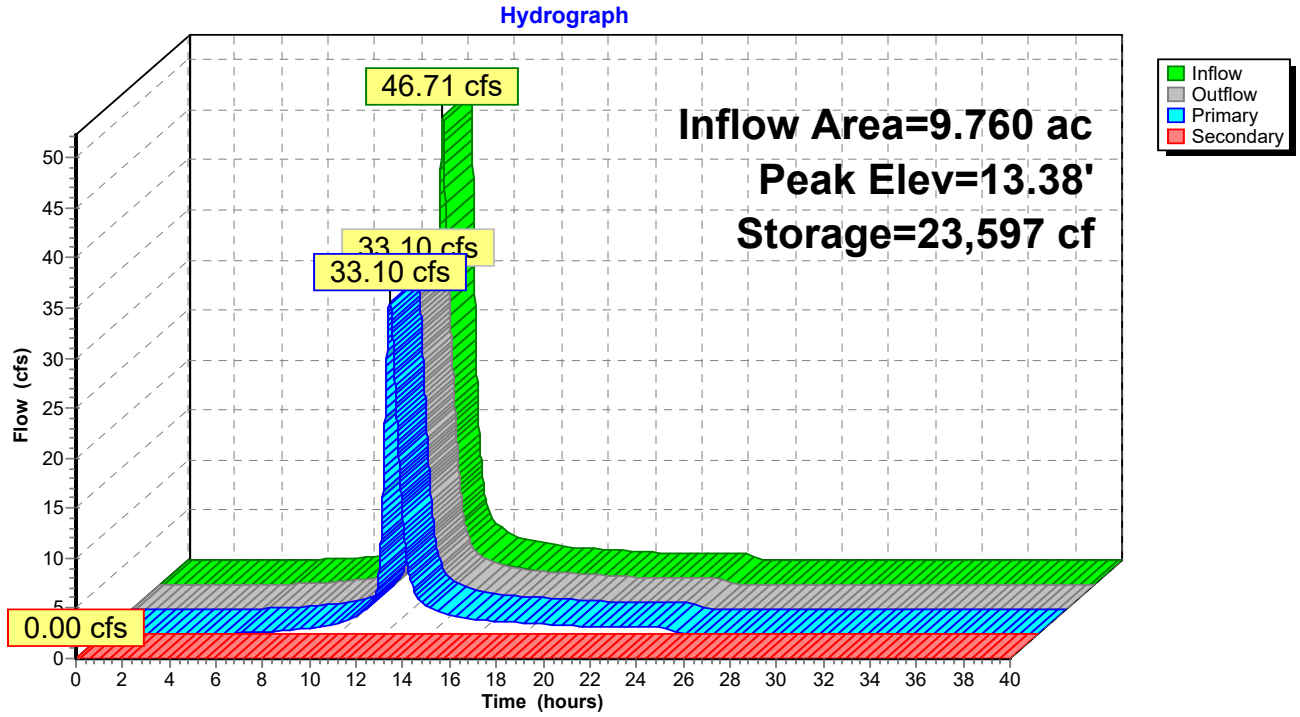
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.50	0	0.0	0	0	0
11.60	28	27.0	1	1	58
11.80	2,042	205.0	154	155	3,344
12.00	7,656	383.0	910	1,065	11,673
13.00	21,500	920.0	13,995	15,060	67,358
14.00	26,830	1,345.0	24,116	39,176	143,970
15.00	33,550	1,610.0	30,127	69,304	206,303
16.00	35,000	1,750.0	34,272	103,576	243,774

Device	Routing	Invert	Outlet Devices
#1	Primary	4.60'	**15.0" Round (3) 15" Culvert X 3.00** L= 115.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.60' / 4.00' S= 0.0052 '/' Cc= 0.900 n= 0.013, Flow Area= 1.23 sf
#2	Device 1	11.50'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

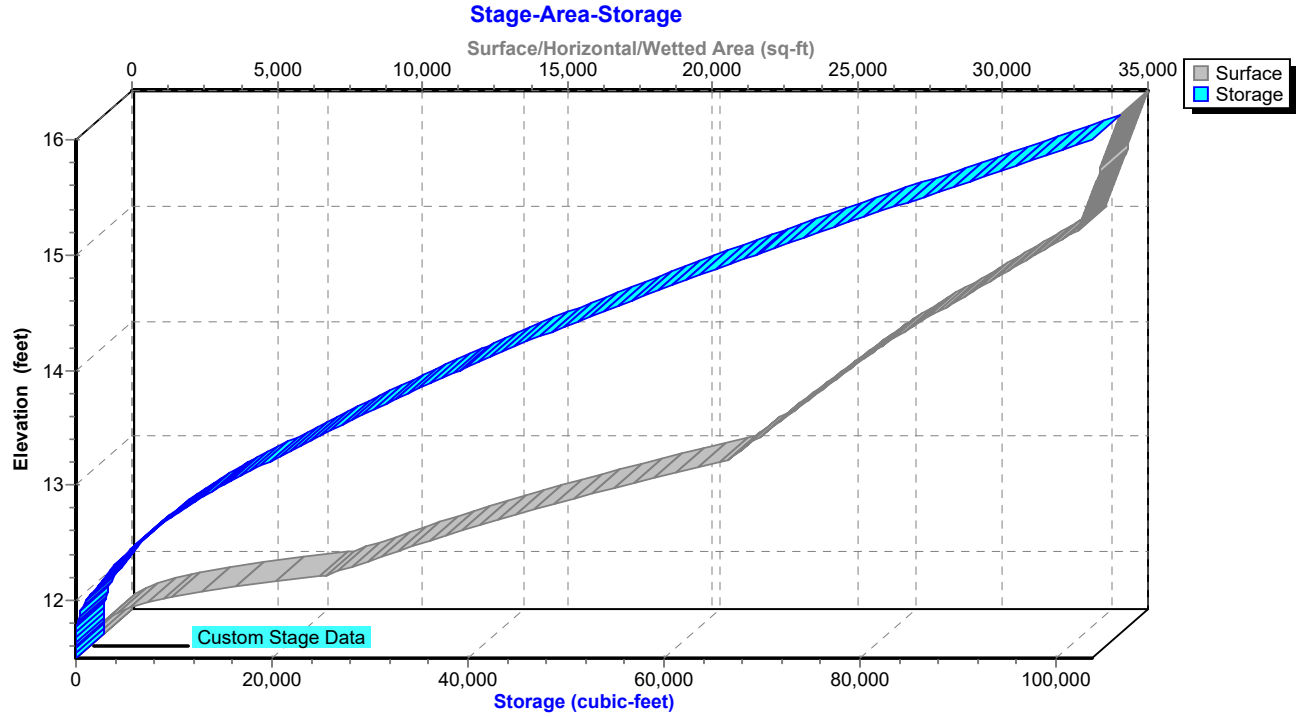
Primary OutFlow Max=33.09 cfs @ 12.24 hrs HW=13.38' TW=6.00' (Dynamic Tailwater)
↑—**1=(3) 15" Culvert** (Passes 33.09 cfs of 39.25 cfs potential flow)
↑—**2=Orifice/Grate** (Orifice Controls 33.09 cfs @ 4.40 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.50' TW=6.00' (Dynamic Tailwater)
↑—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E2P: Proposed Culvert E2



Pond E2P: Proposed Culvert E2



Summary for Pond E3P: Proposed Culvert E3

[62] Hint: Exceeded Reach E2R OUTLET depth by 1.70' @ 12.38 hrs
[62] Hint: Exceeded Reach E3R OUTLET depth by 1.87' @ 12.35 hrs

Inflow Area = 15.640 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 76.25 cfs @ 12.10 hrs, Volume= 5.849 af
Outflow = 42.75 cfs @ 12.30 hrs, Volume= 5.849 af, Atten= 44%, Lag= 12.0 min
Primary = 42.75 cfs @ 12.30 hrs, Volume= 5.849 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 13.50' @ 12.30 hrs Surf.Area= 35,409 sf Storage= 63,127 cf

Plug-Flow detention time= 34.8 min calculated for 5.847 af (100% of inflow)
Center-of-Mass det. time= 34.9 min (848.8 - 813.9)

Volume	Invert	Avail.Storage	Storage Description
#1	11.20'	181,215 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

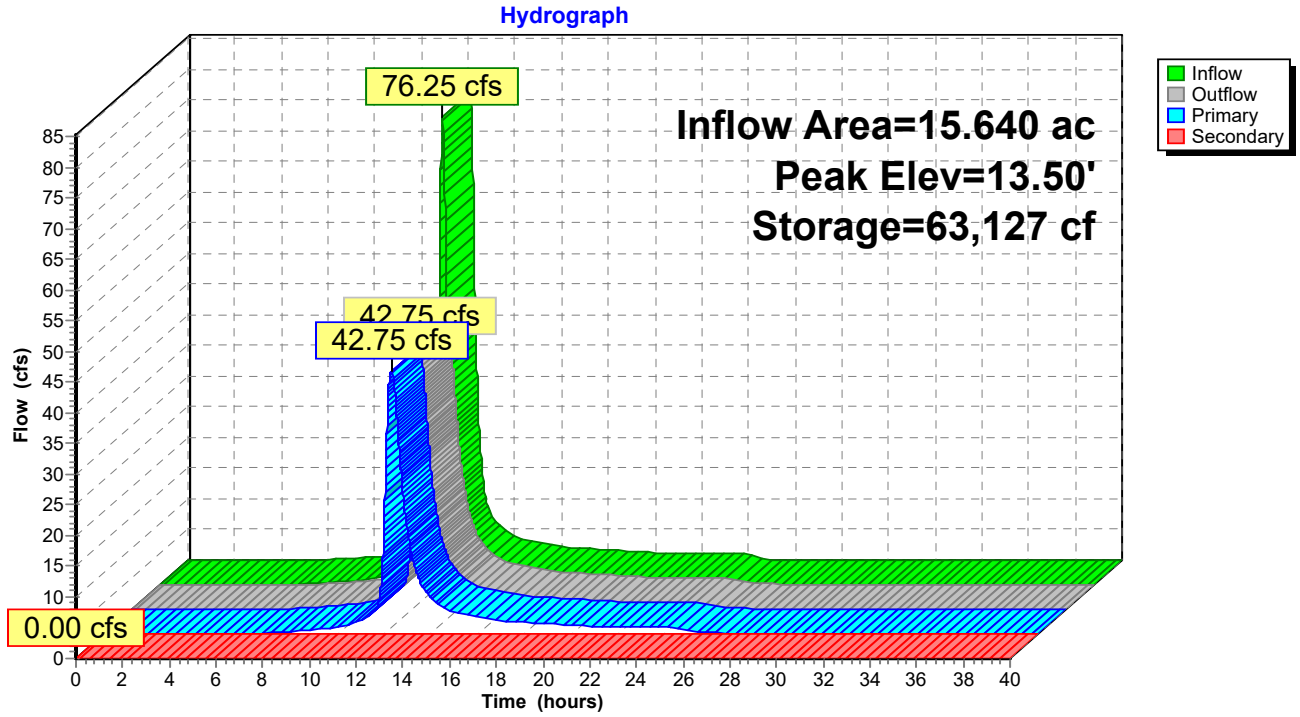
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
11.20	0	0.0	0	0	0
11.25	21,913	735.0	365	365	42,990
12.00	25,341	765.0	17,705	18,070	46,615
13.00	31,293	1,493.0	28,265	46,335	177,431
14.00	39,712	2,135.0	35,419	81,754	362,790
15.00	52,254	2,805.0	45,840	127,593	626,187
16.00	55,000	3,000.0	53,621	181,215	716,313

Device	Routing	Invert	Outlet Devices
#1	Primary	5.55'	**36.0" Round 36" Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.55' / 5.00' S= 0.0055 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf
#2	Device 1	11.20'	**24.0" W x 24.0" H Vert. Orifice/Grate X 2.00** C= 0.600
#3	Secondary	15.50'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

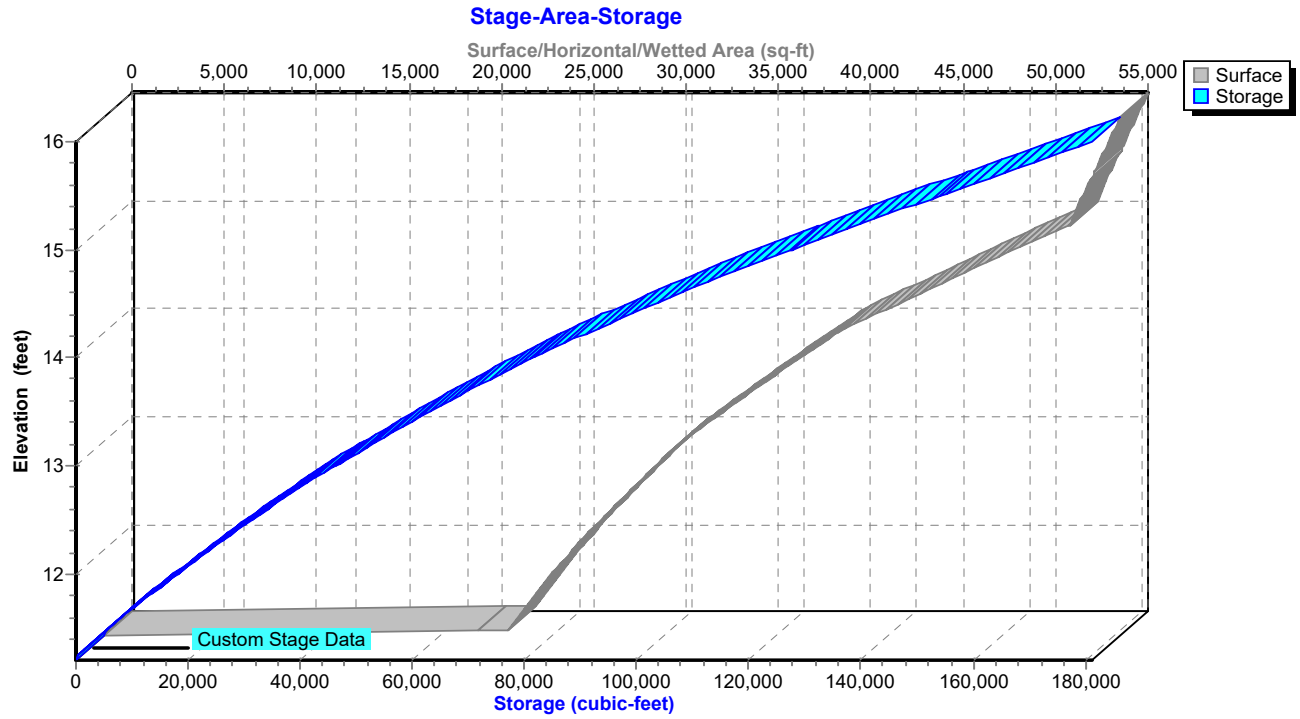
Primary OutFlow Max=42.75 cfs @ 12.30 hrs HW=13.50' TW=6.00' (Dynamic Tailwater)
└**1=36" Culvert** (Passes 42.75 cfs of 86.46 cfs potential flow)
└**2=Orifice/Grate** (Orifice Controls 42.75 cfs @ 5.34 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=11.20' TW=6.00' (Dynamic Tailwater)
└**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E3P: Proposed Culvert E3



Pond E3P: Proposed Culvert E3



Summary for Pond W1P: Proposed Culvert W1

[62] Hint: Exceeded Reach W1R OUTLET depth by 3.51' @ 12.74 hrs
[63] Warning: Exceeded Reach W2R INLET depth by 1.87' @ 12.68 hrs

Inflow Area = 39.330 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 115.92 cfs @ 12.33 hrs, Volume= 14.708 af
Outflow = 70.70 cfs @ 12.67 hrs, Volume= 14.692 af, Atten= 39%, Lag= 20.3 min
Primary = 70.70 cfs @ 12.67 hrs, Volume= 14.692 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 9.80' @ 12.67 hrs Surf.Area= 72,061 sf Storage= 156,495 cf

Plug-Flow detention time= 37.9 min calculated for 14.689 af (100% of inflow)
Center-of-Mass det. time= 37.4 min (865.1 - 827.8)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	389,586 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

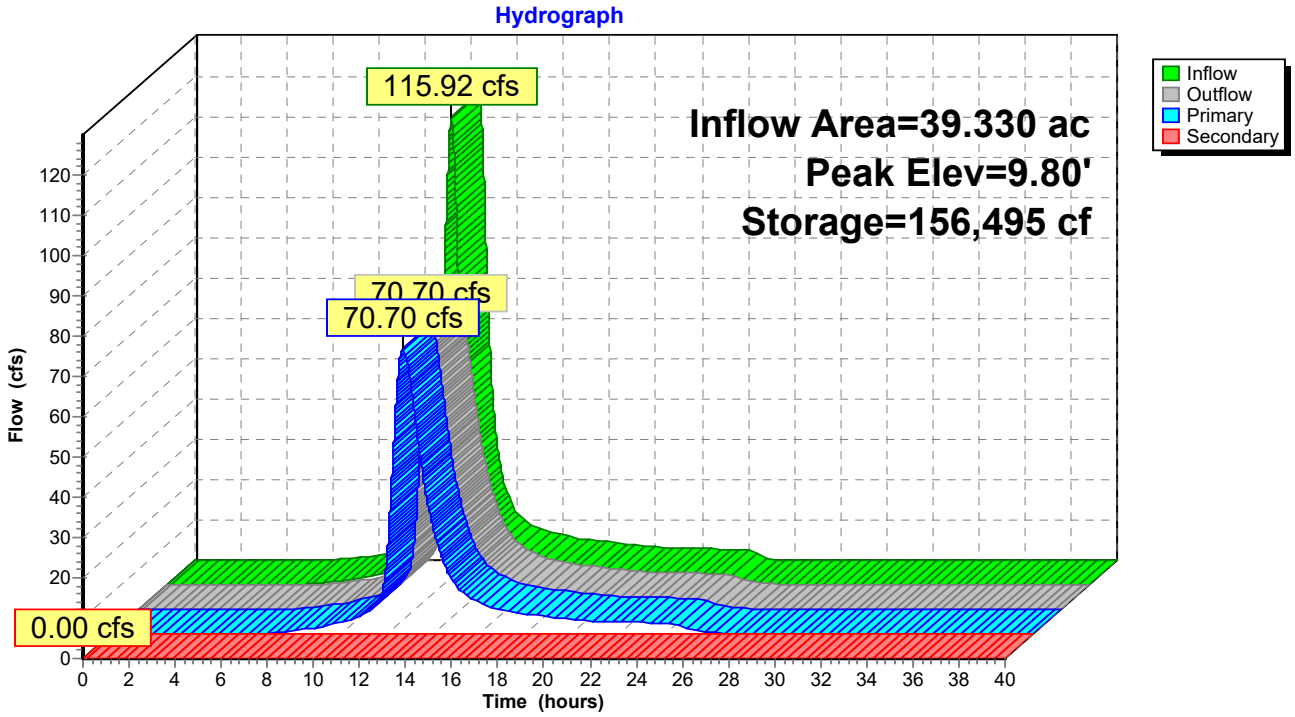
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	451	157.0	0	0	451
7.00	25,631	1,283.0	9,827	9,827	129,483
8.00	50,776	2,315.0	37,494	47,321	424,971
9.00	61,066	2,638.0	55,842	103,163	552,304
10.00	74,913	2,980.0	67,872	171,035	705,227
11.00	119,467	3,282.0	96,327	267,363	855,750
12.00	125,000	3,500.0	122,223	389,586	973,452

Device	Routing	Invert	Outlet Devices
#1	Primary	6.30'	**48.0" Round 48" Culvert** L= 110.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.30' / 5.20' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

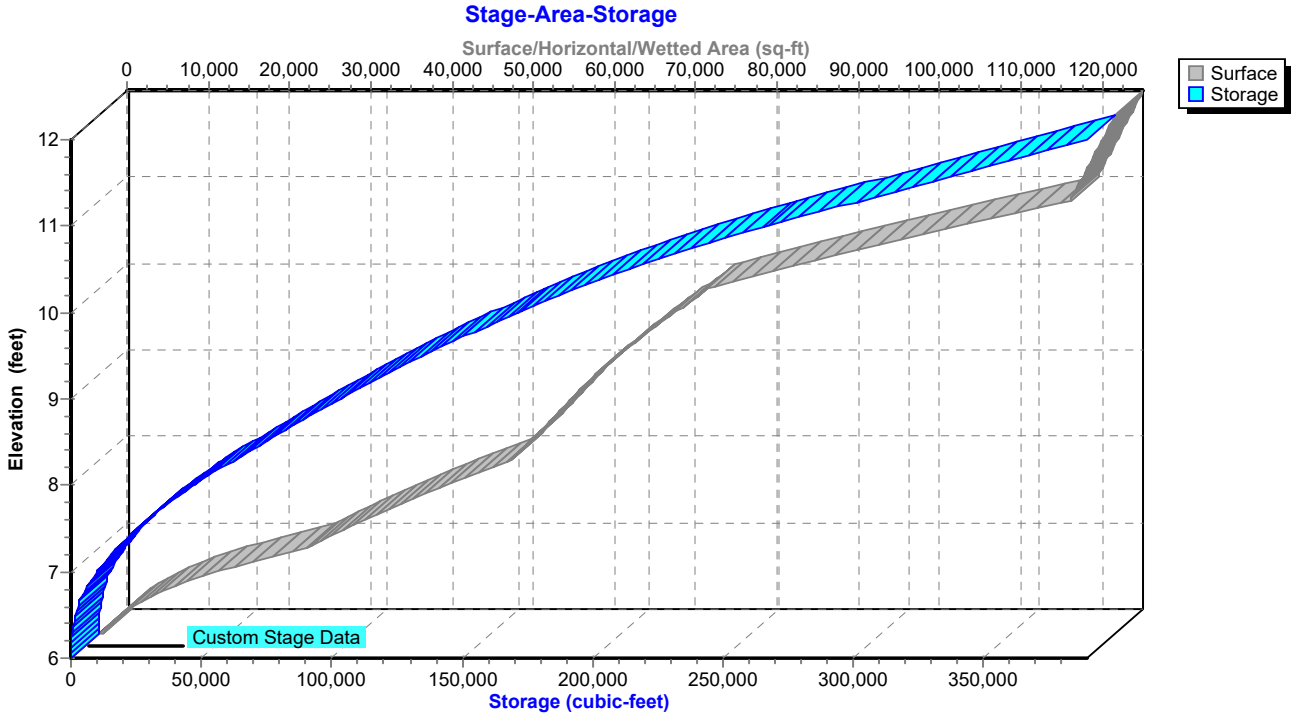
Primary OutFlow Max=70.70 cfs @ 12.67 hrs HW=9.80' TW=6.00' (Dynamic Tailwater)
1=48" Culvert (Barrel Controls 70.70 cfs @ 8.08 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=6.00' TW=6.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond W1P: Proposed Culvert W1



Pond W1P: Proposed Culvert W1



Summary for Pond W2P: Proposed Culvert W2

[63] Warning: Exceeded Reach W3R INLET depth by 1.10' @ 12.69 hrs
[62] Hint: Exceeded Reach W4R OUTLET depth by 3.22' @ 12.72 hrs

Inflow Area = 31.840 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25yr, 24hr event
Inflow = 92.89 cfs @ 12.36 hrs, Volume= 11.907 af
Outflow = 55.79 cfs @ 12.68 hrs, Volume= 11.860 af, Atten= 40%, Lag= 19.3 min
Primary = 55.79 cfs @ 12.68 hrs, Volume= 11.860 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 9.03' @ 12.68 hrs Surf.Area= 64,498 sf Storage= 145,558 cf

Plug-Flow detention time= 65.7 min calculated for 11.857 af (100% of inflow)
Center-of-Mass det. time= 63.4 min (890.7 - 827.4)

Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	411,060 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

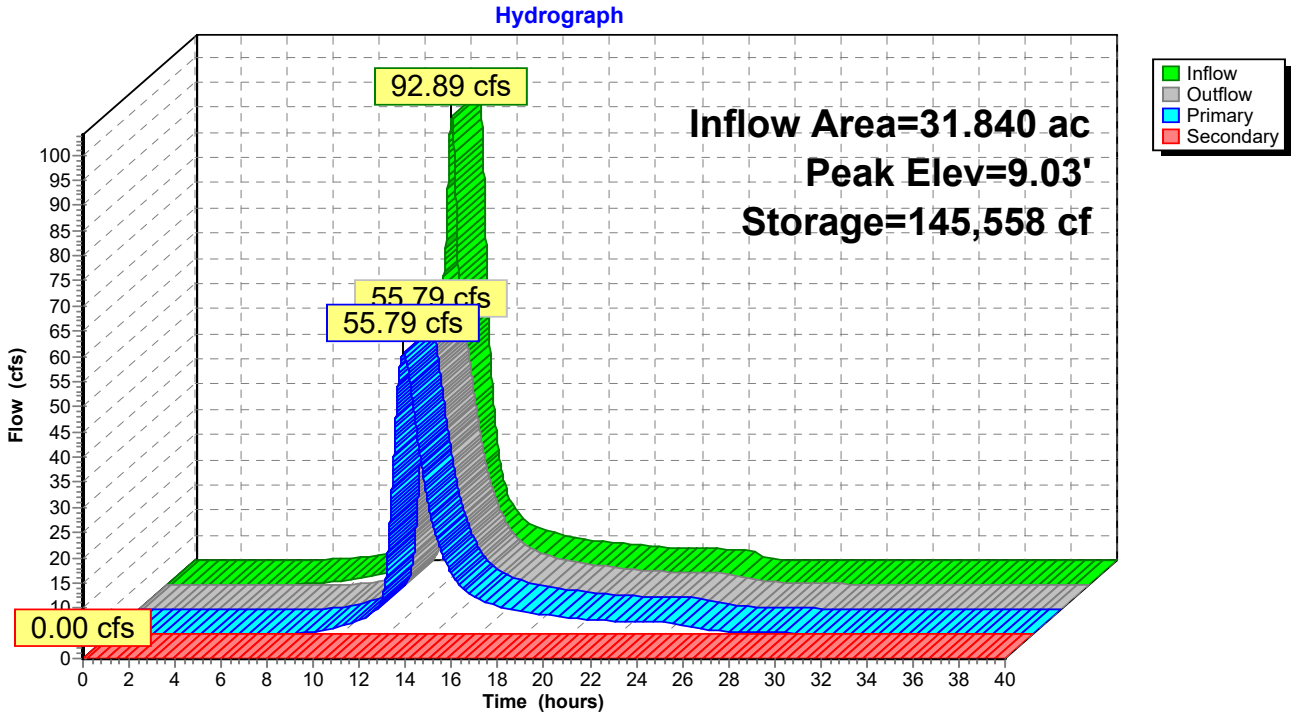
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	19,280	630.0	0	0	19,280
7.00	47,562	1,436.0	32,375	32,375	151,796
8.00	55,664	2,057.0	51,560	83,935	324,421
9.00	64,212	2,211.5	59,887	143,822	376,944
10.00	75,224	2,346.0	69,645	213,467	425,777
11.00	105,412	2,407.0	89,895	303,362	448,971
12.00	110,000	2,500.0	107,698	411,060	485,369

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**48.0" Round 48" Culvert** L= 105.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0095 '/' Cc= 0.900 n= 0.013, Flow Area= 12.57 sf
#2	Secondary	11.00'	**100.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

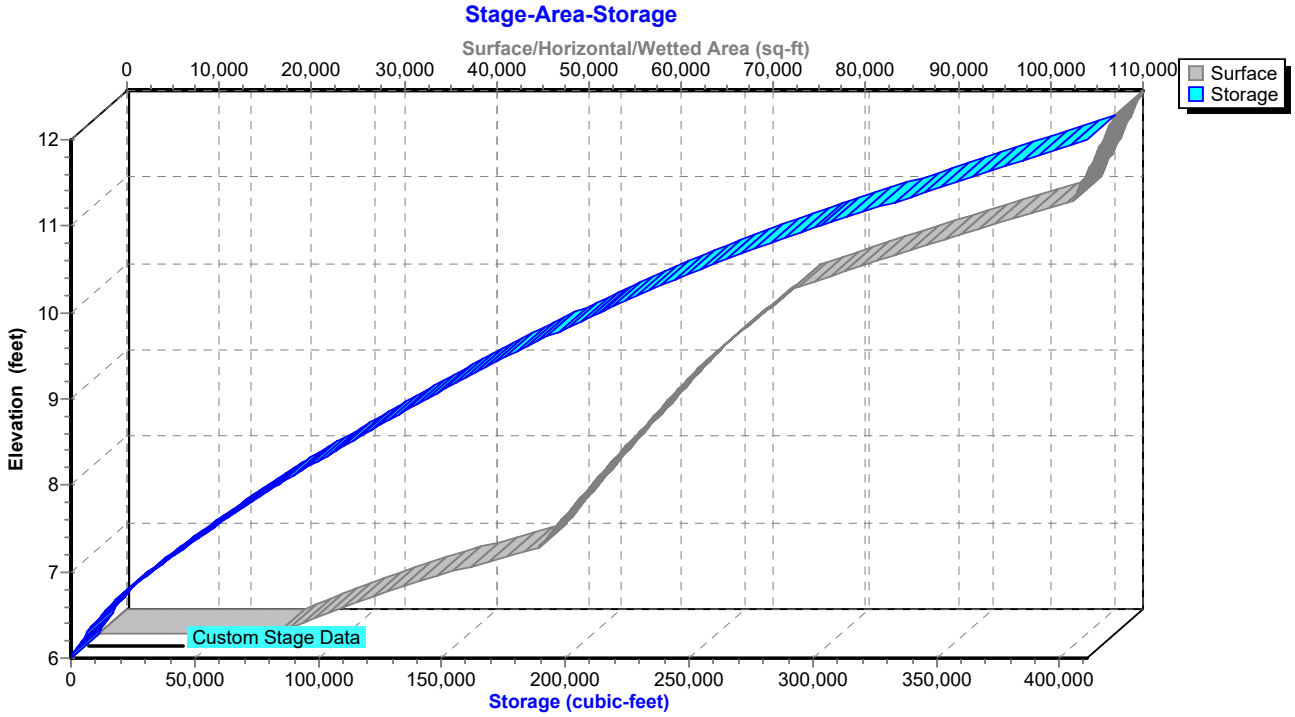
Primary OutFlow Max=55.78 cfs @ 12.68 hrs HW=9.03' TW=6.00' (Dynamic Tailwater)
1=48" Culvert (Barrel Controls 55.78 cfs @ 7.58 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=6.00' TW=6.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond W2P: Proposed Culvert W2



Pond W2P: Proposed Culvert W2



Appendix 4

Water Quality Calculations (VRRM)

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: Chesterfield Power Station
Date: 43998

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**383.98**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	94.63	94.63	24
Managed Turf (acres)	0.00	0.00	0.00	157.50	157.50	40
Impervious Cover (acres)	0.00	0.00	0.00	137.16	137.16	35
					389.29	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	343.59	343.59	88
Impervious Cover (acres)	0.00	0.00	0.00	45.70	45.70	12
					389.29	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.33	0.33	--	0.45
Treatment Volume (ft^3)	469,404	469,404	--	633,103
TP Load (lb/yr)	294.93	294.93	--	397.78

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.02	**0.76**	**0.76**

Total TP Load Reduction Required (lb/yr)	**-23.30**	-23.30	0

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	2109.85	2845.64

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	0.00
Total TN Load Reduction Achieved (lb/yr)	0.00
Remaining Post Development TP Load (lb/yr)	294.93
Remaining TP Load Reduction (lb/yr) Required	**0.00**

**** TARGET TP REDUCTION EXCEEDED BY 23.3 LB/YEAR ****

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - **Version 3.0**

☐ 2011 BMP Standards and Specifications ☑ 2013 Draft BMP Standards and Specifications

CLEAR ALL

data input cells | constant values | calculation cells | final results

Project Name:	Chesterfield Power Station
Date:	6/16/2020
Linear Development Project?	No

Site Information

Post-Development Project (Treatment Volume and Loads)

Enter Total Disturbed Area *(acres)* → 389.29

Check:

BMP Design Specifications List: 2013 Draft Stds & Specs

Maximum reduction required: 20%

Linear project? No

The site's net increase in impervious cover (acres) is: 0

Land cover areas entered correctly? ✔

Post-Development TP Load Reduction for Site (lb/yr): -23.30

Total disturbed area entered? ✔

TP LOAD REDUCTION NOT REQUIRED

Pre-ReDevelopment Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed forest/open space	0.00	0.00	0.00	94.63	94.63
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	157.50	157.50
Impervious Cover (acres)	0.00	0.00	0.00	137.16	137.16
					389.29

Post-Development Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	343.59	343.59
Impervious Cover (acres)	0.00	0.00	0.00	45.70	45.70
Area Check	OK.	OK.	OK.	OK.	389.29

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
Pj (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

LAND COVER SUMMARY -- PRE-REDEVELOPMENT

Land Cover Summary-Pre		
Pre-ReDevelopment	**Listed**	**Adjusted[1]**
Forest/Open Space Cover (acres)	94.63	94.63
Weighted Rv(forest)	0.05	0.05
% Forest	24%	24%
Managed Turf Cover (acres)	157.50	157.50
Weighted Rv(turf)	0.25	0.25
% Managed Turf	40%	40%
Impervious Cover (acres)	137.16	137.16
Rv(impervious)	0.95	0.95
% Impervious	35%	35%
Total Site Area (acres)	**389.29**	**389.29**
Site Rv	**0.45**	**0.45**

Treatment Volume and Nutrient Load

Pre-ReDevelopment Treatment Volume (acre-ft)	14.5340	14.5340
Pre-ReDevelopment Treatment Volume (cubic feet)	633,103	633,103
Pre-ReDevelopment TP Load (lb/yr)	**397.78**	**397.78**
Pre-ReDevelopment TP Load per acre (lb/acre/yr)	1.02	1.02
Baseline TP Load (lb/yr) (**0.41 lbs/acre/yr** applied to pre-redevelopment area excluding pervious land proposed for new impervious cover)		*159.61*

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary-Post (Final)	
Post ReDev. & New Impervious	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	343.59
Weighted Rv (turf)	0.25
% Managed Turf	88%
Impervious Cover (acres)	45.70
Rv(impervious)	0.95
% Impervious	12%
Final Site Area (acres)	**389.29**
Final Post Dev Site Rv	**0.33**

Land Cover Summary-Post	
Post-ReDevelopment	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	343.59
Weighted Rv (turf)	0.25
% Managed Turf	88%
ReDev. Impervious Cover (acres)	45.70
Rv(impervious)	0.95
% Impervious	12%
Total ReDev. Site Area (acres)	**389.29**
ReDev Site Rv	**0.33**

Land Cover Summary-Post	
Post-Development New Impervious	
New Impervious Cover (acres)	0.00
Rv(impervious)	--

Treatment Volume and Nutrient Load

Final Post-Development Treatment Volume (acre-ft)	10.7760	**Post-ReDevelopment Treatment Volume (acre-ft)**	10.7760	**Post-Development Treatment Volume (acre-ft)**	--
Final Post-Development Treatment Volume (cubic feet)	469,404	**Post-ReDevelopment Treatment Volume (cubic feet)**	469,404	**Post-Development Treatment Volume (cubic feet)**	--
Final Post-Development TP Load (lb/yr)	**294.93**	**Post-ReDevelopment Load (TP) (lb/yr)***	**294.93**	**Post-Development TP Load (lb/yr)**	--
Final Post-Development TP Load per acre (lb/acre/yr)	0.76	Post-ReDevelopment TP Load per acre (lb/acre/yr)	0.76		
		Max. Reduction Required (Below Pre-ReDevelopment Load)	**20%**		
		TP Load Reduction Required for Redeveloped Area (lb/yr)	**-23.30**	**TP Load Reduction Required for New Impervious Area (lb/yr)**	**0**

[1] *Adjusted Land Cover Summary:*
Pre ReDevelopment land cover minus pervious land cover (forest/open space or managed turf) acreage proposed for new impervious cover.

Adjusted total acreage is consistent with Post-ReDevelopment acreage (minus acreage of new impervious cover).

Column I shows load reduction requriement for new impervious cover (based on new development load limit, 0.41 lbs/acre/year).

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr) -23.30 **

TP LOAD REDUCTION NOT REQUIRED

Nitrogen Loads (Informational Purposes Only)

Pre-ReDevelopment TN Load (lb/yr)	2845.64	Final Post-Development TN Load (Post-ReDevelopment & New Impervious) (lb/yr)	2109.85

Pre-ReDevelopment Land Cover (acres)	DA A: New CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.81	0.81
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				2.45	2.45
Impervious Cover (acres)				5.63	5.63
				Total	8.89

Post-ReDevelopment Land Cover (acres)	DA A: New CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				2.08	2.08
Impervious Cover (acres)				6.81	6.81
				Total	8.89

Pre-ReDevelopment Land Cover (acres)	DA D: UAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				122.52	122.52
Impervious Cover (acres)				17.37	17.37
				Total	139.89

Post-ReDevelopment Land Cover (acres)	DA D: UAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				135.11	135.11
Impervious Cover (acres)				4.78	4.78
				Total	139.89

Pre-ReDevelopment Land Cover (acres)	DA B: LVWWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				8.10	8.10
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				17.85	17.85
Impervious Cover (acres)				4.83	4.83
				Total	30.78

Post-ReDevelopment Land Cover (acres)	DA B: LVWWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				19.93	19.93
Impervious Cover (acres)				10.85	10.85
				Total	30.78

Pre-ReDevelopment Land Cover (acres)	DA E: FFCP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				85.72	85.72
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				0.28	0.28
Impervious Cover (acres)				0.35	0.35
				Total	86.35

Post-ReDevelopment Land Cover (acres)	DA E: FFCP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				76.30	76.30
Impervious Cover (acres)				10.05	10.05
				Total	86.35

Pre-ReDevelopment Land Cover (acres)	DA C: LAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				7.30	7.30
Impervious Cover (acres)				108.98	108.98
				Total	116.28

Post-ReDevelopment Land Cover (acres)	DA C: LAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				103.07	103.07
Impervious Cover (acres)				13.21	13.21
				Total	116.28

Pre-ReDevelopment Land Cover (acres)	DA F: Old CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				7.10	7.10
Impervious Cover (acres)				0.00	0.00
				Total	7.10

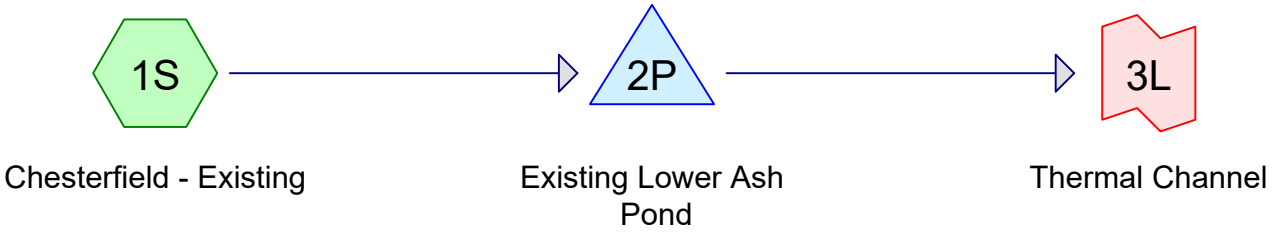
Post-ReDevelopment Land Cover (acres)	DA F: Old CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				7.10	7.10
Impervious Cover (acres)				0.00	0.00
				Total	7.10

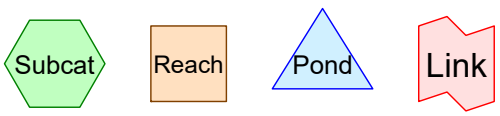
Pre-ReDevelopment Land Cover (acres)	TOTAL				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	94.63	94.63
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	157.50	157.50
Impervious Cover (acres)	0.00	0.00	0.00	137.16	137.16
				Total	389.29

Post-ReDevelopment Land Cover (acres)	TOTAL				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	343.59	343.59
Impervious Cover (acres)	0.00	0.00	0.00	45.70	45.70
				Total	389.29

Appendix 5

HydroCAD Inputs and Outputs—Existing Condition





Routing Diagram for Chesterfield LAP - Existing
Prepared by AECOM, Printed 4/16/2020
HydroCAD® 10.00-12 s/n 00537 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
97.935	98	Roofs, HSG C (1S)
97.935	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
97.935	HSG C	1S
0.000	HSG D	
0.000	Other	
97.935		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	97.935	0.000	0.000	97.935	Roofs	1S
0.000	**0.000**	**97.935**	**0.000**	**0.000**	**97.935**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	2P	5.80	4.80	100.0	0.0100	0.013	63.0	0.0	0.0

Time span=0.00-40.00 hrs, dt=0.03 hrs, 1334 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 1S: Chesterfield - Runoff Area=97.935 ac 100.00% Impervious Runoff Depth=28.46"
Flow Length=2,230' Slope=0.0100 '/' Tc=19.6 min CN=98 Runoff=3,782.71 cfs 232.241 af

Pond 2P: Existing Lower Ash Pond Peak Elev=14.52' Storage=141.284 af Inflow=3,782.71 cfs 232.241 af
63.0" Round Culvert x 2.00 n=0.013 L=100.0' S=0.0100 '/' Outflow=514.69 cfs 232.241 af

Link 3L: Thermal Channel Inflow=514.69 cfs 232.241 af
Primary=514.69 cfs 232.241 af

Total Runoff Area = 97.935 ac Runoff Volume = 232.241 af Average Runoff Depth = 28.46"
0.00% Pervious = 0.000 ac 100.00% Impervious = 97.935 ac

Summary for Subcatchment 1S: Chesterfield - Existing

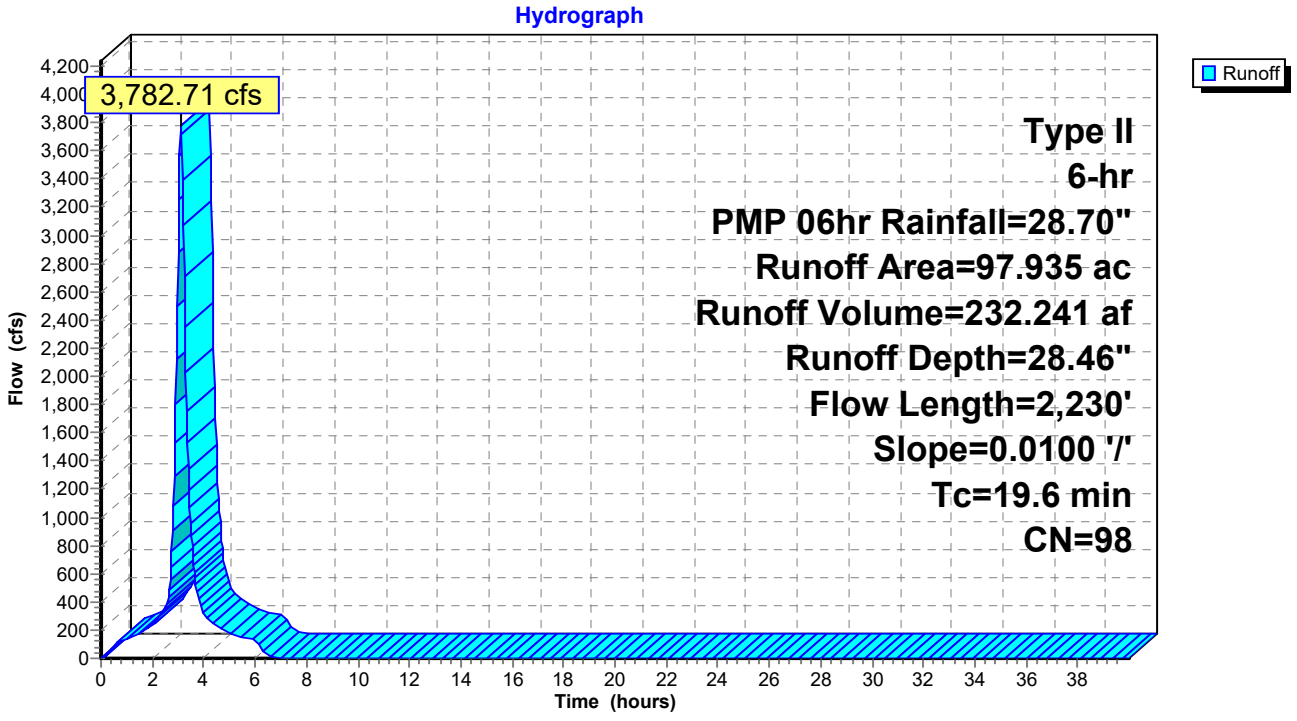
Runoff = 3,782.71 cfs @ 3.11 hrs, Volume= 232.241 af, Depth=28.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs
Type II 6-hr PMP 06hr Rainfall=28.70"

Area (ac)	CN	Description
97.935	98	Roofs, HSG C
97.935		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	300	0.0100	1.33		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 3.37"
15.8	1,930	0.0100	2.03		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
19.6	2,230	Total			

Subcatchment 1S: Chesterfield - Existing



Summary for Pond 2P: Existing Lower Ash Pond

Inflow Area = 97.935 ac,100.00% Impervious, Inflow Depth = 28.46" for PMP 06hr event
Inflow = 3,782.71 cfs @ 3.11 hrs, Volume= 232.241 af
Outflow = 514.69 cfs @ 3.70 hrs, Volume= 232.241 af, Atten= 86%, Lag= 35.3 min
Primary = 514.69 cfs @ 3.70 hrs, Volume= 232.241 af

Routing by Stor-Ind method, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs
Peak Elev= 14.52' @ 3.70 hrs Surf.Area= 30.997 ac Storage= 141.284 af

Plug-Flow detention time= 150.8 min calculated for 232.241 af (100% of inflow)
Center-of-Mass det. time= 150.7 min (343.9 - 193.2)

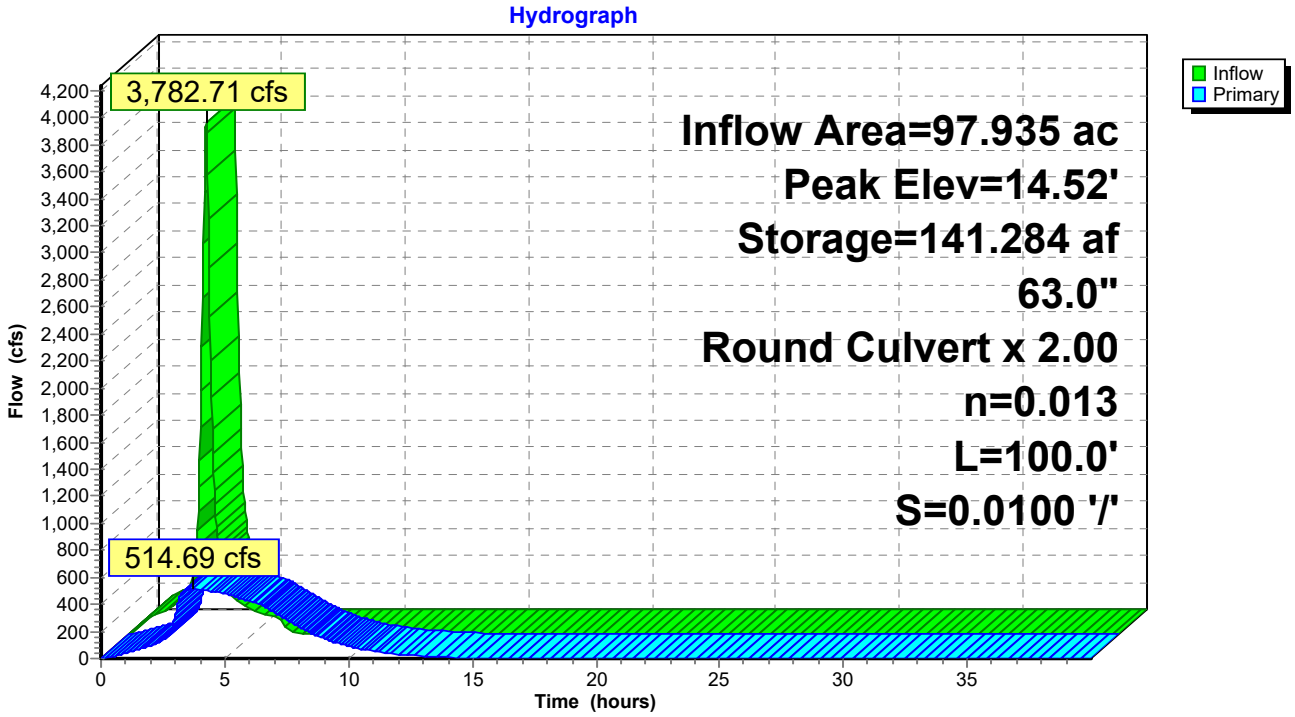
Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	274.798 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
6.00	0.272	560.0	0.000	0.000	0.272
7.00	6.818	3,130.0	2.817	2.817	17.597
8.00	10.509	4,200.0	8.597	11.414	31.925
9.00	13.453	4,905.0	11.951	23.365	43.652
10.00	15.865	5,700.0	14.642	38.008	59.055
11.00	18.777	6,565.0	17.301	55.308	78.437
12.00	21.747	6,965.0	20.244	75.552	88.325
13.00	24.821	7,400.0	23.267	98.819	99.741
14.00	28.948	8,035.0	26.858	125.677	117.648
15.00	32.945	8,245.0	30.925	156.602	123.896
16.00	36.748	10,085.0	34.829	191.431	185.511
17.00	41.453	12,420.0	39.077	230.508	281.511
18.00	47.189	13,020.0	44.290	274.798	309.397

Device	Routing	Invert	Outlet Devices
#1	Primary	5.80'	**63.0" Round Culvert X 2.00** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.80' / 4.80' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 21.65 sf

Primary OutFlow Max=514.68 cfs @ 3.70 hrs HW=14.52' (Free Discharge)
1=Culvert (Inlet Controls 514.68 cfs @ 11.89 fps)

Pond 2P: Existing Lower Ash Pond

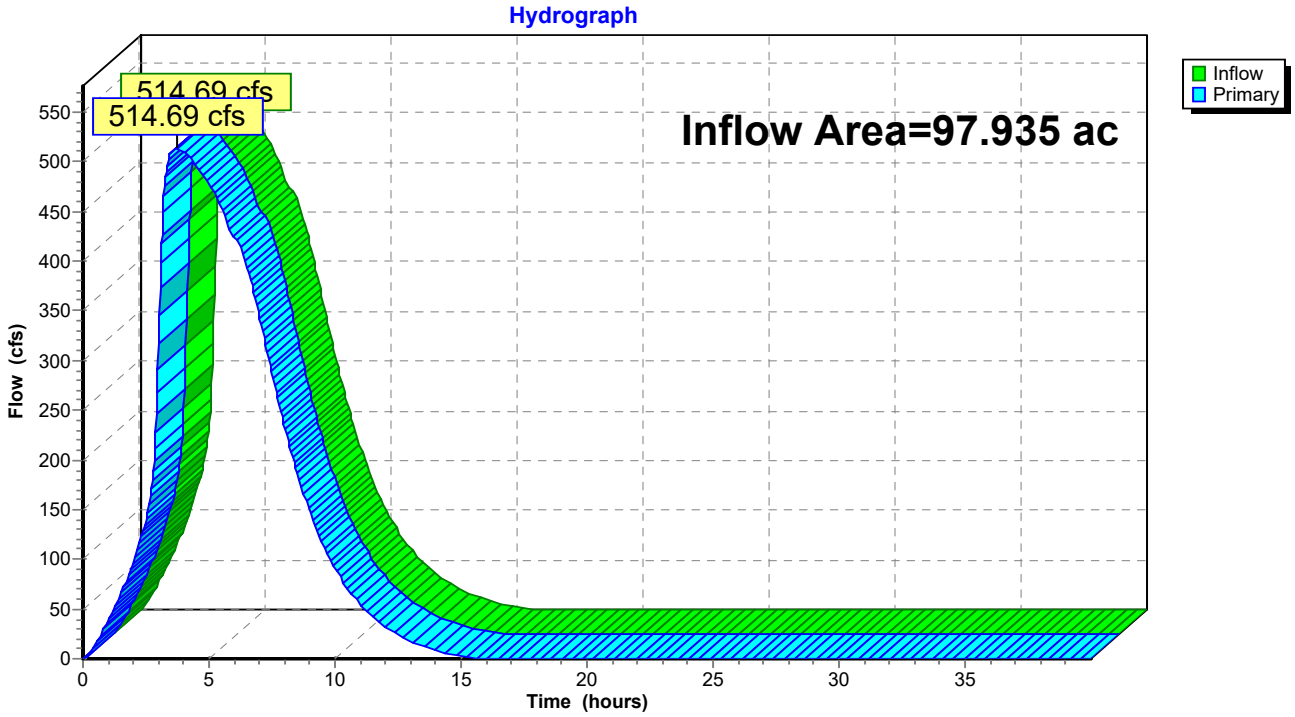


Summary for Link 3L: Thermal Channel

Inflow Area = 97.935 ac,100.00% Impervious, Inflow Depth = 28.46" for PMP 06hr event
Inflow = 514.69 cfs @ 3.70 hrs, Volume= 232.241 af
Primary = 514.69 cfs @ 3.70 hrs, Volume= 232.241 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs

Link 3L: Thermal Channel



Time span=0.00-40.00 hrs, dt=0.03 hrs, 1334 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 1S: Chesterfield - Runoff Area=97.935 ac 100.00% Impervious Runoff Depth=33.66"
Flow Length=2,230' Slope=0.0100 '/' Tc=19.6 min CN=98 Runoff=3,754.14 cfs 274.678 af

Pond 2P: Existing Lower Ash Pond Peak Elev=14.58' Storage=143.032 af Inflow=3,754.14 cfs 274.678 af
63.0" Round Culvert x 2.00 n=0.013 L=100.0' S=0.0100 '/' Outflow=517.05 cfs 274.678 af

Link 3L: Thermal Channel Inflow=517.05 cfs 274.678 af
Primary=517.05 cfs 274.678 af

Total Runoff Area = 97.935 ac Runoff Volume = 274.678 af Average Runoff Depth = 33.66"
0.00% Pervious = 0.000 ac 100.00% Impervious = 97.935 ac

Summary for Subcatchment 1S: Chesterfield - Existing

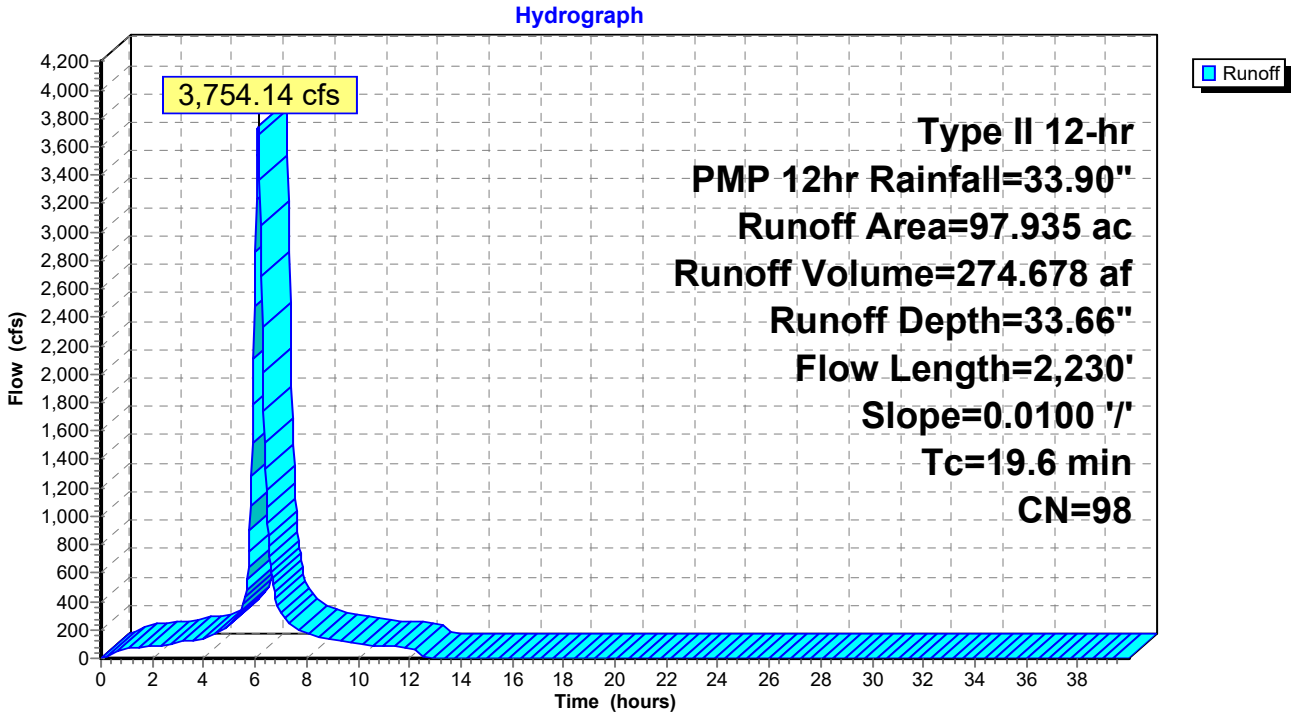
Runoff = 3,754.14 cfs @ 6.11 hrs, Volume= 274.678 af, Depth=33.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs
Type II 12-hr PMP 12hr Rainfall=33.90"

Area (ac)	CN	Description
97.935	98	Roofs, HSG C
97.935		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	300	0.0100	1.33		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 3.37"
15.8	1,930	0.0100	2.03		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
19.6	2,230	Total			

Subcatchment 1S: Chesterfield - Existing



Summary for Pond 2P: Existing Lower Ash Pond

Inflow Area = 97.935 ac,100.00% Impervious, Inflow Depth = 33.66" for PMP 12hr event
Inflow = 3,754.14 cfs @ 6.11 hrs, Volume= 274.678 af
Outflow = 517.05 cfs @ 6.69 hrs, Volume= 274.678 af, Atten= 86%, Lag= 35.0 min
Primary = 517.05 cfs @ 6.69 hrs, Volume= 274.678 af

Routing by Stor-Ind method, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs
Peak Elev= 14.58' @ 6.69 hrs Surf.Area= 31.223 ac Storage= 143.032 af

Plug-Flow detention time= 146.2 min calculated for 274.472 af (100% of inflow)
Center-of-Mass det. time= 146.4 min (521.8 - 375.4)

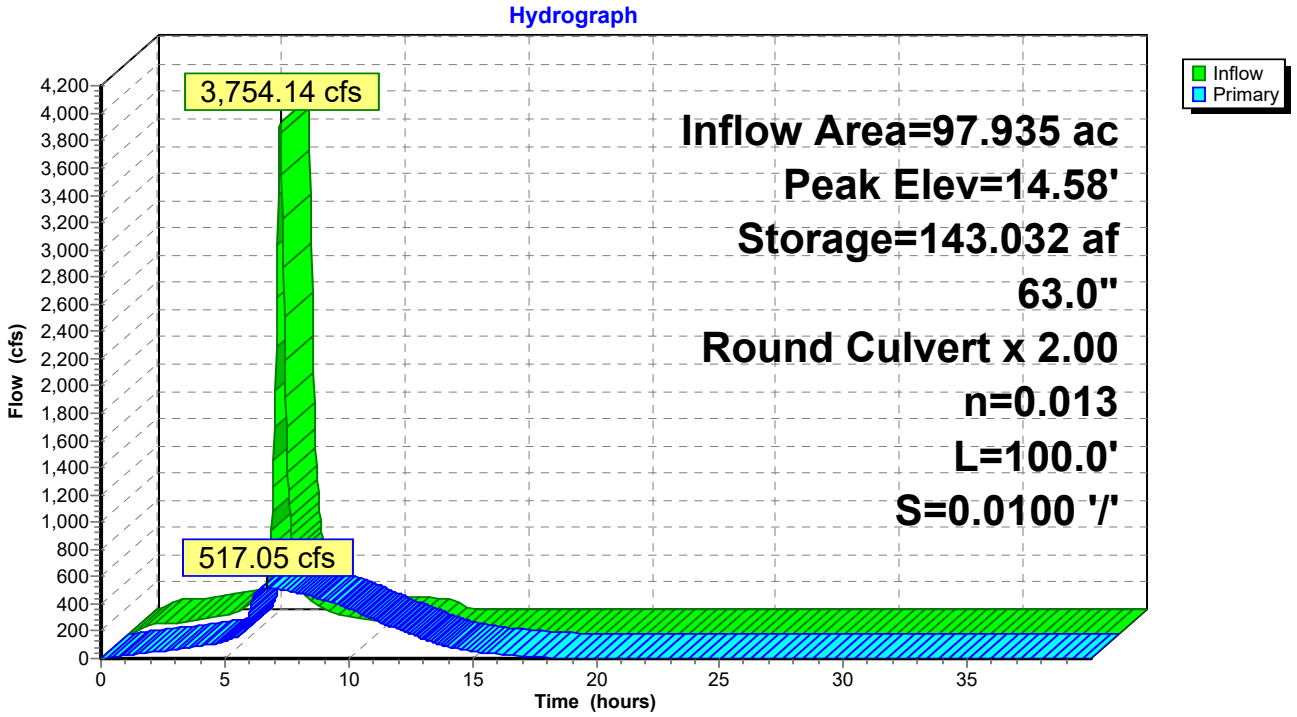
Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	274.798 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
6.00	0.272	560.0	0.000	0.000	0.272
7.00	6.818	3,130.0	2.817	2.817	17.597
8.00	10.509	4,200.0	8.597	11.414	31.925
9.00	13.453	4,905.0	11.951	23.365	43.652
10.00	15.865	5,700.0	14.642	38.008	59.055
11.00	18.777	6,565.0	17.301	55.308	78.437
12.00	21.747	6,965.0	20.244	75.552	88.325
13.00	24.821	7,400.0	23.267	98.819	99.741
14.00	28.948	8,035.0	26.858	125.677	117.648
15.00	32.945	8,245.0	30.925	156.602	123.896
16.00	36.748	10,085.0	34.829	191.431	185.511
17.00	41.453	12,420.0	39.077	230.508	281.511
18.00	47.189	13,020.0	44.290	274.798	309.397

Device	Routing	Invert	Outlet Devices
#1	Primary	5.80'	**63.0" Round Culvert X 2.00** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.80' / 4.80' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 21.65 sf

Primary OutFlow Max=517.05 cfs @ 6.69 hrs HW=14.58' (Free Discharge)
1=Culvert (Inlet Controls 517.05 cfs @ 11.94 fps)

Pond 2P: Existing Lower Ash Pond

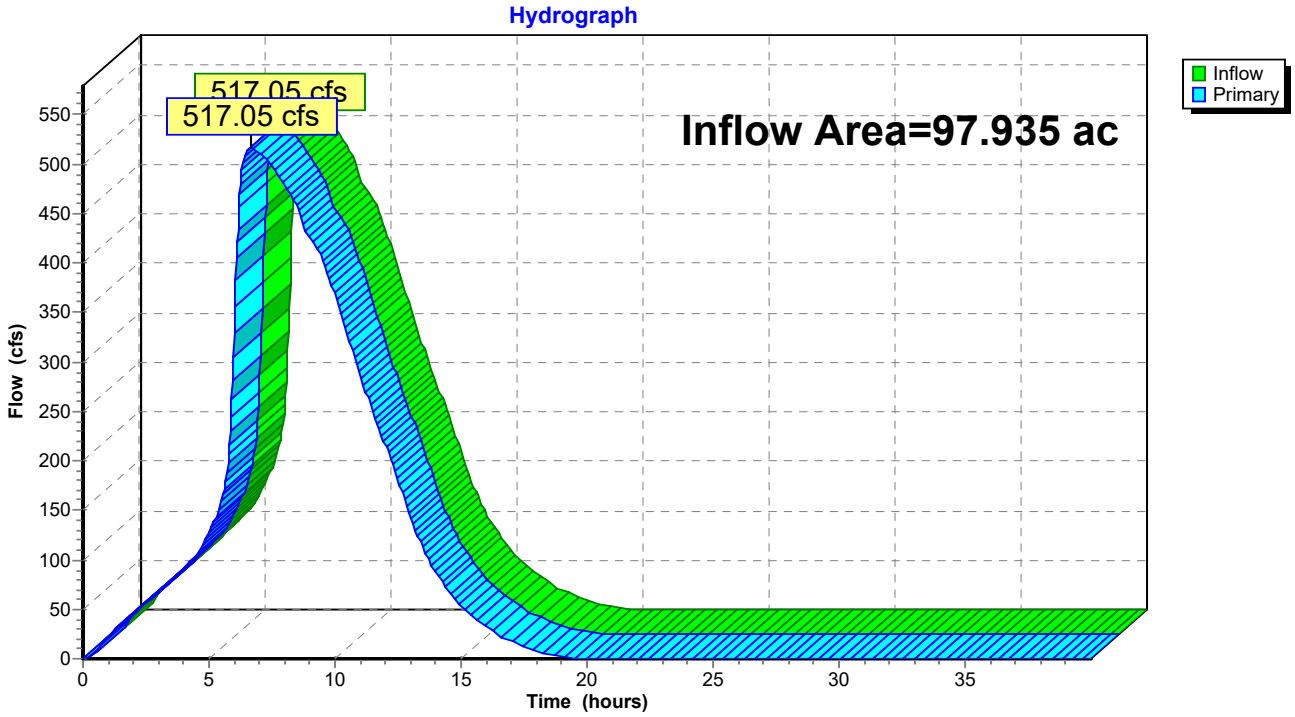


Summary for Link 3L: Thermal Channel

Inflow Area = 97.935 ac,100.00% Impervious, Inflow Depth = 33.66" for PMP 12hr event
Inflow = 517.05 cfs @ 6.69 hrs, Volume= 274.678 af
Primary = 517.05 cfs @ 6.69 hrs, Volume= 274.678 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs

Link 3L: Thermal Channel



Time span=0.00-40.00 hrs, dt=0.03 hrs, 1334 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 1S: Chesterfield - Runoff Area=97.935 ac 100.00% Impervious Runoff Depth=38.16"
Flow Length=2,230' Slope=0.0100 '/' Tc=19.6 min CN=98 Runoff=3,578.19 cfs 311.402 af

Pond 2P: Existing Lower Ash Pond Peak Elev=14.35' Storage=135.940 af Inflow=3,578.19 cfs 311.402 af
63.0" Round Culvert x 2.00 n=0.013 L=100.0' S=0.0100 '/' Outflow=507.27 cfs 311.402 af

Link 3L: Thermal Channel Inflow=507.27 cfs 311.402 af
Primary=507.27 cfs 311.402 af

Total Runoff Area = 97.935 ac Runoff Volume = 311.402 af Average Runoff Depth = 38.16"
0.00% Pervious = 0.000 ac 100.00% Impervious = 97.935 ac

Summary for Subcatchment 1S: Chesterfield - Existing

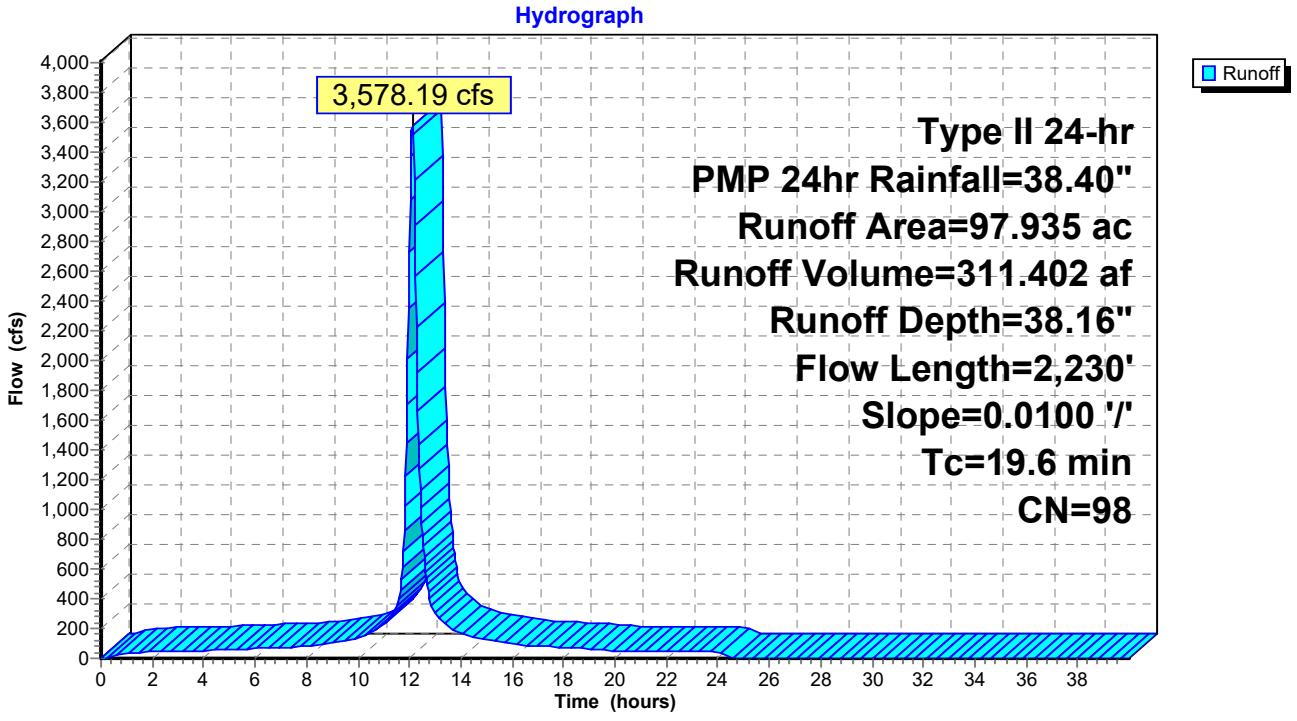
Runoff = 3,578.19 cfs @ 12.11 hrs, Volume= 311.402 af, Depth=38.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs
Type II 24-hr PMP 24hr Rainfall=38.40"

Area (ac)	CN	Description
97.935	98	Roofs, HSG C
97.935		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	300	0.0100	1.33		**Sheet Flow, Sheet** Smooth surfaces n= 0.011 P2= 3.37"
15.8	1,930	0.0100	2.03		**Shallow Concentrated Flow, Shallow** Paved Kv= 20.3 fps
19.6	2,230	Total			

Subcatchment 1S: Chesterfield - Existing



Summary for Pond 2P: Existing Lower Ash Pond

Inflow Area = 97.935 ac,100.00% Impervious, Inflow Depth = 38.16" for PMP 24hr event
Inflow = 3,578.19 cfs @ 12.11 hrs, Volume= 311.402 af
Outflow = 507.27 cfs @ 12.68 hrs, Volume= 311.402 af, Atten= 86%, Lag= 34.3 min
Primary = 507.27 cfs @ 12.68 hrs, Volume= 311.402 af

Routing by Stor-Ind method, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs
Peak Elev= 14.35' @ 12.68 hrs Surf.Area= 30.304 ac Storage= 135.940 af

Plug-Flow detention time= 136.0 min calculated for 311.169 af (100% of inflow)
Center-of-Mass det. time= 136.0 min (873.8 - 737.8)

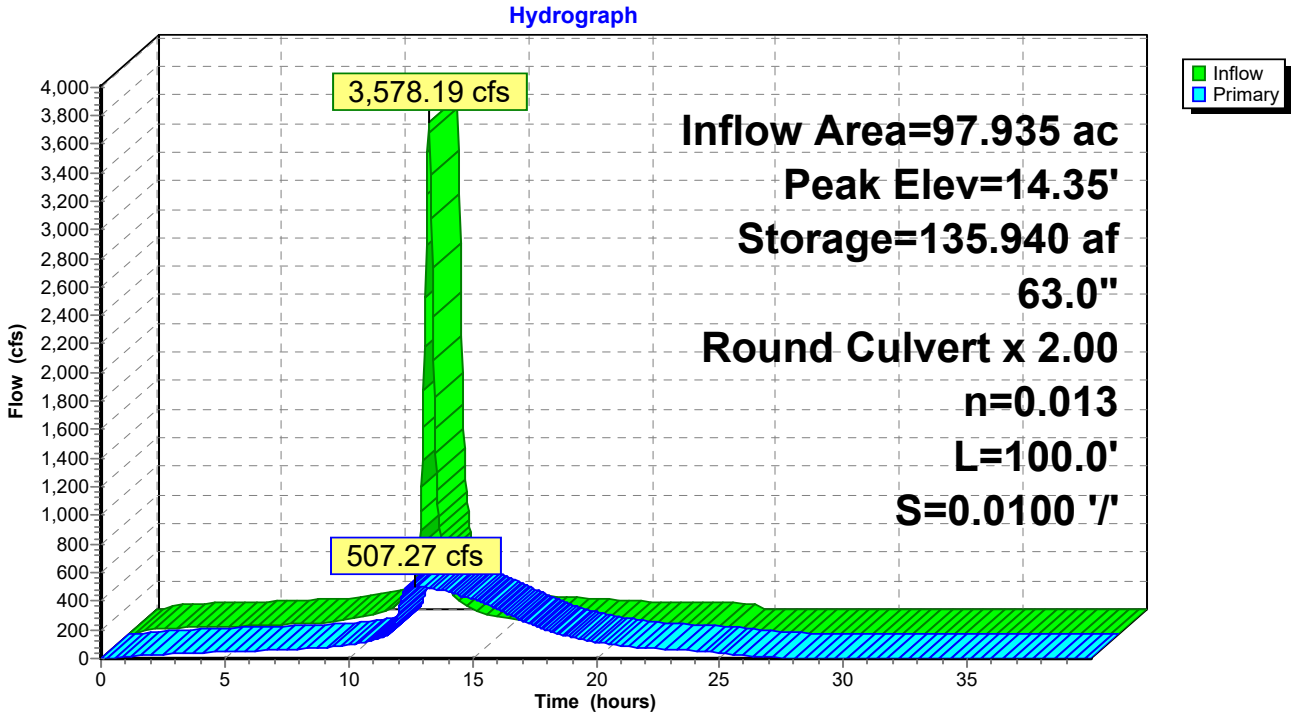
Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	274.798 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
6.00	0.272	560.0	0.000	0.000	0.272
7.00	6.818	3,130.0	2.817	2.817	17.597
8.00	10.509	4,200.0	8.597	11.414	31.925
9.00	13.453	4,905.0	11.951	23.365	43.652
10.00	15.865	5,700.0	14.642	38.008	59.055
11.00	18.777	6,565.0	17.301	55.308	78.437
12.00	21.747	6,965.0	20.244	75.552	88.325
13.00	24.821	7,400.0	23.267	98.819	99.741
14.00	28.948	8,035.0	26.858	125.677	117.648
15.00	32.945	8,245.0	30.925	156.602	123.896
16.00	36.748	10,085.0	34.829	191.431	185.511
17.00	41.453	12,420.0	39.077	230.508	281.511
18.00	47.189	13,020.0	44.290	274.798	309.397

Device	Routing	Invert	Outlet Devices
#1	Primary	5.80'	**63.0" Round Culvert X 2.00** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.80' / 4.80' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 21.65 sf

Primary OutFlow Max=507.27 cfs @ 12.68 hrs HW=14.35' (Free Discharge)
1=Culvert (Inlet Controls 507.27 cfs @ 11.72 fps)

Pond 2P: Existing Lower Ash Pond

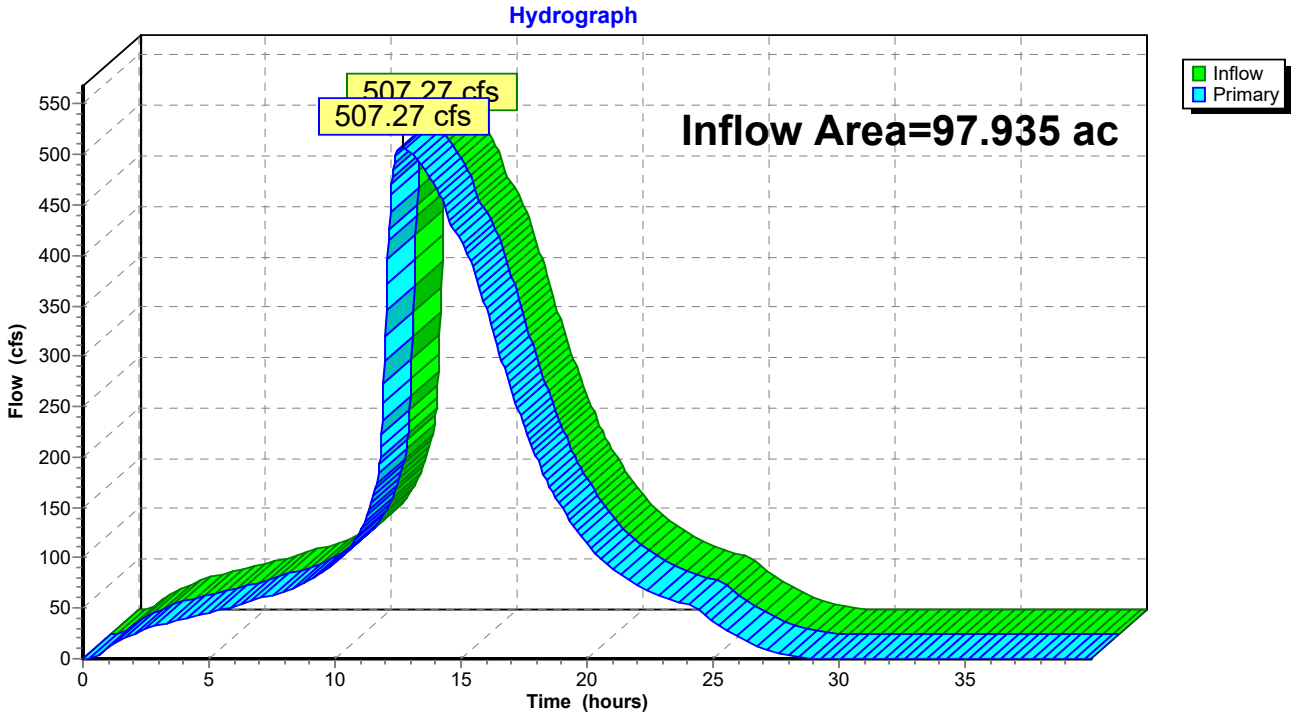


Summary for Link 3L: Thermal Channel

Inflow Area = 97.935 ac,100.00% Impervious, Inflow Depth = 38.16" for PMP 24hr event
Inflow = 507.27 cfs @ 12.68 hrs, Volume= 311.402 af
Primary = 507.27 cfs @ 12.68 hrs, Volume= 311.402 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-39.99 hrs, dt= 0.03 hrs

Link 3L: Thermal Channel



Appendix D

Closure Cost Estimate

Solid Waste Disposal Facility
Cost Estimate Form, DEQ Form CE SWDF

Facility Name: Chesterfield Power Station Lower Ash Pond Permit No. SWP

Location Address: 701 Coxendale Road

City, State, Zip: Chester, VA, 23836

FA Holder: Virginia Electric and Power Company

Estimate Prepared by: Gabe Lang, AECOM

Indicate the plan versions for which this cost estimate was prepared, identifying the following information for each plan:

Closure Plan		Post-Closure Plan	
Title: Surface Impoundment Closure Plan: Lower Ash Pond		Title: N/A	
Plan Date: October, 2020	Approved:	Plan Date:	Approved:
Consultant: AECOM		Consultant:	
Corrective Action Plan		**Corrective Action Monitoring Plan**	
Title: N/A		Title: N/A	
Plan Date:	Approved:	Plan Date:	Approved:
Consultant:		Consultant:	

Cost Estimate Summary

Closure Cost Element	Total Cost	Notes
Total Closure Cost:	$ 196,596,642	
Total Post-Closure Cost:	$	
Total Corrective Action Cost:	$	
Total:	**$ 196,596,642**	

References: Please indicate references used to develop this cost estimate:

Unit costs were independently developed by AECOM as a part of the Closure Design process utilizing our internal costing experience and estimators.

CERTIFICATION BY PREPARER

This is to certify that the cost estimates pertaining to the engineering features and monitoring requirements of this solid waste management facility have been prepared by me and are representative of the design specified in the facility's Closure Plan. The estimate is based on the cost of hiring a third party and does not incorporate any salvage value that may be realized by the sale of wastes, facility structures, or equipment, land or other facility assets at the time of closure. In my professional judgment, the cost estimates are a true, correct, and complete representation of the financial liabilities for closure and postclosure care of the facility and comply with the requirements of 9 VAC 20-70 and all other DEQ rules and statutes of the Commonwealth of Virginia.

SIGNATURE:  DATE: 12/4/2020

NAME: Gabriel Lang

TITLE: Vice President/Program Manager

Acknowledgement by Owner / Operator:

SIGNATURE: Robert W. Sauer
Robert W. Sauer (Dec 18, 2020 09:32 EST) DATE: Dec 18, 2020

NAME: Robert W. Sauer

TITLE: VP System Operations

Chesterfield Power Station
Lower Ash Pond Closure by Removal Cost Estimate

Item #	Line Item	Units	Quantity	Unit Rate ($US)	Bid Item Total ($US)	Notes/Assumptions
1	General Conditions	LS	1	$ 10,560,000	$ 10,560,000	Incidental costs associated with the project including Project Management, Job Office & associated costs, Safety Manager(s), Safety Training and Supplies, Quality Control, Environmental Protection Plan compliance, pumps for water control, and other incidental overhead costs.
2	Construction Surveying	LS	1	$ 805,000	$ 805,000	Includes, but is not limited to, existing site control tie in (horizontal and vertical), establishment of Limits of Disturbance (LOD), wetlands, RPA, etc., As-built/record drawings, and all required layout items.
3	Mobilization	LS	1	$ 207,000	$ 207,000	Temporary facilities, owned/leased/rented equipment, temporary sanitary facilities, electrical/telecom connection and equipment, and all required permits and plans.
4	Site Preparation	LS	1	$ 13,327,000	$ 13,327,000	Lay down area development, truck wash procurement, installation, startup and commissioning, and operation and maintenance, and Instrumentation installation and monitoring (in accordance with the Instrumentation Monitoring Plan).
5	Monitoring Wells	LS	1	$ 360,000	$ 360,000	Monitoring well protection (24 wells), adjustment (26 wells), and abandonment (19 wells).
6	Temporary Access Road Construction	LS	1	$ 87,000	$ 87,000	Aggregate, typical asphalt, and concrete temporary access roads.
7	Demolition	LS	1	$ 2,446,000	$ 2,446,000	Removal of the existing liner/wind defender, twin 63" HDPE outlet pipes, remaining culvert pipes, utility protection, utility relocation, and pavement/road removal.
8	Dewatering System	LS	1	$ 22,518,000	$ 22,518,000	Procurement of all required materials, and all labor and equipment for the installation, commissioning, testing, operation, maintenance, and demolition/removal of the dewatering system.
9	Contact Water Management System	LS	1	$ 3,170,000	$ 3,170,000	Procurement of all required materials, and all labor and equipment for the installation, commissioning, testing, operation, maintenance, and demolition/removal of the contact water management system to maintain separation of the contact water from any stormwater.
10	Stormwater Management System	LS	1	$ 2,578,000	$ 2,578,000	Procurement of all required materials, and all labor and equipment for the installation, commissioning, testing, operation, maintenance, and demolition/removal of the stormwater management system to maintain separation of the stormwater from any contact water.
11	CCR Material Handling				$ 52,302,000	
11a	Excavation, Hauling, Placing, and Compacting at On-Site Landfill (FFCP)	CY	2,800,000	$ 17.34	$ 48,552,000	Labor, resources, equipment, and materials required to test, excavate, haul, place, and compact CCR at the FFCP landfill.
11b	Excavation and Hauling to Off-Site Landfill	Ton	125,000	$ 30.00	$ 3,750,000	Labor, resources, equipment, and materials required to test, excavate, and haul via truck to an Off-site Landfill.
12	Sub-Soil (6" Over excavation) Material Handling	CY	87,000	$ 16.94	$ 1,473,780	Includes all labor, resources, equipment, and materials required to excavate, haul, place, and compact at the FFCP landfill.
13	On-site Fill	CY	1,800,000	$ 5.20	$ 9,360,000	Excavate, Haul, Place, and Compact On-Site Fill Material.
14	Off-site Fill	CY	1,200,000	$ 37.89	$ 45,468,000	Purchase, Haul, Place, and Compact Off-Site Fill Material.
15	Earthwork	CY	84,000	$ 4.66	$ 391,440	Berm modifications/lowering and all earthwork items outside the limits of the LAP.
16	Stormwater	LS	1	$ 904,000	$ 904,000	Procurement of all required materials and all labor and equipment for the installation of all stormwater outlets, including RCP, Endwalls, bedding and backfill, outlet protection, emergency spillway, and all appurtenances.
17	Erosion and Sediment Controls	LS	1	$ 7,191,000	$ 7,191,000	Controls used during CCR Excavation (as needed) and Final Site Plan Grading to reduce erosion and sedimentation, including but not limited to construction entrance, silt fence, super silt fence, inlet protection, temporary diversion berm, temporary sediment trap, temporary sediment basin, temporary slope drain, outlet protection, rock check dams, riprap, turbidity curtains, concrete lined channels, temporary seeding, permanent seeding, mulching, rolled erosion control products, flexible growth medium, soil amendments, maintenance, and removal.
18	Pavement Installation	LS	1	$ 2,768,000	$ 2,768,000	Procurement of required materials, and all labor and equipment for the installation including the Henricus Park Road improvements along the LAP.
19	Access Road Repair	LS	1	$ 64,000	$ 64,000	Procurement of required materials, and all labor and equipment for the repair of site access roads.
20	Fence and Gates	LS	1	$ 358,000	$ 358,000	Procurement of required materials, and all labor and equipment for the installation of the security fence, wooden fence, and all gates.
21	Demobilization	LS	1	$ 106,000	$ 106,000	Removal of all items not required for ponds post closure operation and maintenance, including items within pond closure construction laydown area development and mobilization.
22	Groundwater Monitoring	Year	30	$ 76,000	$ 2,280,000	Yearly groundwater monitoring and required annual reporting.
23	Contingency (10%)	%	1	$ 17,872,422	$ 17,872,422	
				Total	$ 196,596,642	

The enclosed Opinion of Probable Cost is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to; local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events and developing bidding conditions, etc. may affect the accuracy of this estimate. AECOM is not responsible for any variance from this Opinion of Probable Cost or actual prices and conditions obtained.

SURFACE IMPOUNDMENT CLOSURE PLAN
UPPER ASH POND
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TABLE OF CONTENTS

Section ***Page***

1.0 PLAN CERTIFICATION 1
2.0 INTRODUCTION 2
2.1 General UAP Information 2
3.0 CLOSURE IMPLEMENTATION 3
3.1 Overview of Closure Approach 3
3.2 CCR Transportation Plan 4
3.3 Contact Water Management and Treatment 5
3.4 Erosion and Sediment and Stormwater Controls during Closure 6
4.0 CLOSURE TIMEFRAMES 7
5.0 INVENTORY REMOVAL AND DISPOSAL 7
5.1 Waste Removal, Decontamination and Disposal 7
5.2 Sampling and Testing Program 8
5.3 Other Areas 8
6.0 FINAL CLOSURE AND POST-CLOSURE IMPLEMENTATION 9
6.1 Post-Closure Stormwater Controls 9
6.2 Dam Modification 9
6.3 Posting 9
6.4 Certification 10
6.5 Post-Closure Use 10
7.0 CLOSURE COST ESTIMATE 10

LIST OF TABLES

Table 4-1 Projected UAP Closure Timeline 7

LIST OF APPENDICES

Appendix A Traffic Impact Analysis

Appendix B Contact Water Pond Design Calculations

Appendix C Stormwater Calculations

Appendix D Closure Cost Estimate

1.0 PLAN CERTIFICATION

This Closure Plan for the Upper Ash Pond (UAP) at the Chesterfield Power Station was prepared by AECOM. The document and Certification/Statement of Professional Opinion are based on and limited to information that AECOM has relied on from Dominion Energy and others, but not independently verified, as well as work products produced by AECOM.

On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the Commonwealth of Virginia that this document has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the document was prepared consistent with the requirements in §257.102 of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015, with an effective date of October 19, 2015 (40 CFR §257.102), as well as with the requirements in §257.100 resulting from the EPA's "Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vacatur" published in the Federal Register on August 5, 2016 with an effective date of October 4, 2016 (40 CFR §257.100).

The use of the word "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

_____
Printed Name of Professional Engineer

_____ _____
Commonwealth of Virginia License No. Signature and Date

2.0 INTRODUCTION

Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion) owns and operates the Chesterfield Power Station (Station) located at 500 Coxendale Road in Chesterfield County, Virginia. The Station includes two Coal Combustion Residuals (CCR) surface impoundments, as well as a Fossil Fuel Combustion Products (FFCP) Management Facility operating under Virginia Department of Environmental Quality (VADEQ) Solid Waste Facility Permit No. 609, issued on June 29, 2016.

This Closure Plan was prepared for one of the Station's CCR surface impoundments, the Upper Ash Pond (UAP), and describes the design for closure of the UAP. A separate Closure Plan is being submitted for the other CCR surface impoundment, the Lower Ash Pond (LAP). This Closure Plan is being submitted to VADEQ as part of a Part B Solid Waste Closure Permit Application (Permit Application). This Closure Plan was prepared in accordance with 40 CFR 257, Subpart D and is consistent with the requirements of 40 CFR 257.102 for closure of CCR surface impoundments and 9 VAC 20-81-800 of the Virginia Solid Waste Management Regulations (VSWMR). The UAP will be closed by removal pursuant to 40 CFR 257.102(c) and § 10.1-1402.03 of the Code of Virginia.

2.1 General UAP Information

As noted previously, there are three CCR units at the Station, the UAP, the LAP, and the FFCP Management Facility. This Closure Plan is for the UAP only. The UAP is a surface impoundment that was used by the Station to store CCR material. The UAP is currently regulated under the following permits:

- VADEQ Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004146
- Virginia Department of Conservation and Recreation (DCR) Operation and Maintenance Certification, Inventory No. 04145

It is Dominion's intent to monitor groundwater for the UAP under the solid waste permit and remove these requirements from the referenced VPDES permit.

The UAP is approximately 113 acres in size. The estimated volume of CCR material in the UAP is approximately 11.8 million cubic yards (MCY). The UAP is constructed of earthen dikes, with a 20-foot

minimum crest width at approximate elevation of 40 feet above mean sea level (MSL). The estimated bottom of CCR material grades in the UAP are presented on Drawing No. 004 (Estimated Bottom of CCR Material Plan). The maximum bottom elevation level of CCR material in the UAP is estimated to be minus 12 feet below MSL. The estimated area of disturbance to complete the UAP closure activities is 140 acres.

3.0 CLOSURE IMPLEMENTATION

3.1 Overview of Closure Approach

This Closure Plan provides for the closure of the UAP by removal of the CCR material. Closure is considered complete under 40 CFR 257.102 and 9 VAC 20-81-810 when:

1. A Professional Engineer licensed in the Commonwealth of Virginia certifies all CCR has been removed from the UAP. In addition, consistent with its other closure by removal projects, Dominion will also over-excavate the visually clean certified area by a minimum of six (6) inches of underlying material.

2. The UAP's downgradient monitoring wells do not exhibit levels in excess of a maximum contaminant limit (MCL) or established groundwater protection standard for any CCR Appendix IV constituent on or after a minimum of ten sampling events have occurred after CCR material has been verified as removed by a Professional Engineer in Virginia.

It is estimated that there is approximately 14.6 MCY of CCR material to be removed from the UAP and LAP combined. Approximately 11.8 MCY of CCR material will be excavated and removed from the UAP. All CCR material removed from the UAP will be relocated to the FFCP Management Facility or an offsite permitted industrial waste landfill for disposal, or beneficially reused offsite. The expected storage capacity of the FFCP Management Facility is 9.36 MCY. Approximately 0.43 MCY of production CCR material is anticipated from ongoing and future Station operations. A combination of fill material generated from future onsite activities at the Chesterfield Power Station and soil imported from offsite will be used as backfill material to complete the UAP closure and site restoration activities.

Dominion is proposing phased excavation and removal plans for the purposes of managing stormwater and contact water. Once the CCR material has been removed and the UAP backfilled with soil, the UAP will

be graded to promote stormwater drainage and seeded to establish cover vegetation. The final closure grades are shown on Drawing No. 005 (Final Grading Plan); profiles of the final closure grades are shown on Drawing Nos. 007 through 009 and details are provided on Drawing No. 010. The final closure grades will be established at an elevation between 10 and 23 feet above MSL around the perimeter, and then graded at 0.5% minimum upwards towards the northern portion of the pond to approximate elevation 23 feet above MSL. The closure area will consist of the following from top to bottom:

- 1-foot topsoil layer capable of supporting vegetative growth;
- 3-feet of low permeability fill soil ($k < 1 \times 10\text{-}5$ cm/sec); and,
- Compacted fill soil, at least 6 inches below the bottom elevation of the CCR material.

Dominion's Construction Quality Assurance (CQA) representative will perform field compaction testing of the compacted, low permeability, and structural fill soil to verify conformance with the compaction standards.

After topsoil placement is completed, Dominion will apply seed, fertilizer, lime, and mulch, in accordance with the VADEQ Erosion & Sediment Control Handbook (VESCH), to achieve a permanent vegetative cover over the closure area.

3.2 CCR Transportation Plan

Dominion is planning to haul the excavated CCR from the UAP to the FFCP Management Facility or to a potential beneficial use facility on Dominion property located to the northwest of the current pond locations. This will require a rotation of trucks for CCR hauling to circulate between the UAP, the FFCP Management Facility, and the beneficial use facility for an extended duration until the project is complete. The hauling route for trucks between the UAP, the FFCP Management Facility, and the beneficial use facility involves adding truck traffic associated with the project to public roadways. Therefore, a traffic impact analysis (TIA) was performed to determine if any potential significant impacts to the existing public roadway network or projected traffic operations would result from the proposed project. A copy of the TIA is provided in Appendix A.

Based on the results of operational analysis and the findings of the TIA, it is projected that the CCR truck hauling operations are not expected to have a significant impact on study area traffic operations at any point between existing conditions through final closure conditions (2035 conditions) for any of the anticipated circulating truck loads. A conservative 100-truck schedule is also not projected to impact operations or deteriorate any turning movement below Level of Service B in the study area during the closure timeframe. Therefore, no mitigation is needed in association with the currently projected Dominion trucking operations.

3.3 Contact Water Management and Treatment

Dominion will ensure that contact water, including water from dewatering efforts, and any other non-stormwater flows are kept separate from stormwater at all times during closure activities. Contact water and any other non-stormwater flows will require treatment prior to discharge. A Centralized Source Water Treatment System (CSWTS) will be constructed onsite for wastewater treatment and will have a design capacity of 1,500 gallons per minutes (gpm). A Concept Engineering Report (CER) for the CSWTS was submitted to the VADEQ Water Division under the Station's existing VPDES permit and was approved by the Water Division on September 16, 2020. Treated effluent discharged from the CSWTS will meet all applicable requirements in the VPDES permit. The CSWTS is expected to be operational by April 2021.

For each phase of CCR excavation and removal, Dominion will install Best Management Practices (BMPs), such as lined contact water ponds, for the management of the contact water generated during CCR material excavation. Contact water ponds will be sized to contain the runoff volume from a 100-year, 24-hour storm event for the contributing drainage area (see Appendix B for calculations). Contact water ponds will be lined with 40-mil linear low-density polyethylene (LLDPE), and the liner will be anchored around the entire perimeter top of the contact water pond. For each phase, Dominion will convey the contact water from the contact water pond(s) or other BMPs to a connection on the CSWTS influent pipe.

Contact water from the active excavation area will be conveyed by gravity or pumped from the active excavation area to the contact water pond(s) or other BMPs when possible. For CCR excavation below the lined pond invert, Dominion will construct sumps or other BMPs in each active excavation area to convey the contact water from the active excavation area to the contact water pond(s).

Dewatering of the active excavation area will also be provided to maintain safe water levels and facilitate dry excavation of the CCR material. Contact water from dewatering efforts will be conveyed to the contact water ponds or other storage location prior to being sent to the CSWTS for treatment. Dominion will provide other means of storage or management of contact water (e.g. tanks) in addition to the contact water ponds, as needed, to ensure that the discharge flow to the CSWTS does not exceed 1,500 gpm.

3.4 Erosion and Sediment and Stormwater Controls during Closure

Currently, stormwater within the UAP site sheet-flows from the top of the impoundment to the existing let-downs along the side slopes that discharge into ditches draining to the existing stormwater/sedimentation basin in the eastern portion of the UAP site. Stormwater from this basin leaves the site through an existing VPDES outfall (005) under the Station's VPDES permit. The existing ditches and stormwater/sedimentation basin will remain in place as the removal process starts and will only be removed once additional temporary or permanent measures are implemented.

Temporary sediment and erosion control measures will be utilized throughout all phases of closure activities. The existing stormwater/sedimentation basin in the eastern portion of the UAP site and the proposed, temporary stormwater/sedimentation basins shown on Drawing No. 006 (Erosion and Sediment Control Plan) will be the primary stormwater and erosion and sediment (E&S) control utilized during CCR excavation and removal. Stormwater will be conveyed to the sedimentation basins by existing drainage ditches, temporary stormwater diversion berms, and/or by stormwater pumping operations. The existing UAP perimeter dam will also provide stormwater/flood control for the site, as it will be maintained at its existing condition through the CCR excavation and removal process. Once the new sedimentation basins and outlets are operational, existing VPDES outfall 005 will be removed from service, prior to the excavation portion of this phase of work. After stabilization of the final UAP closure area is complete, the temporary stormwater/sedimentation basins will be decommissioned by removing sediment accumulation and the riser structures

Additional E&S controls to be installed during UAP closure activities include dual bay truck washes, super silt fence, and a Flexible Growth Medium (FGM) or equivalent lining for slope stabilization. Locations and details are provided on Drawing Nos. 006 and 010 in Attachment III of the Permit Application package. Design calculations for the E&S and stormwater controls during closure are provided in Appendix C.

4.0 CLOSURE TIMEFRAMES

Dominion has elected to excavate and remove all CCR material from the UAP for disposal in the FFCP Management Facility or an offsite permitted landfill, or for beneficial reuse offsite. It is anticipated that the UAP closure activities may take approximately 13 years to complete once started.

The projected timeframes for closure activities are provided in Table 4-1 below.

Table 4-1 Projected UAP Closure Timeline

Activity	Tentative Date
Commencement of CCR Removal/Closure Activities - UAP	2nd Quarter 2021
Completion of Closure	NLT April 2034

Closure is considered complete when the elements of this Closure Plan specified above have been performed as certified by a Professional Engineer licensed in the Commonwealth of Virginia. This certification will be included as part of a closure certification report. In accordance with 40 CFR 257.102(h), Dominion will prepare a notification of closure of the UAP within 30 days of completion of closure and will place the notification in the operating record.

5.0 INVENTORY REMOVAL AND DISPOSAL

5.1 Waste Removal, Decontamination and Disposal

The protocol for closure by removal of the UAP will involve removing accumulated CCR such that no residual materials remain visible, followed by over-excavating the removal footprint by a minimum of six (6) inches. Removed CCR material will be transferred to the FFCP Management Facility or an offsite permitted industrial waste landfill, or beneficially reused offsite. To facilitate effective management of stormwater and contact water, closure by removal of areas within the UAP will be achieved in phases. The phased closures will be sequenced as necessary to support traffic patterns and other constraints, including the management of stormwater and contact water during a 100-year, 24-hour design storm event. A phased approach will also allow for documentation of certified clean areas within the excavation area that are approved for soil backfill. Temporary CCR excavation slopes will not exceed 5H:1V.

In environmentally-sensitive areas outside of the defined CCR unit boundary, such as Resource Protection Areas (RPAs), groundwater monitoring well locations, or wetlands, a modified excavation protocol will be followed for removal of any identified CCR. The CCR will be removed to a visually clean condition using methods that minimize impact to surrounding soils. Following CCR removal, the area will be stabilized to prevent erosion with materials suitable for the area.

Interim soil cover and vegetation (or approved equal) will be installed over excavation slopes. Water levels in the excavation area will be maintained at least 5-feet below the deepest excavation adjacent to the slope.

After CCR removal and certification, the UAP will be graded to promote stormwater drainage to the site's permitted stormwater outfalls. Vegetative stabilization will be established to prevent erosion. The area will be maintained as a grassy open area.

5.2 Sampling and Testing Program

After removal of the CCR material and the 6-inch over-excavation material from the UAP, the area will be visually inspected to verify the CCR removal and over-excavation has been achieved. In addition, the UAP will be further inspected by targeted soil cores, dug by hand using a hand auger or similar tool, to a depth of at least six (6) inches at a frequency of at least one core per acre.

Verification surveys of the pond closure will be prepared by a Commonwealth of Virginia licensed Land Surveyor and will consist of a survey of the "visually clean" surface and a survey of the "over-excavation" surface to verify the minimum 6-inch removal. Certification of the closure by removal will be provided by a Commonwealth of Virginia licensed Professional Engineer.

Groundwater monitoring will be conducted in accordance with the approved Groundwater Monitoring Plan to meet the closure by removal standard set forth in 40 CFR 257.102(c) and the VSWMR.

5.3 Other Areas

Aboveground and underground electric utilities currently run along the northern boundary of the UAP along Henricus Park Road. It is possible that CCR material may be found beneath the ground surface or that the existing utilities may be located within the limits of CCR in some locations. If this occurs, Dominion will

expose the utility by hand-digging, ensure the utility is appropriately supported, and carefully remove any CCR material in the vicinity of the utility within the waste unit boundary.

The aboveground and underground utilities will need to be relocated by others prior to closure activities. Dominion will over-excavate and remove the pole foundations for offsite disposal.

6.0 FINAL CLOSURE AND POST-CLOSURE IMPLEMENTATION

6.1 Post-Closure Stormwater Controls

The UAP post-closure stormwater controls are shown on Drawing No. 005 (Final Grading Plan) in Attachment III of the Permit Application package. Several tied concrete block mat-lined stormwater conveyance channels will direct stormwater runoff from the closure area to proposed stormwater outfalls in the closure area. The west outlet and emergency spillway will discharge to the Dutch Gap Conservation Area. The middle (southern) and east outlets and emergency spillways will discharge to the Old Channel of the James River. Design calculations for the post-closure stormwater controls are included in Appendix C.

6.2 Dam Modification

Dominion intends to request approval to lower and then decommission the existing dam around the western, southern, and eastern sides of the UAP closure area. Plan and details of the proposed dam modification are provided on Drawing Nos. 011 through 013 in Attachment III of the Permit Application package. Therefore, once the UAP is closed, the UAP will no longer be regulated as an impounding structure by DCR.

6.3 Posting

A gate will be installed at the entrance to the ponds on Coxendale Road at the conclusion of closure activities. The existing fence along the Henricus Park Hiking Trail on the downstream (southern) side of the UAP and along the upstream (northern) side of the UAP (Henricus Park Road) will be removed during closure construction and will be re-set at the completion of closure activities. A sign will be posted at the site entrance notifying all persons of the final closure of the UAP and the prohibition against further receipt of CCR.

6.4 Certification

Upon completion of closure construction, a certification statement signed by a Professional Engineer registered in the Commonwealth of Virginia will be placed in the operating record and submitted to VADEQ along with the documentation from the Sampling and Testing Program. The certification statement will read as follows:

> "I certify that closure has been completed in accordance with the Closure Plan dated [DATE] for Solid Waste Facility Permit No. XXX issued to Dominion Chesterfield Power Station, with the exception of the following discrepancies: TBD
>
> In addition, a sign was posted on [DATE] at the site entrance notifying all persons of the closing [and state other notification procedures if applicable] and barriers [indicate type] were installed at [location] to prevent new waste from being deposited.
>
> [Signature, date, and stamp of Professional Engineer]

6.5 Post-Closure Use

There are currently no proposed dedicated land uses for this area. A gravel-surfaced perimeter access road will be constructed around the UAP closure area. The existing Henricus Park hiking trail along the southern perimeter of the UAP will be reconstructed as needed at the completion of closure activities. The former UAP area will be allowed to revegetate and return to a natural habitat area.

7.0 CLOSURE COST ESTIMATE

The UAP closure cost estimate is estimated to be approximately $480,000,000. The estimate includes the cost of all closure construction activities, as well as costs for inspection, testing, and certification as proposed in this Closure Plan. See Appendix D for the Closure Cost Estimate.

Appendices

Appendix A

Traffic Impact Analysis

AECOM
10 South Jefferson Street
Roanoke, VA 24011
aecom.com

Project name:
Dominion Chesterfield Station

Project ref:
Traffic Impact Analysis

To:
Ginger Phelps - Dominion

From:
Stuart Martin, PE

CC:
Gabe Lang, PE

Date:
September 10, 2020

DRAFT

Memorandum

Subject: Dominion Chesterfield Station - Traffic Impact Analysis

Introduction

AECOM has been tasked with providing professional engineering services such as design and permitting support for Dominion related to proposed activities at Dominion's Chesterfield Power Station in Chester, Virginia. One of the proposed operations involves transporting CCR stored at the facility's Upper and Lower Ash Ponds to the FFCP management facility and to a potential beneficial use facility on Dominion property to the northwest of the current pond locations. This will require a rotation of trucks for CCR hauling to circulate between the ponds and the FFCP and beneficial use facility for an extended duration until the project is complete.

Purpose and Need

The hauling route for trucks between the ponds and the FFCP and beneficial use facility involve adding truck traffic associated with the project to public roadways. Therefore, a traffic impact analysis is required to determine any potential significant impacts to the existing public roadway network or projected traffic operations. The purpose of this memorandum is to summarize the traffic impact analysis performed by AECOM on behalf of Dominion for review by the Virginia Department of Transportation and Chesterfield County.

Study Area

The study area was determined to include any intersection involving public roadways that would be impacted by the CCR haul truck routing. The proposed route between the FFCP and the ponds to the southeast involves trucks departing from the FFCP and accessing Coxendale Road at its intersection with the Dominion Entrance. Truck traffic will continue along Coxendale Road by turning left at its intersection with Old Stage Road south of the Dominion Entrance. Truck traffic will follow Coxendale Road until reaching Henricus Park Road to the east, then turn right and follow Henricus Park Road to the southeast corner of the Lower Ash Pond for truck access to the haul roads for the Upper and Lower Ash Ponds. After loading CCR for transport in the Upper and Lower Ash Ponds, truck traffic will converge at the haul road from the Lower Ash Pond onto Henricus Park Road. Loaded trucks will continue north on Henricus Park Road until its intersection with Coxendale Road, turning left and heading west to follow the same route used to access the ponds in reverse towards the FFCP. Traffic associated with a beneficial use facility is anticipated to follow a similar, but shorter pattern as described above from the ponds.

In total, five intersections involving public roadways will be impacted by the proposed CCR hauling operation. These intersections are as follows, and are shown below in **Figure 1**:

1. Dominion Entrance at Coxendale Road
2. Coxendale Road at Old Stage Road
3. Coxendale Road at Existing Lower Ash Pond Entrance and Beneficial Use facility
4. Henricus Park Road at Coxendale Road
5. Henricus Park Road at Proposed Lower Ash Pond Entrance

Figure 1 – Traffic Impact Analysis Study Area



Existing Conditions

The primary roadway utilized for the CCR truck hauling route is Coxendale Road, which is a two-lane roadway in the study area with soft shoulders. The posted speed limit is 35 miles per hour. Henricus Park Road will also comprise part of the truck circulation route, which is currently a two-lane roadway with soft shoulders and a posted speed limit of 25 miles per hour. Dominion is proposing improvements to Henricus Park Road before CCR hauling operations begin in order to support the truck traffic, which includes widening and paved shoulders. All study intersections are three-way unsignalized intersections with the minor approaches controlled by stop sign. The includes the proposed Henricus Park Road intersection with a new Lower and Upper Ash Pond Entrance as the westbound approach to the intersection across from the 90-degree right turn on the Henricus Park Road eastbound approach.

Peak hour traffic data is utilized as a basis of traffic operations analysis for traffic impact studies such as this. A previous traffic study was performed by consulting firm JMT for a different operation in 2015. Traffic data was collected at three of the study area intersections during the AM and PM peak periods, which was utilized to represent existing conditions peak hour traffic data for this study. The JMT study determined that no traffic volume growth had occurred on Coxendale Road in the study area according to the Average Annual Daily Traffic (AADT) data published by the VDOT Count Program over the five years prior to the 2015 study. This methodology was expanded to include the most recent AADT data published through 2018 in order to determine if growth in the study area occurred that might indicate a need for updated turning movement count data at the study intersections. As shown below in **Table 1**, traffic volume data is still lower in the study area than it was in 2010. The published data has shown a net decrease over time, with a factored count published in 2018 remaining below 2010 levels despite defying the decreasing trend.

Table 1 – Average Annual Daily Traffic Summary

Year	Average Annual Daily Traffic	Percent Trucks and Buses
2010	1300	10%
2011	1300	10%
2012	1100	9%
2013	1000	9%
2014	1100	9%
2015	990	9%
2016	930	9%
2017	910	9%
2018	1200	12%

Data obtained from: https://www.virginiadot.org/info/ct-TrafficCounts.asp

Considering there has been no growth in traffic volumes in the study area over the last nine years of published count data, it was determined that using the 2015 turning movement count data would be satisfactory as a basis for determining the impacts of proposed truck traffic on the study area roadway network. The counts indicated that the AM peak hour was from 6:15 to 7:15 AM and the PM peak was from 3:30 to 4:30 PM.

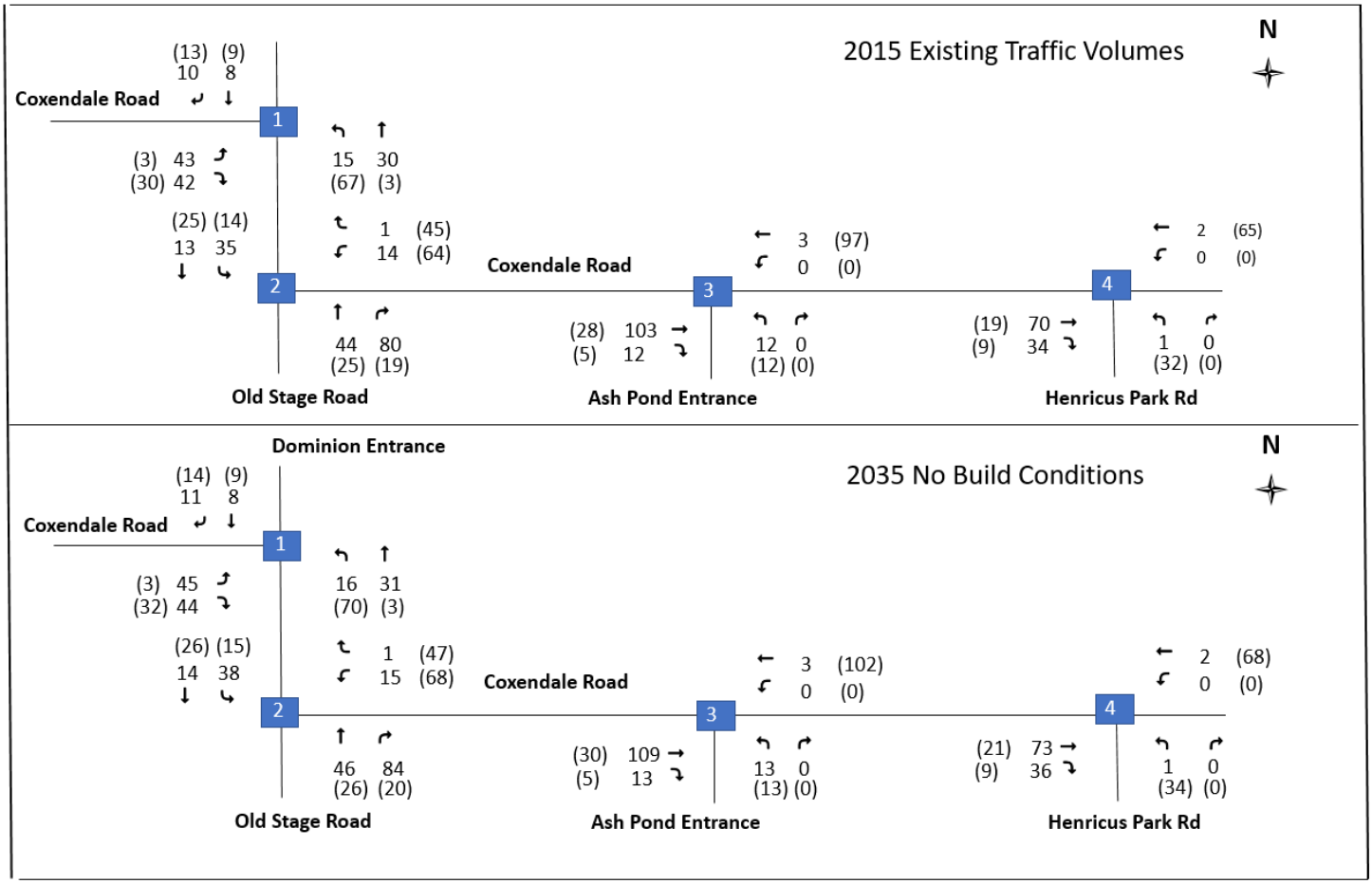
Future Conditions

In order to determine future traffic volumes for use in operations analysis, background growth must be projected. Based on the information in Table 1 that demonstrated no growth in approximately a decade, the conservative assumption from the 2015 JMT study to add 5% total background growth to existing conditions volumes was also employed for this study. The JMT study did not include the Henricus Park Road intersection with Coxendale Road in the study area, so peak hour turning movement counts were not available. However, the segment volumes on Coxendale Road at this location are known from the previous count data. To project Henricus Park Road turning movements, a conservative estimate of one-third of Coxendale Road traffic west of the Ash Pond Entrance was projected to originate from or be destined to Henricus Park Road, even though this minor roadway only serves a small park facility to the south of the study area as opposed to the heavier Dominion development and a boat ramp to the east on Coxendale Road. This is a conservative estimate for an operations analysis as it would involve more traffic on Henricus Park Road sharing a stop-controlled left-turning movement with the projected truck traffic to generate a worst-case scenario for delay and Level of Service projections.

It is projected that all hauling activities and associated truck traffic will be completed by 2035. This 5% additional growth was added to the existing conditions peak hour turning movement count data to generate projected 2035 'No-Build' (no truck traffic associated with CCR haul operations) traffic volumes for use in

operations analysis. The operations for existing and No-Build conditions will be compared to Build condition (with trucks) projected volumes to determine if the Dominion CCR haul operations have a significant impact on traffic operations in the study area. The projected AM and PM peak hour volumes for existing conditions and 2035 No-Build are shown in **Figure 2** with PM volumes in parentheses, or: 'AM (PM)'.

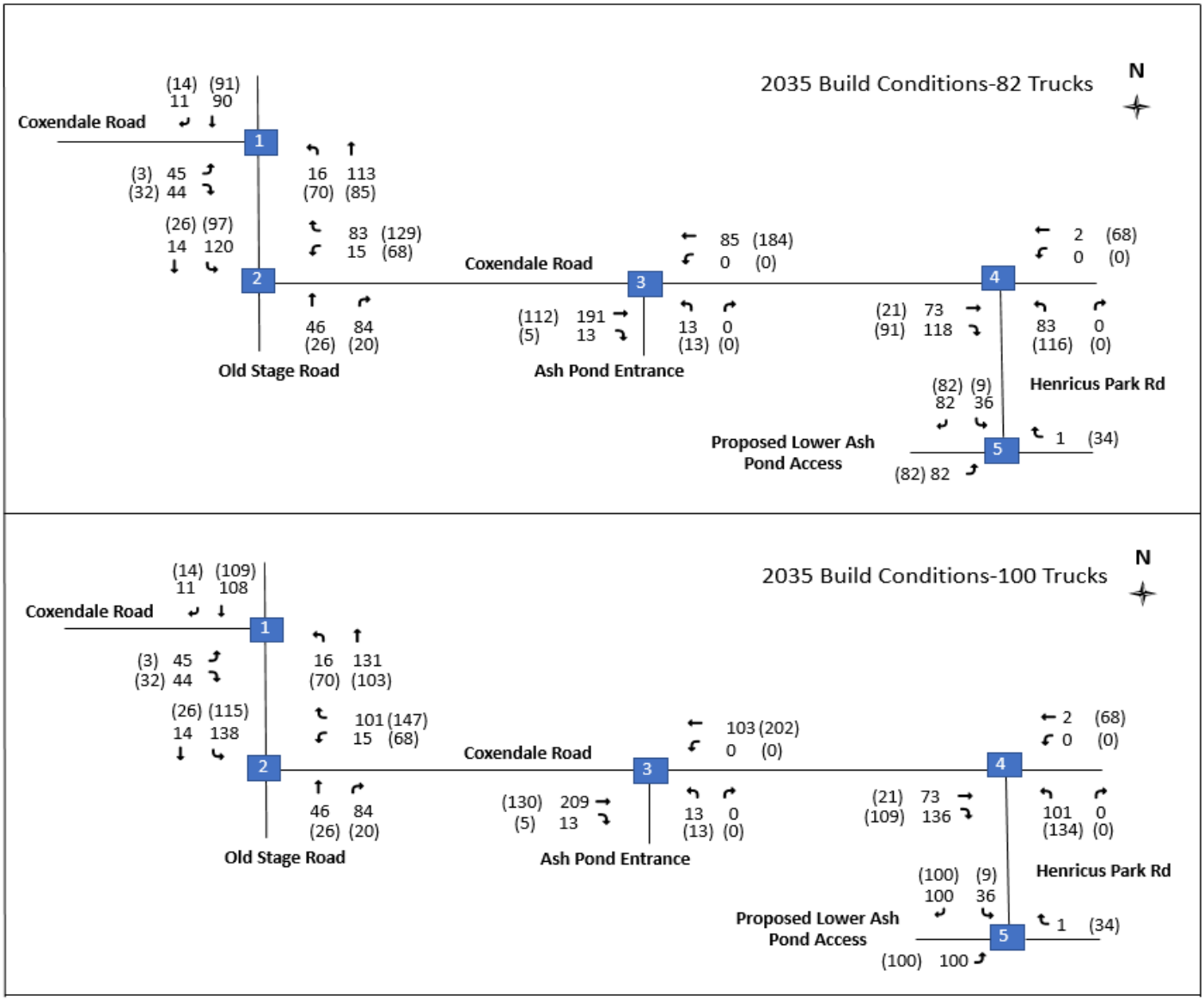
Figure 2 – Peak Hour Turning Movement Counts for Existing and 2035 No-Build Analysis



The anticipated haul truck frequency for each operation that will occur at differing intervals between existing conditions and the projected 2035 completion date is scheduled to vary depending on active projects in the study area. The year 2025 and half of 2026 when trucking operations are expected to be the most active is projected as follows: 30 trucks per hour hauling CCR from the ponds to the FFCP, 33 trucks per hour hauling CCR to a beneficial facility and 19 trucks per hour hauling fill material from the FFCP to the ponds. Therefore, an hourly truck loading of 82 trucks per hour is projected. To be conservative, this level of truck traffic will be analyzed with the full 5% background growth projection by 2035.

Two future traffic operations scenarios were analyzed for this study in order to account for the expected peak of truck traffic and also account for all of the anticipated background traffic growth: a projected 2035 analysis with the projection of 82 trucks per hour circulating within the study area, and also a conservative projected 2035 analysis with 100 trucks circulating to serve as a maximum loading and to determine how close the Dominion operations may be to negatively impacting traffic operations in the study area, if at all. The trucks were distributed to the network along the route as previously discussed and added to 2035 No-Build volumes to generate 2035 Build condition volumes for operational analysis. The two 2035 AM and PM Build condition scenario peak hour traffic volume projections are shown in **Figure 3**.

Figure 3 – Peak Hour Turning Movement Counts for 2035 Build Analysis



Traffic Operations Analysis

Traffic operations analysis was performed for the scenarios described previously using Synchro software for the five study area intersections. A base network was built in Synchro using existing roadway geometry that included inputs for lane configuration, stop control, design speed and lane width. In addition to inputting the traffic volumes for each analysis scenario, additional factors such as heavy vehicle percentage and peak hour factor were input. The existing conditions heavy vehicle percentages were based on the 8% heavy vehicle percentage recorded in a count from the 2015 JMT study, and these values were updated in each scenario based on the changes in truck traffic for each Build condition analyzed. The peak hour factor for each turning movement was assumed to be 0.92 to match the JMT study, which did not publish the count data or actual peak hour factors.

For each analysis scenario, Synchro generated projections for delays and Levels of Service (LOS). The LOS is a qualitative representation of factors such as flow rate, delays and driver comfort that reflect how well a facility is serving the traffic demand relative to available capacity. It is generally accepted that the threshold of

acceptable LOS for roadways and intersections is LOS C or better for rural conditions and LOS D or better for urban conditions.

All Synchro analysis results were generated and reviewed for each of the five analysis scenarios: Existing Conditions, 2035 No-Build, 2035 Build with 82 Trucks, and 2035 Build with 100 Trucks. The LOS results were reviewed and the lowest LOS for any turning movement at the study intersections is reported in **Table 2** below. With the poorest LOS being shown in Table 2, all other turning movements at each intersection are projected to be as good or better than the reported lowest LOS.

Table 2 – Traffic Operations Analysis Results (Synchro, Unsignalized Intersections)

	2015 Existing Conditions		2035 No-Build		2035 Build with 82 Trucks		2035 Build with 100 Trucks	
	AM	PM	AM	PM	AM	PM	AM	PM
Coxendale Road / Dominion Entrance	Eastbound LOS A	Eastbound LOS A	Eastbound LOS A	Eastbound LOS A	Southbound LOS A	Southbound LOS A	Southbound LOS B	Southbound LOS B
Coxendale Road / Old Stage Road	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A
Coxendale Road / Existing Ash Pond Access	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS B	Northbound LOS B	Northbound LOS B	Northbound LOS B
Coxendale Road / Henricus Park Road	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS A	Northbound LOS B	Northbound LOS B	Northbound LOS B	Northbound LOS B
Henricus Park Road / Proposed Ash Pond Access	Westbound LOS A	Westbound LOS A	Westbound LOS A	Westbound LOS A	Eastbound LOS B	Eastbound LOS B	Eastbound LOS B	Eastbound LOS B

As shown in Table 2, all turning movements at all study area intersections are projected to operate at an acceptable LOS B or better for all analysis scenarios, including the 2035 Build condition with 100 trucks that exceeds the projected operation level of 82 circulating trucks per hour by Dominion at any point between now and 2035. There are no significant delays or queuing projected anywhere in the study area for any of the trucking scenarios modeled.

Conclusions and Recommendations

As indicated by Synchro operational analysis and as displayed in Table 2, there are no existing operational concerns in the study area under existing and 2035 No-Build conditions. All turning movements operate at LOS A under these conditions. Build condition analysis of the truck traffic scenarios indicates that all turning movements are projected to operate at an acceptable LOS B or better throughout the duration of the project until 2035 when the hauling operations are expected to be complete. For the expected operation of 82 trucks per hour, LOS B or better was maintained throughout the study area for all movements, as well as for the conservative 100 truck operations estimate.

Based on the results of operational analysis and the findings of this Traffic Impact Analysis, it is projected that the Dominion CCR haul trucking operations are not expected to have a significant impact on study area traffic operations at any point between existing and 2035 conditions for any of the anticipated circulating trucking loads. The conservative 100 truck operation is also not projected to impact operations or deteriorate any turning movement below LOS B in the study area during either peak period. Throughout most of the project schedule, it is estimated that 82 trucks per hour or less will be circulating. Therefore, no mitigation is recommended in association with the Dominion trucking operations as scheduled and anticipated.

Appendix B

Contact Water Ponds Design Calculations

Contact Water Pond Sizing 100 year, 24 hour storm event = 8.45" rainfall

Subphase*	Excavation Area (AC)	Contact Water Pond Area (AC)	Other Areas Exposed to Contact Water (AC)	Volume of Storage Required (CF)	Volume of Storage Provided (CF)	Pond Bottom Area (SF)	Pond Top Area (SF)	Pond Depth (FT)
	10.0	2.0	8.0	245,243	312,107	69,260	87,120	4
	11.0	2.0	9.0	269,767	312,107	69,260	87,120	4
	12.0	2.0	10.0	294,291	312,107	69,260	87,120	4
	13.0	2.0	11.0	318,859	379,408	65,340	87,120	5
	14.0	2.0	12.0	343,383	379,408	65,340	87,120	5
	15.0	2.0	13.0	367,908	379,408	65,340	87,120	5

* The contact water pond size is based on the subphase excavation area, therefore a range of conceptual subphase excavation areas have been used to show the required size of the contact water pond.

Appendix C

Stormwater Calculations

STORMWATER REPORT
UPPER ASH POND (UAP) HYDROLOGIC AND HYDRAULIC STORMWATER CALCULATIONS REPORT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TABLE OF CONTENTS

Section ***Page***

1.0 INTRODUCTION AND OBJECTIVES 1
2.0 FACILITY BACKGROUND AND PROPOSED CONDITIONS 1
3.0 DESIGN CRITERIA 2
3.1 Erosion and Sediment Control 2
3.2 Stormwater Quality Management 3
3.3 Run-On and Run-Off Criteria 3
3.4 Stormwater Quantity Management 3
3.5 Floodplain Management 3
3.6 Dam Permit Requirements 4
4.0 METHODOLOGY 4
4.1 Hydrology Methods 4
4.2 Hydraulics Methods 5
5.0 DESIGN COMPLIANCE 6
5.1 Erosion and Sediment Control Compliance 6
5.2 Stormwater Quality Management Compliance 6
5.3 Run-On and Run-Off Control System Compliance 6
5.4 Stormwater Quantity Management Compliance 9
5.5 Floodplain Management Compliance 10
5.6 Dam Permit Requirements Compliance 10
6.0 REFERENCES 11

LIST OF FIGURES

Figure 1 Overall Site Aerial
Figure 2 Lower Ash Pond Stormwater Drainage Areas

LIST OF TABLES

Table 1 NOAA Atlas 14 24-Hour Rainfall Depths for Chester, Virginia, Latitude: 37.3702°, Longitude: -77.3698°
Table 2 Sediment Basin Required and Provided Volumes
Table 3 Drainage Area Peak Flows
Table 4 UAP Storage Basin Performance
Table 5 Two-Year Culvert Peak Flows and Velocities
Table 6 10-Year Stormwater Channel Peak Flows

LIST OF APPENDICES

Appendix 1 Site Hydrologic Calculations Supporting Data
Appendix 2 HydroCAD Inputs and Outputs—Post-Closure Condition
Appendix 3 Sediment Basin Design Calculations
Appendix 4 Water Quality Calculations (VRRM)

LIST OF ACRONYMS

BMP	Best Management Practice
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CLOMR	Conditional Letter of Map Revision
CN	Curve Number
CSWTS	Centralized Source Water Treatment System
FEMA	Federal Emergency Management Agency
FFCP	Fossil Fuel Combustion Products
FIRM	Flood Insurance Rate Map
HydroCAD	HydroCAD Stormwater Modeling Software
H&H	Hydrologic and Hydraulic
LAP	Lower Ash Pond
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
PMP	Probable Maximum Precipitation
RCP	Reinforced Concrete Pipe
SCS	Soil Conservation Service
Tc	Time of Concentration
TR	Technical Reference
UAP	Upper Ash Pond
USDA	United States Department of Agriculture
VADEQ	Virginia Department of Environmental Quality
VDCR	Virginia Department of Conservation and Recreation
VESCH	Virginia Erosion and Sediment Control Handbook
VPDES	Virginia Pollution Discharge Elimination System
VRRM	Virginia Runoff Reduction Method
VSWMR	Virginia Solid Waste Management Regulations

1.0 INTRODUCTION AND OBJECTIVES

This Hydrologic and Hydraulic (H&H) calculation package for the Chesterfield Power Station Upper Ash Pond (UAP) has been prepared on behalf of the Virginia Electric and Power Company (d/b/a Dominion Energy Virginia) by AECOM. The included calculations support closure activities at the UAP of the Chesterfield Power Station located at 500 Coxendale Road, Chester, Virginia 23836 (Figure 1).

This document and the following calculations support the Virginia Department of Environmental Quality's (VADEQ's) Part B Permit Application for Solid Waste Disposal Facilities and the County of Chesterfield's Land Disturbance Permit Application. The calculations were prepared following the Virginia Solid Waste Management Regulations (VSWMR) (§9VAC20-81-470) and the Chesterfield County Environmental Engineering Reference Manual (2011). The closure plan meets the requirements of 40 CFR §257.81, which are incorporated as part of §9VAC-20-81, including §9VAC-20-81-800, the Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.

The objectives of this package are to: (1) review applicable regulations and establish the appropriate design criteria, (2) discuss the H&H methods used in this analysis, and (3) include appropriate calculations and modeling that supported stormwater design.

All vertical elevations reference the North American Vertical Datum of 1988 (NAVD88).

2.0 FACILITY BACKGROUND AND PROPOSED CONDITIONS

The UAP is located southeast of the LAP (Figure 1). It is bordered to the south and the west by the James River, to the east by the Henricus Historical Park, and to the north by the Henricus Park Road. The UAP is located in the Federal Emergency Management Agency's (FEMA) floodplain Zone X (unshaded), which designates areas of minimal flood risk outside the 1-percent and 0.2 percent-annual-chance floodplains according to the FEMA Digital Flood Insurance Rate Maps and Flood Insurance Rate Maps (FIRM) 51041C0335D and 51041C0351D (12/18/2012). Under the existing condition, the UAP has a perimeter dike with a top elevation of approximately

42 feet, separating the UAP from the James River 1-percent-annual-chance floodplain, coded Zone A.

The UAP contains approximately 11.8 million cubic yards of CCR, and the pond is approximately 113 acres in size. Currently, stormwater within the UAP moves via sheet flow from the top of the impoundment to the existing let-downs along the side slopes that discharge into ditches draining to the existing sediment basin in the eastern portion of the site. The top of the stack currently ranges between 80 and 105 feet NAVD88 in elevation.

The proposed UAP excavation and removal plan consists of a phased closure approach limited to areas less than 20 acres in size at any one time so that stormwater and contact water may be managed separately. The phases also include vertical depths with approximately 15 feet in removal depth per stage. The final grades range from about 8 to 22 feet NAVD88, following the Final Grading Plan of the Closure Plan - Upper Ash Pond, Issued for Construction (drawing no. 008), included in Attachment III of this Solid Waste Permit Application package (2020).

The proposed design divides the UAP site into three main drainage areas, i.e., west, middle, and east. Within each drainage area, tied concrete block mat-lined drainage channels are designed to route stormwater runoff to a stormwater detention basin. The detention basin will be designed to function as a stormwater sediment basin during construction as an erosion and sediment control measure, and to function as a stormwater detention pond to manage post-closure runoff discharge once the UAP is closed. The west, middle, and east detention basins each discharge directly to the James River via an outfall consisting of three 18-inch reinforced concrete pipes (RCPs) and an emergency spillway (Figure 2).

3.0 DESIGN CRITERIA

3.1 Erosion and Sediment Control

The erosion and sediment control plan must follow the Virginia Erosion and Sediment Control Regulations (VESCH) under §9VAC25-840. The regulations determine that if drainage areas are greater than or equal to three acres, they must be controlled by a temporary sediment basin with a minimum capacity of 134 cubic yards per acre of drainage area, and the outfall must be able to

maintain the structural integrity of the basin during a 25-year, 24-hour storm (§9VAC25-840-40 6b.).

3.2 Stormwater Quality Management

For development on prior developed lands disturbing greater than or equal to one acre with a net increase in impervious cover, the total phosphorus load for the increased impervious area shall not exceed 0.41 pounds per acre per year. The total phosphorus load for the remaining portion of the site shall be reduced at least 20% below the pre-development total phosphorus load (§9VAC25-870-63). The UAP site must show compliance following the Virginia Runoff Reduction Method (VRRM) or another equivalent method. The site may use approved Best Management Practices (BMPs) from this criteria or those listed on the Virginia Stormwater BMP Clearinghouse Website (§9VAC25-870-65). Alternatively, offsite alternatives, such as the nutrient offset program, may be utilized if the site falls within specific criteria (§9VAC25-870-69).

3.3 Run-On and Run-Off Criteria

In accordance with §9VAC20-81-130, which specifies the design requirements for landfills under VSWMR, and 40 CFR §257.81, which specifies controls for CCR landfills, the run-on control system must collect and control water during the peak discharge from a 25-year, 24-hour storm, and the run-off control system must be designed and constructed to control the water volume from the 25-year, 24-hour storm.

3.4 Stormwater Quantity Management

The system must be designed to ensure there is no erosion from the two-year, 24-hour peak flow in manmade stormwater conveyance systems as required by the channel protection criteria (§9VAC-870-66 B1.). The system must also be designed to ensure no localized flooding from the 10-year, 24-hour peak flow rate and that the limits of analysis to comply with flood protection are met in accordance with §9VAC-870-66 C.

3.5 Floodplain Management

The site is proposed to discharge into FEMA Zone A floodplains for the James River within the watershed HUC 020802060106 (Virginia 6th-order JL06). When FEMA-regulated waterways or floodplains are on or within the vicinity of a site, the project must comply with the National Flood

Insurance Program (NFIP) regulations, accounting for the base flood elevations, floodplains, and floodways.

3.6 Dam Permit Requirements

The Virginia Department of Conservation and Recreation (VDCR) Dam Safety Program regulates impounding structures 25 feet or greater in height with a maximum impounding capacity of 15 acre-feet or greater (§4VAC50-20-30). Hydraulic structures for existing impounding structures with a high hazard potential must be designed for the 0.9 probable maximum precipitation (PMP) event, which is theoretically the greatest depth of a precipitation for a given duration that is meteorologically possible.

4.0 METHODOLOGY

4.1 Hydrology Methods

HydroCAD Stormwater Modeling software (HydroCAD) (version 10.00) was used to calculate the hydrology and hydraulics for the UAP site. Design storm rainfall amounts were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Data Server (2020), as listed in Table 1. The rainfall total depths were input into HydroCAD, and the Soil Conservation Service (SCS) 24-hour, Type II curve was applied in the model for the rainfall distribution.

Table 1 NOAA Atlas 14 24-Hour Rainfall Depths for Chester, Virginia
Latitude: 37.3702, Longitude: -77.3698

Design Storm	Total Rainfall Depth (Inches)
1-Year	2.78
2-Year	3.36
10-Year	5.11
25-Year	6.31
100-Year	8.45

The United States Department of Agriculture's (USDA) SCS Technical Reference 20 (TR-20) method was used within HydroCAD to calculate the runoff. Hydrology inputs into HydroCAD

included curve numbers (CNs) and times of concentration (Tc). Both were determined following the USDA's National Resources Conservation Service (NRCS) TR-55 (1986) guidelines. To be conservative, the post-closure condition assumed that the site would have 50-75% grass cover and soil group D, resulting in a CN of 84. Although the grass cover is expected to be greater than 50-75%, this estimate was used to size the stormwater infrastructure conservatively. The minimum six-minute Tc recommended in TR-55 was applied to all drainage basins except one, for which a ten-minute Tc was used to account for more than 700 feet of sheet flow path on an unpaved surface. Additional site hydrologic data and drainage area maps are included in Appendix 1.

4.2 Hydraulics Methods

Hydraulic routing and calculations within HydroCAD were used to determine peak flow values, water surface elevations, and velocities, to ensure compliance with relevant stormwater criteria. The HydroCAD layout and complete input and output parameters are in Appendix 2. The Dynamic Storage-Indication method was used within HydroCAD for the reach routing and pond routing.

Reaches were used for tied concrete block mat-lined channels in the post-closure model. Dimensions, such as channel depth, side slopes, length, and inlet/outlet elevations are as indicated on the closure plan drawings (drawings no. 008, 030) included in Attachment III of the Solid Waste Permit application package (2020).

The elevation-area storage curves for storage units were derived from the proposed grading. The outlets for the storage areas include three 18-inch RCPs. The pipe lengths, inverts, and other attributes are as indicated on the closure plan drawings (drawings no. 008, 029) included in Attachment III of the Solid Waste Permit application package (2020). The storage units in the proposed condition also incorporate an emergency spillway that is modeled as a rectangular broad-crested weir. The invert elevation, crest length, and crest breadth are as indicated on the closure plan drawings (drawing no. 029) included in Attachment III of this Solid Waste Permit application package (2020), and HydroCAD tabulates a head-coefficient table based on the crest breadth value.

5.0 DESIGN COMPLIANCE

5.1 Erosion and Sediment Control Compliance

All conveyances have been designed to convey the 100-year, 24-hour storm (which is larger than the required 25-year, 24-hour storm), and all outlet protection and energy dissipation, following the VESCH, will provide stable outlets for this design storm.

The west, middle, and east sediment basins were designed to hold a minimum volume of 134 cubic yards per acre of drainage area, half of which must be wet storage. The minimum required volumes and actual volumes are listed in Table 2. All provided volumes are greater than the required volumes. The full sediment basin calculations are in Appendix 3.

Table 2 Sediment Basin Required and Provided Volumes

Basin ID	Drainage Area (ac.)	Bottom Elevation (Feet)	Riser Elevation (Feet)	Wet Storage		Total Storage	
				Volume Required (CY)	Volume Provided (CY)	Volume Required (CY)	Volume Provided (CY)
West	46.60	6.00	8.70	3,122	3,193	6,244	8,840
Middle	51.80	7.00	10.00	3,471	3,757	6,941	11,517
East	26.50	10.00	12.10	1,776	1,785	3,551	6,383

5.2 Stormwater Quality Management Compliance

Following the VRRM, the different sites undergoing land disturbance within the Chesterfield Power Station were analyzed to determine if water quality treatment is needed. The total phosphorus load reduction requirement for the entire site is less than zero, so the water quality management requirements are met with no further action. The full stormwater quality results are included in Appendix 4.

5.3 Run-On and Run-Off Control System Compliance

Run-on and run-off control systems for the UAP site were designed to account for the temporary construction and post-closure conditions. The UAP site is topographically above the surrounding grades before and after closure, so a defined run-on control system is not needed for the outer perimeter of the closed UAP site.

5.3.1 Run-Off Control Systems During Construction

The UAP excavation and removal plan consists of phases, limited to areas less than 20 acres in size at any one time, in order to effectively manage stormwater and contact water separately for run-off control. This approach will also manage the site in vertical stages that are approximately 15 feet in depth per stage. The goal of this approach is to place fill in the “clean” areas so that those areas will not require future removal. One BMP utilized will be a lined contact water pond. This will be used to temporarily handle contact water to prevent CCR resaturation. The contact water will then be pumped to the new CSWTS at a maximum rate of 1,500 gallons per minute for the duration of the project. Contact water will be managed up to a 100-year storm event.

Currently, stormwater within the UAP site sheet-flows from the top of the impoundment to the existing let-downs along the side slopes that discharge into ditches draining to the existing sediment basin in the eastern portion of the site. Stormwater from this sediment basin leaves the site through an existing Virginia Pollution Discharge Elimination System (VPDES) outfall (005) under VPDES Permit VA0004146. The existing ditches and sediment basin will remain in place as the removal process starts and will only be removed once additional temporary or permanent measures are implemented.

Temporary sediment and erosion control measures will be utilized throughout all phases of closure activities. Stormwater runoff from events up to and including the 0.9 PMP event will be handled until the embankment is declassified by VDCR as an existing dam. Pumping of stormwater to either the existing sediment basin or to new sediment basins may be required, as well as the use of temporary outfalls to take the stormwater offsite. Once the new sediment basins and outlets are operational, existing VPDES outfall 005 will be removed from service, prior to the excavation portion of this phase of work. Once vegetation is established and the UAP site is considered stabilized, the temporary sediment basin risers will be removed, and the stormwater outlets will be reconfigured based on the final post-closure conditions.

5.3.2 Run-Off Control Systems Post-Construction

Post-construction, the stormwater storage basins at the bottoms of the drainage channels are designed to provide adequate detention volumes to hold runoff from the 100-year storm below

the engineered spillways. The outlets of the storage basins are designed to adequately convey the 100-year storm event. The entire site is divided into three drainage areas: the west, middle, and east areas. Within each drainage area, engineered drainage swales will be constructed to collect and convey stormwater runoff from the top of the grade to designated storage basins before discharging offsite to the James River.

The 25-year and 100-year runoff peak discharge and water volume from each drainage catchment feeding into a channel are listed in Table 3. The total 100-year runoff water volume throughout the UAP site is 67.1 acre-feet. The storage basin performance for the 25-year and 100-year, 24-hour storm events is listed in Table 4. The storage basins provide between 9,000 and 22,000 cubic yards of volume, and the peak outflow rates are reduced by 80-91% compared to the peak inflow rates, as a result of the detention.

Supporting calculations and modeling results for all stormwater management criteria are included in Appendix 2.

Table 3 Drainage Area Peak Flows

Drainage Area	Size (Acres)	Curve Number	Time of Concentration (min)	25-Year Storm		100-Year Storm	
				Peak Flow (cfs)	Water Volume (acre-feet)	Peak Flow (cfs)	Water Volume (acre-feet)
West 1	5.837	84	6.0	43.3	2.183	61.59	3.175
West 2	7.233	84	6.0	53.7	2.705	76.32	3.935
West 3	14.150	84	6.0	105.0	5.291	149.31	7.698
West 4	11.630	84	6.0	86.3	4.349	122.72	6.327
West 5	7.290	84	6.0	54.1	2.726	76.93	3.966
Middle 1	5.736	84	6.0	42.5	2.145	60.53	3.120
Middle 2	12.628	84	6.0	93.7	4.722	133.25	6.870
Middle 3	19.614	84	6.0	145.5	7.335	206.97	10.670
Middle 4	9.879	84	10.0	65.1	3.694	92.81	5.374
Middle 5	3.587	84	6.0	26.6	1.341	37.85	1.951
East 1	2.239	84	6.0	16.6	0.837	23.63	1.218
East 2	4.167	84	6.0	30.9	1.558	43.97	2.267
East 3	10.335	84	6.0	76.7	3.865	109.06	5.622
East 4	9.065	84	6.0	67.2	3.390	95.66	4.931

Table 4 UAP Storage Basin Performance

Basin ID	Drainage Area (ac.)	Berm Top Elev. (NAVD88 Feet)	25-Year				100-Year			
			Q In (cfs)	Q Out (cfs)	Storm Elevation (NAVD88 Feet)	Freeboard (Feet)	Q In (cfs)	Q Out (cfs)	Storm Elevation (NAVD88 Feet)	Freeboard (Feet)
West	46.14	11.00	237.56	37.19	10.09	0.91	359.23	41.10	10.88	0.12
Middle	51.44	12.50	267.95	39.37	11.39	1.11	402.72	43.20	12.18	0.32
East	25.81	14.00	150.84	33.99	13.05	0.95	224.30	38.19	13.72	0.28

5.4 Stormwater Quantity Management Compliance

Since the post-closure stormwater conveyance has been sized for the 100-year, 24-hour design storm, the design satisfies the two-year and 10-year design criteria in the Virginia Stormwater Management Program and Chesterfield County regulations. Since the channels are tied concrete block mat-lined, erosion is not expected. At the downstream ends of the culverts draining the detention basins, Class 1 riprap will be used as classified by the Virginia Department of Transportation with a minimum thickness of 1.5 feet to dissipate any erosive velocities. The maximum two-year velocities in the culverts are listed in Table 5, and the 10-year stormwater peak flows are listed in Table 6. Additionally, since the culverts from the sediment basins take stormwater offsite to an area within the base flood elevation of the James River (Zone A), the limits of analysis criteria are satisfied.

Table 5 Two-Year Culvert Peak Flows and Velocities

Channel ID	Q2 (cfs)	V2 (ft/s)
West	27.24	5.14
Middle	29.74	5.61
East	25.56	5.18

Table 6 10-Year Stormwater Channel Peak Flows

Channel ID	Q10 (cfs)	Avg. Depth at Peak Storage (ft)	Total Depth (ft)
West 1	21.25	0.37	1.00
West 2	28.67	0.41	1.00
West 3	47.36	0.56	1.10

Channel ID	Q10 (cfs)	Avg. Depth at Peak Storage (ft)	Total Depth (ft)
West 4	45.81	0.55	1.00
West 5	28.32	0.40	1.00
Middle 1	21.03	0.34	1.00
Middle 2	52.20	0.59	1.10
Middle 3	72.75	0.72	1.50
Middle 4	36.77	0.47	1.00
Middle 5	13.67	0.26	1.00
East 1	10.17	0.21	1.00
East 2	17.18	0.30	1.00
East 3	39.73	0.50	1.00
East 4	44.35	0.54	1.00

The complete HydroCAD stormwater quantity modeling inputs and results are included in Appendix 2.

5.5 Floodplain Management Compliance

A hydraulic analysis is being conducted simultaneously to determine the potential project impacts on the James River and its floodplains. A Conditional Letter of Map Revision (CLOMR) will be prepared if an impact is identified.

5.6 Dam Permit Requirements Compliance

In the post-closure condition, the existing UAP dike, which is considered a dam by the VDCR, will be decommissioned. Prior to the dam decommissioning, the design criteria for the existing facility is that the hydraulic structures be designed for the 0.9 PMP event. The existing dike will be left in place as long as possible throughout the UAP closure process.

The calculations for the existing UAP impounding structure showing compliance to this design criteria are included in the Stormwater Management Calculations report prepared for Dominion Energy by Geosyntec Consultants (2019). A copy of this report can be provided upon request.

6.0 REFERENCES

Chesterfield County Department of Environmental Engineering. 2011. Environmental Engineering Reference Manual. Retrieved from: https://www.chesterfield.gov/DocumentCenter/View/393/Environmental-Engineering-Reference-Manual-PDF?bidId=.March

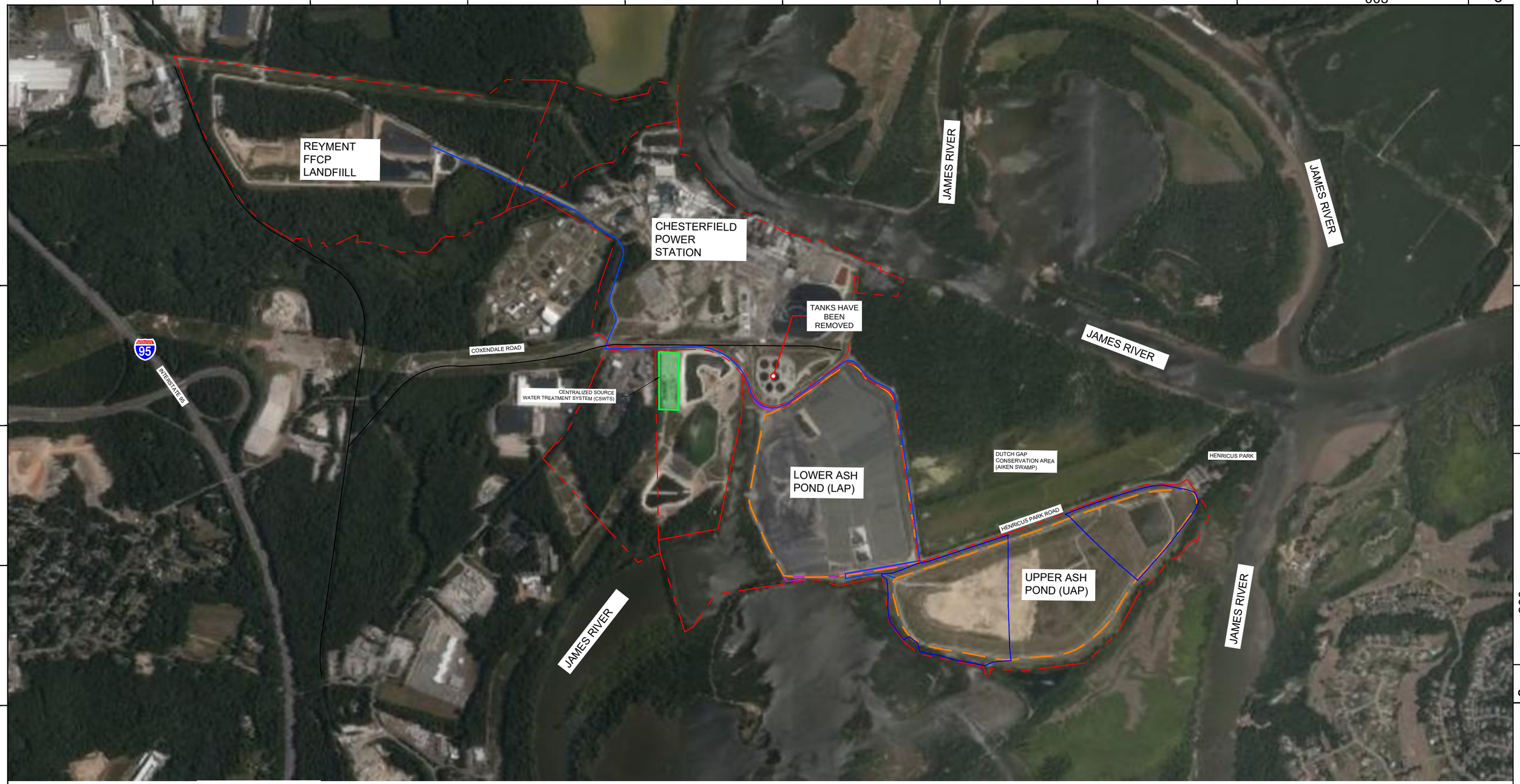
Dominion Energy. 2020. Dominion Energy Chesterfield Power Station Closure Plan – Upper Ash Pond: Issued for Construction. Prepared by AECOM. March.

Dominion Energy. 2019. Stormwater Management Calculations for the Chesterfield Power Station Upper Ash Pond: DCR Compliance Plan. Prepared by Geosyntec Consultants. Project Number: MV1795. October.

FEMA. 2012. FIRM 51041C0335D and 51041C0351D. Effective Date: December 18, 2012.

USDA NRCS. 1986. Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds. June.

Figures



LEGEND

- CCR POND BOUNDARY (APPROXIMATE)
- 50 PROPERTY BOUNDARY
- TWO-WAY CONSTRUCTION TRAFFIC
- RAILROAD

NOTES

1. BASIS OF BEARINGS: NAD83, VIRGINIA STATE PLANE, SOUTH ZONE.
2. SITE ADDRESS: 500 COXENDALE ROAD, CHESTER, CHESTERFIELD COUNTY, VIRGINIA

N

0 1,200 2,400 3,600
GRAPHIC SCALE (IN FEET)

AECOM

TITLE
OVERALL SITE AERIAL
CHESTERFIELD POWER STATION
CLOSURE PLAN - **UPPER** ASH POND
CHESTERFIELD COUNTY, VIRGINIA

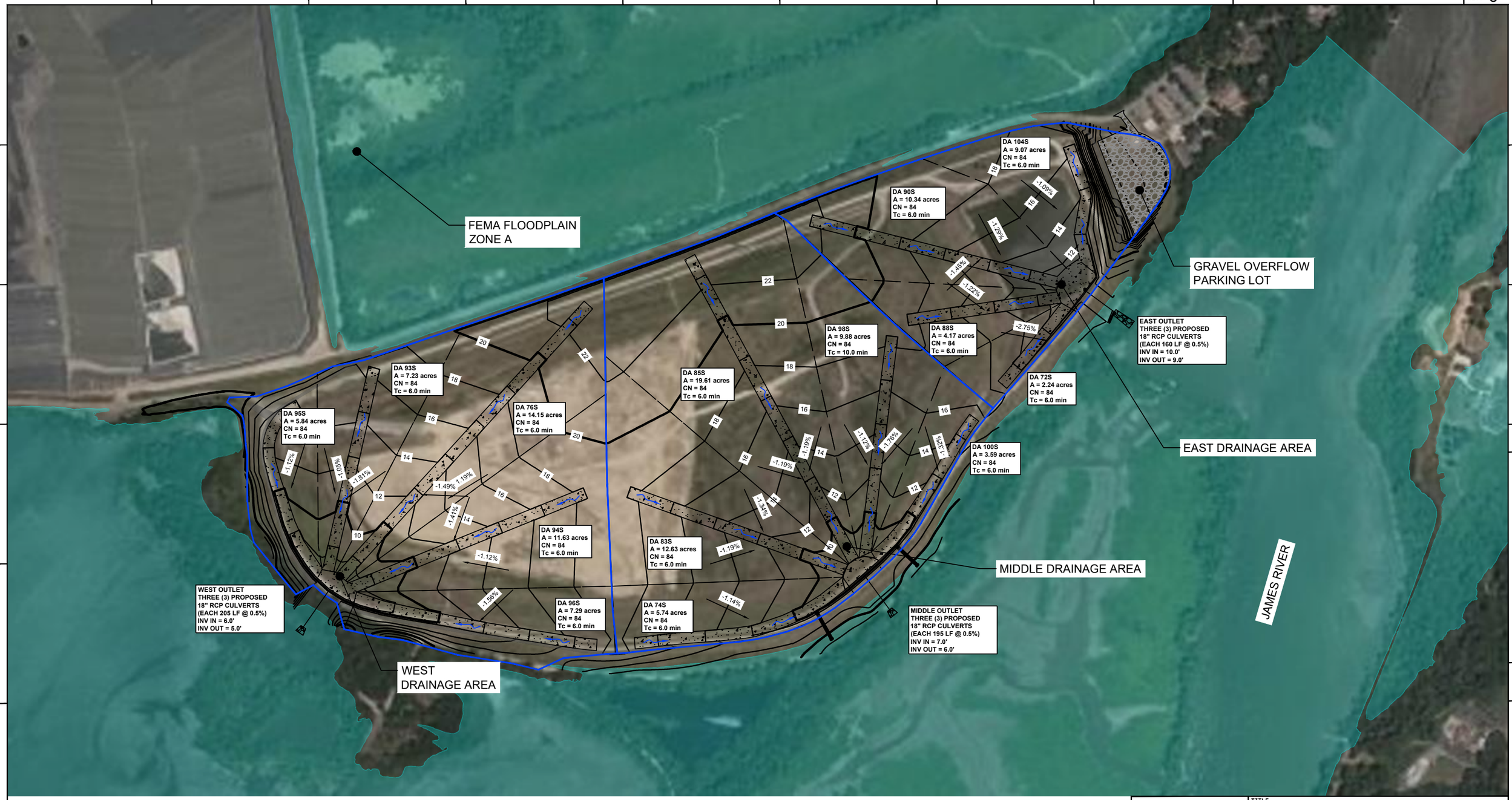
FOR
PERMITTING

SEAL

SCALE: 1"=1,200'	DES: MSR
DWG TYPE: .DWG	DFTR: JBM
JOB NO: 60614683	CHKD: RJB
DATE: 06-17-2020	ENGR: GWL
FILENAME: EXISTING CONDITION PLAN WITH AERIAL.DWG	APPD: GWL
DWG SIZE: ANSI B 11.0"x17.0"	FIGURE NO.1
EXISTING CONDITIONS	REVISION: 0

0 INCHES 1 2 3 — TENTHS 10 20 30

REV. 0



LEGEND

- 10 — PROPOSED MAJOR TOPOGRAPHIC CONTOUR
- 8 — PROPOSED MINOR TOPOGRAPHIC CONTOUR
- RESOURCE PROTECTION AREA BOUNDARY
- PROPOSED UAP PERIMETER ACCESS ROAD/ HIKING TRAIL REPLACEMENT

NOTES

1. BASIS OF BEARINGS: NAD83, VIRGINIA STATE PLANE, SOUTH ZONE. ELEVATIONS ARE BASED ON NAVD88.

LEGEND

- PROPOSED CONCRETE BLOCK MAT-LINED STORMWATER CONVEYANCE CHANNEL
- HENRICUS HISTORICAL PARK GRAVEL OVERFLOW PARKING
- STORMWATER FLOW ARROW
- DRAINAGE BASIN
- DRAINAGE SUBBASIN
- FEMA FLOODPLAIN ZONE A

N

GRAPHIC SCALE 400 800 1,200 (IN FEET)

AECOM

TITLE
UPPER ASH POND STORMWATER DRAINAGE AREAS
CHESTERFIELD POWER STATION
CLOSURE PLAN - **UPPER** ASH POND
CHESTERFIELD COUNTY, VIRGINIA

FOR
PERMITTING

SEAL

SCALE: 1"=300'	DES: MSR
DWG TYPE: .DWG	DFTR: JBM
JOB NO: 60614683	CHKD: RJB
DATE: 06-17-2020	ENGR: GWL
FILENAME:	APPD: GWL
DWG SIZE: ANSI B 11.0"x17.0"	FIGURE NO. 2
	REVISION: 0

UAP DRAINAGE AREAS

REV. 0

Appendices

Calculations

Appendix 1

Site Hydrologic Calculations Supporting Data

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Chesterfield County, Virginia, and Henrico County, Virginia



March 30, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....6
Soil Map.....9
Soil Map.....10
Legend.....11
Map Unit Legend.....13
Map Unit Descriptions.....15
Chesterfield County, Virginia.....17
1A—Fluvaquents.....17
3A—Fluvaquents, ponded.....17
8B—Tetotum fine sandy loam, ponded.....18
15—Made land.....19
17B—Gritney fine sandy loam, 2 to 6 percent slopes.....20
17C—Gritney fine sandy loam, 6 to 12 percent slopes.....21
21B—Atlee silt loam, 0 to 4 percent slopes.....22
26B—Toccoa fine sandy loam, 0 to 4 percent slopes.....23
28—Chewacla loam.....24
30B—Lenoir silt loam, 0 to 4 percent slopes.....25
31—Chastain loam.....26
33B—Coxville loam, 2 to 6 percent slopes.....27
37—Forestdale silt loam.....28
41B—Craven fine sandy loam, 2 to 6 percent slopes.....29
49B—Bourne fine sandy loam, 2 to 6 percent slopes.....30
51B—Pamunkey loam, 0 to 6 percent slopes.....31
67B—Lenoir loam, flooded, 0 to 4 percent slopes.....32
68B—Dogue loam, variant, 0 to 4 percent slopes.....33
70B—Norfolk fine sandy loam, 0 to 6 percent slopes.....34
71B—Buncombe loamy fine sand, 0 to 4 percent slopes.....35
80B—Colfax fine sandy loam, variant, 0 to 4 percent slopes.....36
82B—Kempsville-Bourne complex, 2 to 6 percent slopes.....37
92B—Rumford loamy fine sand, 2 to 6 percent slopes.....39
100—Hydraquents.....40
112B—Orangeburg-Faceville sandy loams, 2 to 6 percent slopes.....41
157B—Faceville-Gritney fine sandy loams, 2 to 6 percent slopes.....42
158B—Tetotum loam, clayey substratum, 2 to 6 percent slopes.....44
169B—Bourne sandy loam, 2 to 6 percent slopes.....45
172D—Nevarc-Remlik complex, 6 to 12 percent slopes.....46
172E—Nevarc-Remlik complex, 12 to 20 percent slopes.....47
172F—Nevarc-Remlik complex, 20 to 35 percent slopes.....49
188—Dunbar fine sandy loam, 0 to 4 percent slopes.....50
191—Myatt loam, 0 to 2 percent slopes, rarely flooded.....51
212B—Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes.....52
244B—Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes.....54
W—Water.....55

Henrico County, Virginia....56
AgA—Angie loam, 0 to 2 percent slopes....56
Ak—Angie loam, concretionary subsoil variant....56
Ch—Chewacla silt loam....57
FL—Fluvaquents....58
Le—Lenoir silt loam....59
OUF—Nevarc-Remlik complex, 15 to 50 percent slopes....60
PmA—Pamunkey fine sandy loam, 0 to 2 percent slopes....62
PmB—Pamunkey fine sandy loam, 2 to 6 percent slopes....63
PmD—Pamunkey fine sandy loam, 6 to 15 percent slopes....64
Ro—Roanoke silt loam....65
To—Toccoa fine sandy loam....66
UE—Udorthents, loamy....67
W—Water....67
Soil Information for All Uses....69
Soil Properties and Qualities....69
Soil Qualities and Features....69
Hydrologic Soil Group....69
References....77

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

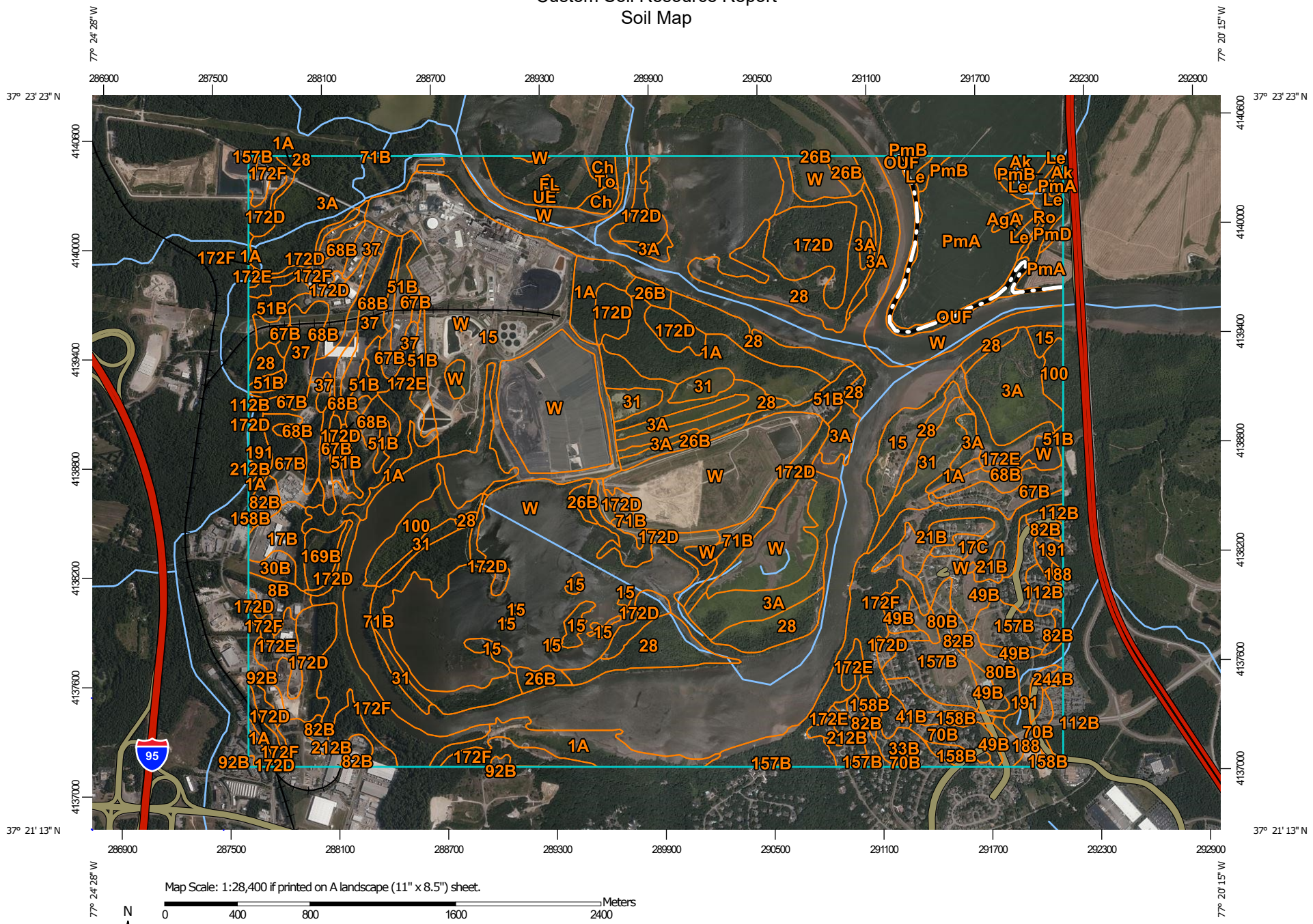
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Chesterfield County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Soil Survey Area: Henrico County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 1, 2019—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1A	Fluvaquents	140.1	3.7%
3A	Fluvaquents, ponded	211.9	5.7%
8B	Tetotum fine sandy loam, ponded	14.2	0.4%
15	Made land	298.5	8.0%
17B	Gritney fine sandy loam, 2 to 6 percent slopes	20.8	0.6%
17C	Gritney fine sandy loam, 6 to 12 percent slopes	5.3	0.1%
21B	Atlee silt loam, 0 to 4 percent slopes	24.1	0.6%
26B	Toccoa fine sandy loam, 0 to 4 percent slopes	38.4	1.0%
28	Chewacla loam	212.6	5.7%
30B	Lenoir silt loam, 0 to 4 percent slopes	8.0	0.2%
31	Chastain loam	62.5	1.7%
33B	Coxville loam, 2 to 6 percent slopes	13.1	0.4%
37	Forestdale silt loam	59.4	1.6%
41B	Craven fine sandy loam, 2 to 6 percent slopes	6.6	0.2%
49B	Bourne fine sandy loam, 2 to 6 percent slopes	67.4	1.8%
51B	Pamunkey loam, 0 to 6 percent slopes	89.9	2.4%
67B	Lenoir loam, flooded, 0 to 4 percent slopes	60.8	1.6%
68B	Dogue loam, variant, 0 to 4 percent slopes	79.2	2.1%
70B	Norfolk fine sandy loam, 0 to 6 percent slopes	30.5	0.8%
71B	Buncombe loamy fine sand, 0 to 4 percent slopes	62.4	1.7%
80B	Colfax fine sandy loam, variant, 0 to 4 percent slopes	19.3	0.5%
82B	Kempsville-Bourne complex, 2 to 6 percent slopes	35.6	1.0%
92B	Rumford loamy fine sand, 2 to 6 percent slopes	10.8	0.3%
100	Hydraquents	34.5	0.9%
112B	Orangeburg-Faceville sandy loams, 2 to 6 percent slopes	16.2	0.4%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
157B	Faceville-Gritney fine sandy loams, 2 to 6 percent slopes	66.2	1.8%
158B	Tetotum loam, clayey substratum, 2 to 6 percent slopes	20.2	0.5%
169B	Bourne sandy loam, 2 to 6 percent slopes	13.2	0.4%
172D	Nevarc-Remlik complex, 6 to 12 percent slopes	221.0	5.9%
172E	Nevarc-Remlik complex, 12 to 20 percent slopes	43.0	1.2%
172F	Nevarc-Remlik complex, 20 to 35 percent slopes	245.8	6.6%
188	Dunbar fine sandy loam, 0 to 4 percent slopes	7.9	0.2%
191	Myatt loam, 0 to 2 percent slopes, rarely flooded	28.5	0.8%
212B	Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes	38.3	1.0%
244B	Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes	2.4	0.1%
W	Water	1,119.1	30.0%
Subtotals for Soil Survey Area		**3,427.5**	**91.8%**
Totals for Area of Interest		**3,735.7**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AgA	Angie loam, 0 to 2 percent slopes	4.8	0.1%
Ak	Angie loam, concretionary subsoil variant	7.7	0.2%
Ch	Chewacla silt loam	9.8	0.3%
FL	Fluvaquents	1.2	0.0%
Le	Lenoir silt loam	10.4	0.3%
OUF	Nevarc-Remlik complex, 15 to 50 percent slopes	18.5	0.5%
PmA	Pamunkey fine sandy loam, 0 to 2 percent slopes	123.0	3.3%
PmB	Pamunkey fine sandy loam, 2 to 6 percent slopes	6.7	0.2%
PmD	Pamunkey fine sandy loam, 6 to 15 percent slopes	2.3	0.1%
Ro	Roanoke silt loam	9.7	0.3%
To	Toccoa fine sandy loam	1.4	0.0%
UE	Udorthents, loamy	33.8	0.9%
W	Water	78.9	2.1%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Subtotals for Soil Survey Area		**308.2**	**8.2%**
Totals for Area of Interest		**3,735.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Chesterfield County, Virginia

1A—Fluvaquents

Map Unit Setting

National map unit symbol: 3zp3
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Fluvaquents and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 40 inches: silty clay loam
H3 - 40 to 50 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

3A—Fluvaquents, ponded

Map Unit Setting

National map unit symbol: 3zqh
Elevation: 10 to 350 feet

Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition
Fluvaquents, ponded and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents, Ponded

Setting
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile
H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 50 inches: clay
H3 - 50 to 72 inches: very gravelly sandy clay loam

Properties and qualities
Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

8B—Tetotum fine sandy loam, ponded

Map Unit Setting
National map unit symbol: 3zrp
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Tetotum and similar soils: 85 percent
Minor components: 3 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tetotum

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 54 inches: clay loam
H3 - 54 to 70 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

15—Made land

Map Unit Setting

National map unit symbol: 3zn9
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Made land: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

17B—Gritney fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3znz
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Gritney and similar soils: 85 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gritney

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 52 inches: clay
H3 - 52 to 85 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

17C—Gritney fine sandy loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 3zp0
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Gritney and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gritney

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 52 inches: clay
H3 - 52 to 85 inches: sandy loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Hydric soil rating: No

21B—Atlee silt loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zpk
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Atlee and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Atlee

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: silt loam
H2 - 11 to 20 inches: loam
H3 - 20 to 36 inches: clay loam
H4 - 36 to 72 inches: clay loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions

Hydric soil rating: Yes

26B—Toccoa fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zpz
Elevation: 470 to 1,500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Toccoa and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Toccoa

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 15 inches: fine sandy loam
H2 - 15 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 36 to 60 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A
Hydric soil rating: No

28—Chewacla loam

Map Unit Setting

National map unit symbol: 3zq0
Elevation: 0 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Chewacla and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chewacla

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 5 inches: loam
H2 - 5 to 13 inches: clay loam
H3 - 13 to 26 inches: sandy clay loam
H4 - 26 to 40 inches: clay loam
H5 - 40 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B/D
Hydric soil rating: No

Minor Components

Fluvaquents
Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Hydraquents
Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

Chastain
Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

30B—Lenoir silt loam, 0 to 4 percent slopes

Map Unit Setting
National map unit symbol: 3zq5
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Lenoir and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenoir

Setting
Landform: Hillslopes
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loamy alluvium

Typical profile
H1 - 0 to 16 inches: silt loam
H2 - 16 to 60 inches: clay

Properties and qualities
Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

31—Chastain loam

Map Unit Setting

National map unit symbol: 3zq6
Elevation: 10 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Chastain and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chastain

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium

Typical profile

H1 - 0 to 13 inches: loam
H2 - 13 to 36 inches: clay loam
H3 - 36 to 80 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Fluvaquents

Percent of map unit: 8 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Forestdale

Percent of map unit: 7 percent
Landform: Flood plains
Hydric soil rating: Yes

33B—Coxville loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zq7
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Coxville and similar soils: 85 percent
Minor components: 6 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Coxville

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 10 inches: loam
H2 - 10 to 75 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Fluvaquents

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Pouncey

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

37—Forestdale silt loam

Map Unit Setting

National map unit symbol: 3zqc
Mean annual precipitation: 31 to 54 inches

Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition
Forestdale and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Forestdale

Setting
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium

Typical profile
H1 - 0 to 9 inches: silt loam
H2 - 9 to 43 inches: clay
H3 - 43 to 74 inches: silt loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Hydric soil rating: Yes

41B—Craven fine sandy loam, 2 to 6 percent slopes

Map Unit Setting
National map unit symbol: 3zqj
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Craven and similar soils: 85 percent
Minor components: 3 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Craven

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 15 inches: fine sandy loam
H2 - 15 to 59 inches: clay
H3 - 59 to 95 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

49B—Bourne fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zqr
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Bourne and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bourne

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 22 inches: sandy clay loam
H3 - 22 to 44 inches: fine sandy loam
H4 - 44 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: About 22 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

51B—Pamunkey loam, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zqy
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Pamunkey and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 14 inches: loam
H2 - 14 to 50 inches: clay loam
H3 - 50 to 72 inches: loamy fine sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

67B—Lenoir loam, flooded, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrd
Elevation: 10 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Lenoir and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenoir

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 16 inches: loam
H2 - 16 to 60 inches: clay

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Forestdale

Percent of map unit: 3 percent
Landform: Flood plains
Hydric soil rating: Yes

Chastain

Percent of map unit: 2 percent
Landform: Flood plains
Hydric soil rating: Yes

68B—Dogue loam, variant, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrf
Elevation: 10 to 750 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Dogue, variant, and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dogue, Variant

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey alluvium

Typical profile

H1 - 0 to 9 inches: loam
H2 - 9 to 42 inches: clay
H3 - 42 to 72 inches: loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

70B—Norfolk fine sandy loam, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zrh
Elevation: 30 to 450 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Norfolk and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Norfolk

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 31 inches: sandy clay loam
H3 - 31 to 90 inches: clay
H4 - 90 to 107 inches: sandy loam

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

71B—Buncombe loamy fine sand, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrj
Elevation: 10 to 90 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Buncombe and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Buncombe

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 9 inches: loamy fine sand

H2 - 9 to 57 inches: loamy fine sand
H3 - 57 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Chastain

Percent of map unit: 3 percent
Landform: Flood plains
Hydric soil rating: Yes

80B—Colfax fine sandy loam, variant, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zrl
Elevation: 150 to 400 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Colfax, variant, and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colfax, Variant

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy granite and gneiss

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 16 inches: sandy clay loam
H3 - 16 to 21 inches: sandy clay loam
H4 - 21 to 52 inches: sandy clay loam
H5 - 52 to 73 inches: clay

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: About 21 inches to fragipan
Natural drainage class: Somewhat poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

Pouncey

Percent of map unit: 2 percent
Landform: Depressions
Hydric soil rating: Yes

82B—Kempsville-Bourne complex, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zrm
Elevation: 100 to 400 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Kempsville and similar soils: 45 percent
Bourne and similar soils: 40 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kempsville

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 19 inches: sandy loam
H2 - 19 to 37 inches: sandy clay loam
H3 - 37 to 65 inches: sandy clay
H4 - 65 to 150 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Bourne

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: fine sandy loam
H2 - 11 to 22 inches: sandy clay loam
H3 - 22 to 44 inches: fine sandy loam
H4 - 44 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: About 22 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches

Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

92B—Rumford loamy fine sand, 2 to 6 percent slopes

Map Unit Setting
National map unit symbol: 3zrq
Elevation: 80 to 150 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Rumford and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rumford

Setting
Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile
H1 - 0 to 21 inches: loamy fine sand
H2 - 21 to 40 inches: fine sandy loam
H3 - 40 to 72 inches: fine sand

Properties and qualities
Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Hydric soil rating: No

100—Hydraquents

Map Unit Setting

National map unit symbol: 3zmg
Elevation: 0 to 10 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Hydraquents and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hydraquents

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

H1 - 0 to 8 inches: mucky clay loam
H2 - 8 to 44 inches: silty clay
H3 - 44 to 60 inches: sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Available water storage in profile: High (about 10.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

112B—Orangeburg-Faceville sandy loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zmy
Elevation: 170 to 500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Orangeburg and similar soils: 50 percent
Faceville and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Orangeburg

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 16 inches: sandy loam
H2 - 16 to 24 inches: sandy loam
H3 - 24 to 43 inches: sandy clay loam
H4 - 43 to 72 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Faceville

Setting

Landform: Marine terraces

Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 12 inches: sandy loam
H2 - 12 to 18 inches: sandy clay loam
H3 - 18 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

157B—Faceville-Gritney fine sandy loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3znf
Elevation: 200 to 450 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Faceville and similar soils: 50 percent
Gritney and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Faceville

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 18 inches: sandy clay loam
H3 - 18 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Gritney

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 52 inches: clay
H3 - 52 to 85 inches: loamy sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

158B—Tetotum loam, clayey substratum, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zng
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Tetotum and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tetotum

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Concave
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 11 inches: loam
H2 - 11 to 54 inches: clay loam
H3 - 54 to 70 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

169B—Bourne sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3znt
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Not prime farmland

Map Unit Composition

Bourne and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bourne

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 11 inches: sandy loam
H2 - 11 to 22 inches: sandy clay loam
H3 - 22 to 44 inches: fine sandy loam
H4 - 44 to 72 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: About 22 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

172D—Nevarc-Remlik complex, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2y7k2
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F
Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Hydric soil rating: No

172E—Nevarc-Remlik complex, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2y7k3
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F
Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Hydric soil rating: No

172F—Nevarc-Remlik complex, 20 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2y7k4
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F
Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

188—Dunbar fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 3zp1
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Dunbar and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dunbar

Setting

Landform: Marine terraces

Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 12 inches: fine sandy loam
H2 - 12 to 20 inches: sandy clay loam
H3 - 20 to 72 inches: clay

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Coxville

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

Pouncey

Percent of map unit: 2 percent
Landform: Depressions
Hydric soil rating: Yes

191—Myatt loam, 0 to 2 percent slopes, rarely flooded

Map Unit Setting

National map unit symbol: 2y7jv
Elevation: 500 to 1,100 feet
Mean annual precipitation: 31 to 52 inches
Mean annual air temperature: 48 to 66 degrees F
Frost-free period: 210 to 230 days
Farmland classification: Not prime farmland

Map Unit Composition

Myatt, rarely flooded, and similar soils: 93 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Myatt, Rarely Flooded

Setting

Landform: Depressions
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Fluviomarine deposits

Typical profile

A - 0 to 9 inches: loam
Btg - 9 to 50 inches: clay loam
Cg - 50 to 80 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

212B—Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes

Map Unit Setting

National map unit symbol: 3zph
Elevation: 170 to 500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Lucy and similar soils: 45 percent
Orangeburg and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lucy

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 26 inches: loamy sand
H2 - 26 to 60 inches: sandy clay loam
H3 - 60 to 90 inches: loamy sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Orangeburg

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 16 inches: loamy sand
H2 - 16 to 24 inches: sandy loam
H3 - 24 to 43 inches: sandy clay loam
H4 - 43 to 72 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Moderate (about 6.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

244B—Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 3zpm
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 46 to 70 degrees F
Frost-free period: 170 to 202 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Edgehill and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Edgehill

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 17 inches: very gravelly fine sandy loam
H2 - 17 to 41 inches: very gravelly clay
H3 - 41 to 80 inches: very gravelly sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B

Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Properties and qualities

Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Henrico County, Virginia

AgA—Angie loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 400x
Elevation: 150 to 600 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Angie and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Angie

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile

H1 - 0 to 8 inches: loam
H2 - 8 to 79 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: D
Hydric soil rating: No

Ak—Angie loam, concretionary subsoil variant

Map Unit Setting

National map unit symbol: 4012

Elevation: 150 to 600 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Angie, variant, and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Angie, Variant

Setting
Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Typical profile
H1 - 0 to 7 inches: loam
H2 - 7 to 30 inches: silty clay loam
H3 - 30 to 79 inches: very gravelly silty clay loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: D
Hydric soil rating: No

Ch—Chewacla silt loam

Map Unit Setting
National map unit symbol: 401r
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Chewacla and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chewacla

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 44 inches: silt loam
H3 - 44 to 79 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 11.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C
Hydric soil rating: Yes

FL—Fluvaquents

Map Unit Setting

National map unit symbol: 4025
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Fluvaquents and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fluvaquents

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 4 inches: loam
H2 - 4 to 52 inches: sandy clay loam
H3 - 52 to 74 inches: gravelly sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Le—Lenoir silt loam

Map Unit Setting

National map unit symbol: 402v
Elevation: 10 to 350 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Lenoir and similar soils: 85 percent
Minor components: 6 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenoir

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 79 inches: silty clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Roanoke

Percent of map unit: 3 percent
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: Yes

Coxville

Percent of map unit: 3 percent
Landform: Marine terraces, depressions
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: Yes

OUF—Nevarc-Remlik complex, 15 to 50 percent slopes

Map Unit Setting

National map unit symbol: 2y7jz
Elevation: 20 to 150 feet
Mean annual precipitation: 45 to 55 inches
Mean annual air temperature: 61 to 68 degrees F

Frost-free period: 200 to 225 days
Farmland classification: Not prime farmland

Map Unit Composition

Nevarc and similar soils: 45 percent
Remlik and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nevarc

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 54 inches: clay
C - 54 to 80 inches: fine sandy loam

Properties and qualities

Slope: 15 to 50 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Remlik

Setting

Landform: Marine terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy marine deposits

Typical profile

A - 0 to 29 inches: fine sand
Bt - 29 to 50 inches: fine sandy loam
E and Bt - 50 to 80 inches: loamy fine sand

Properties and qualities

Slope: 15 to 50 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.57 to 19.98 in/hr)
Depth to water table: About 48 to 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

PmA—Pamunkey fine sandy loam, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 4039
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Pamunkey and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile
H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 57 inches: sandy clay loam
H3 - 57 to 99 inches: sandy clay loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Hydric soil rating: No

PmB—Pamunkey fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 403b
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Pamunkey and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 57 inches: sandy clay loam
H3 - 57 to 99 inches: sandy clay loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

PmD—Pamunkey fine sandy loam, 6 to 15 percent slopes

Map Unit Setting

National map unit symbol: 403c
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Pamunkey and similar soils: 95 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pamunkey

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile

H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 57 inches: sandy clay loam
H3 - 57 to 99 inches: sandy clay loam

Properties and qualities

Slope: 6 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Ro—Roanoke silt loam

Map Unit Setting

National map unit symbol: 403l
Elevation: 10 to 350 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Roanoke and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Roanoke

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 79 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.57 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

To—Toccoa fine sandy loam

Map Unit Setting

National map unit symbol: 4040
Elevation: 470 to 1,500 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Toccoa and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Toccoa

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 15 inches: fine sandy loam
H2 - 15 to 79 inches: fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 36 to 60 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Chewacla

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

UE—Udorthents, loamy

Map Unit Setting

National map unit symbol: 4047
Elevation: 50 to 300 feet
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 85 percent
Minor components: 1 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Minor Components

Kinston

Percent of map unit: 1 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

W—Water

Map Unit Setting

National map unit symbol: 4049
Mean annual precipitation: 31 to 54 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 170 to 201 days

Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

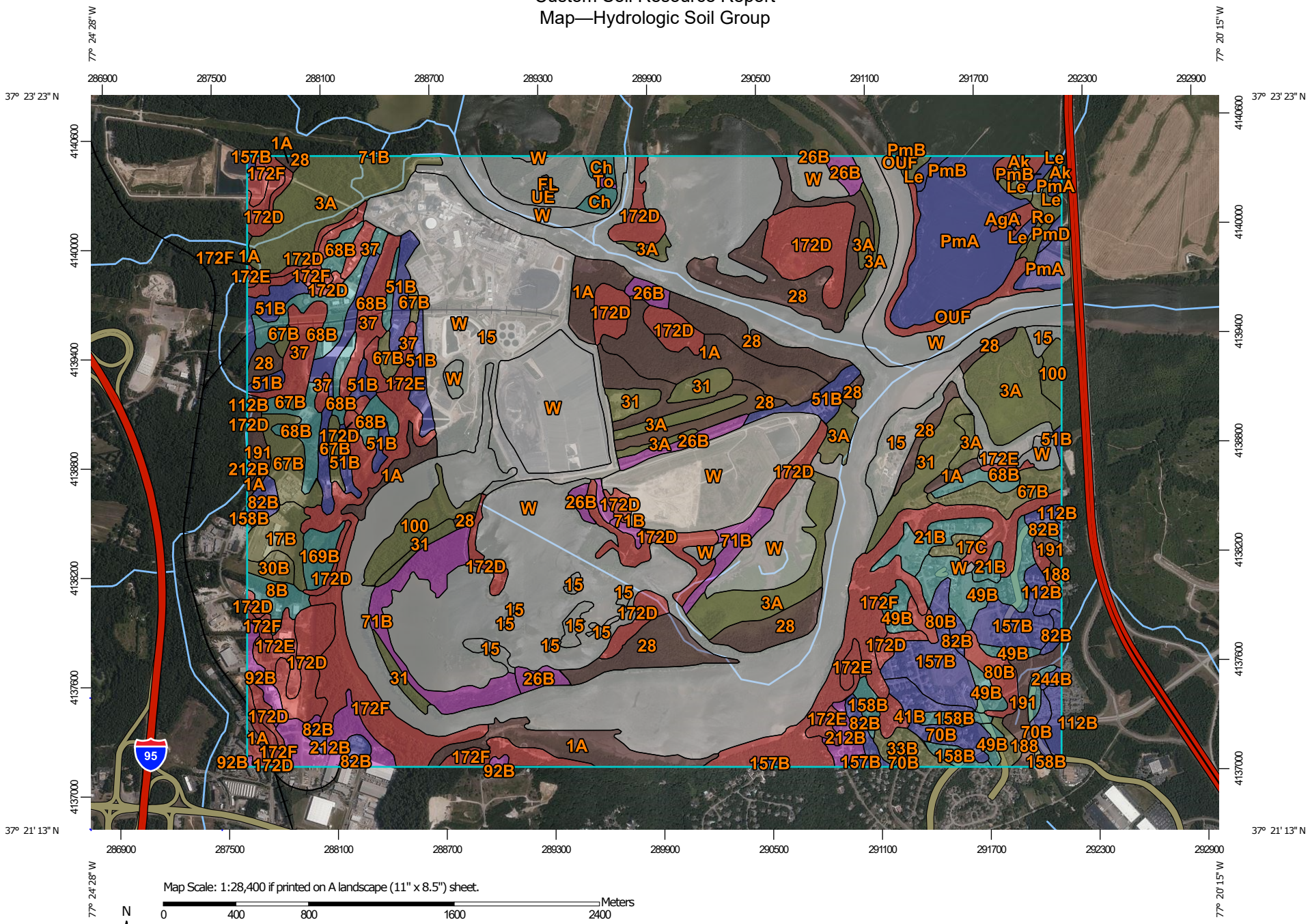
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.


77° 24' 28" W
77° 20' 15" W
37° 23' 23" N
37° 21' 13" N
286900
287500
288100
288700
289300
289900
290500
291100
291700
292300
292900
4140600
4140000
4139400
4138800
4138200
4137600
4137000
95
Map Scale: 1:28,400 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 400 800 1600 2400
Feet
0 1000 2000 4000 6000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Chesterfield County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Soil Survey Area: Henrico County, Virginia
Survey Area Data: Version 12, Sep 16, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 1, 2019—Jul 25, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1A	Fluvaquents	B/D	140.1	3.7%
3A	Fluvaquents, ponded	C/D	211.9	5.7%
8B	Tetotum fine sandy loam, ponded	C	14.2	0.4%
15	Made land		298.5	8.0%
17B	Gritney fine sandy loam, 2 to 6 percent slopes	C/D	20.8	0.6%
17C	Gritney fine sandy loam, 6 to 12 percent slopes	C/D	5.3	0.1%
21B	Atlee silt loam, 0 to 4 percent slopes	C	24.1	0.6%
26B	Toccoa fine sandy loam, 0 to 4 percent slopes	A	38.4	1.0%
28	Chewacla loam	B/D	212.6	5.7%
30B	Lenoir silt loam, 0 to 4 percent slopes	C/D	8.0	0.2%
31	Chastain loam	C/D	62.5	1.7%
33B	Coxville loam, 2 to 6 percent slopes	C/D	13.1	0.4%
37	Forestdale silt loam	D	59.4	1.6%
41B	Craven fine sandy loam, 2 to 6 percent slopes	D	6.6	0.2%
49B	Bourne fine sandy loam, 2 to 6 percent slopes	C	67.4	1.8%
51B	Pamunkey loam, 0 to 6 percent slopes	B	89.9	2.4%
67B	Lenoir loam, flooded, 0 to 4 percent slopes	C/D	60.8	1.6%
68B	Dogue loam, variant, 0 to 4 percent slopes	C	79.2	2.1%
70B	Norfolk fine sandy loam, 0 to 6 percent slopes	B	30.5	0.8%
71B	Buncombe loamy fine sand, 0 to 4 percent slopes	A	62.4	1.7%
80B	Colfax fine sandy loam, variant, 0 to 4 percent slopes	D	19.3	0.5%
82B	Kempsville-Bourne complex, 2 to 6 percent slopes	B	35.6	1.0%
92B	Rumford loamy fine sand, 2 to 6 percent slopes	A	10.8	0.3%
100	Hydraquents	C/D	34.5	0.9%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
112B	Orangeburg-Faceville sandy loams, 2 to 6 percent slopes	B	16.2	0.4%
157B	Faceville-Gritney fine sandy loams, 2 to 6 percent slopes	B	66.2	1.8%
158B	Tetotum loam, clayey substratum, 2 to 6 percent slopes	C	20.2	0.5%
169B	Bourne sandy loam, 2 to 6 percent slopes	C	13.2	0.4%
172D	Nevarc-Remlik complex, 6 to 12 percent slopes	D	221.0	5.9%
172E	Nevarc-Remlik complex, 12 to 20 percent slopes	D	43.0	1.2%
172F	Nevarc-Remlik complex, 20 to 35 percent slopes	D	245.8	6.6%
188	Dunbar fine sandy loam, 0 to 4 percent slopes	C/D	7.9	0.2%
191	Myatt loam, 0 to 2 percent slopes, rarely flooded	B/D	28.5	0.8%
212B	Lucy-Orangeburg loamy sands, 2 to 6 percent percent slopes	A	38.3	1.0%
244B	Edgehill very gravelly fine sandy loam, 2 to 6 percent slopes	B	2.4	0.1%
W	Water		1,119.1	30.0%
Subtotals for Soil Survey Area			**3,427.5**	**91.8%**
Totals for Area of Interest			**3,735.7**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AgA	Angie loam, 0 to 2 percent slopes	D	4.8	0.1%
Ak	Angie loam, concretionary subsoil variant	D	7.7	0.2%
Ch	Chewacla silt loam	C	9.8	0.3%
FL	Fluvaquents	B/D	1.2	0.0%
Le	Lenoir silt loam	C/D	10.4	0.3%
OUF	Nevarc-Remlik complex, 15 to 50 percent slopes	D	18.5	0.5%
PmA	Pamunkey fine sandy loam, 0 to 2 percent slopes	B	123.0	3.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
PmB	Pamunkey fine sandy loam, 2 to 6 percent slopes	B	6.7	0.2%
PmD	Pamunkey fine sandy loam, 6 to 15 percent slopes	B	2.3	0.1%
Ro	Roanoke silt loam	C/D	9.7	0.3%
To	Toccoa fine sandy loam	A	1.4	0.0%
UE	Udorthents, loamy		33.8	0.9%
W	Water		78.9	2.1%
Subtotals for Soil Survey Area			**308.2**	**8.2%**
Totals for Area of Interest			**3,735.7**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

NOAA Atlas 14, Volume 2, Version 3
Location name: Chester, Virginia, USA*
Latitude: 37.3702°, Longitude: -77.3698°
Elevation: 79.01 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.379** (0.343-0.420)	**0.449** (0.407-0.497)	**0.525** (0.475-0.581)	**0.589** (0.531-0.652)	**0.661** (0.594-0.730)	**0.716** (0.641-0.791)	**0.768** (0.684-0.848)	**0.816** (0.723-0.901)	**0.874** (0.768-0.966)	**0.920** (0.803-1.02)
10-min	**0.606** (0.548-0.672)	**0.718** (0.651-0.795)	**0.841** (0.761-0.931)	**0.942** (0.849-1.04)	**1.05** (0.946-1.16)	**1.14** (1.02-1.26)	**1.22** (1.09-1.35)	**1.29** (1.15-1.43)	**1.38** (1.22-1.53)	**1.45** (1.26-1.60)
15-min	**0.757** (0.684-0.839)	**0.902** (0.818-1.00)	**1.06** (0.962-1.18)	**1.19** (1.07-1.32)	**1.34** (1.20-1.48)	**1.45** (1.29-1.59)	**1.54** (1.37-1.70)	**1.63** (1.45-1.80)	**1.74** (1.53-1.92)	**1.82** (1.59-2.01)
30-min	**1.04** (0.938-1.15)	**1.25** (1.13-1.38)	**1.51** (1.37-1.67)	**1.73** (1.56-1.91)	**1.98** (1.78-2.19)	**2.18** (1.95-2.40)	**2.36** (2.11-2.61)	**2.54** (2.25-2.81)	**2.77** (2.43-3.06)	**2.95** (2.57-3.26)
60-min	**1.29** (1.17-1.44)	**1.56** (1.42-1.73)	**1.94** (1.75-2.15)	**2.25** (2.03-2.49)	**2.64** (2.37-2.91)	**2.95** (2.64-3.25)	**3.26** (2.90-3.60)	**3.57** (3.16-3.93)	**3.97** (3.49-4.39)	**4.30** (3.75-4.76)
2-hr	**1.54** (1.39-1.72)	**1.87** (1.68-2.07)	**2.33** (2.10-2.59)	**2.74** (2.46-3.04)	**3.27** (2.92-3.61)	**3.70** (3.29-4.10)	**4.16** (3.66-4.59)	**4.62** (4.05-5.10)	**5.27** (4.56-5.81)	**5.79** (4.98-6.40)
3-hr	**1.66** (1.49-1.86)	**2.01** (1.81-2.25)	**2.52** (2.26-2.81)	**2.96** (2.65-3.30)	**3.55** (3.15-3.94)	**4.03** (3.56-4.48)	**4.54** (3.98-5.03)	**5.06** (4.41-5.61)	**5.79** (4.99-6.42)	**6.40** (5.46-7.09)
6-hr	**2.01** (1.80-2.27)	**2.42** (2.16-2.73)	**3.03** (2.70-3.41)	**3.58** (3.18-4.02)	**4.32** (3.82-4.84)	**4.96** (4.35-5.54)	**5.63** (4.90-6.29)	**6.35** (5.48-7.08)	**7.38** (6.28-8.21)	**8.25** (6.94-9.18)
12-hr	**2.40** (2.16-2.72)	**2.90** (2.60-3.27)	**3.65** (3.26-4.12)	**4.34** (3.86-4.88)	**5.30** (4.66-5.94)	**6.14** (5.36-6.88)	**7.06** (6.09-7.87)	**8.05** (6.87-8.95)	**9.50** (7.97-10.6)	**10.8** (8.91-12.0)
24-hr	**2.78** (2.54-3.06)	**3.36** (3.08-3.71)	**4.31** (3.93-4.76)	**5.11** (4.65-5.64)	**6.31** (5.69-6.94)	**7.33** (6.57-8.05)	**8.45** (7.52-9.27)	**9.70** (8.55-10.6)	**11.6** (10.0-12.6)	**13.1** (11.3-14.4)
2-day	**3.24** (2.97-3.56)	**3.92** (3.59-4.31)	**5.00** (4.58-5.50)	**5.90** (5.38-6.48)	**7.21** (6.53-7.90)	**8.31** (7.49-9.11)	**9.51** (8.50-10.4)	**10.8** (9.59-11.9)	**12.7** (11.1-14.0)	**14.3** (12.4-15.8)
3-day	**3.42** (3.14-3.76)	**4.15** (3.81-4.55)	**5.28** (4.84-5.79)	**6.22** (5.69-6.81)	**7.59** (6.89-8.30)	**8.74** (7.89-9.56)	**9.98** (8.96-10.9)	**11.3** (10.1-12.4)	**13.3** (11.7-14.6)	**15.0** (13.0-16.5)
4-day	**3.61** (3.32-3.95)	**4.37** (4.02-4.79)	**5.56** (5.11-6.08)	**6.54** (5.99-7.15)	**7.97** (7.26-8.70)	**9.16** (8.30-10.0)	**10.5** (9.41-11.4)	**11.9** (10.6-13.0)	**13.9** (12.3-15.2)	**15.6** (13.6-17.2)
7-day	**4.17** (3.85-4.56)	**5.02** (4.63-5.49)	**6.28** (5.79-6.87)	**7.33** (6.74-8.01)	**8.83** (8.08-9.64)	**10.1** (9.18-11.0)	**11.4** (10.3-12.5)	**12.9** (11.6-14.1)	**15.0** (13.3-16.4)	**16.7** (14.7-18.3)
10-day	**4.76** (4.41-5.17)	**5.70** (5.29-6.20)	**7.06** (6.53-7.66)	**8.15** (7.53-8.85)	**9.71** (8.93-10.5)	**11.0** (10.1-11.9)	**12.3** (11.2-13.4)	**13.8** (12.4-15.0)	**15.8** (14.1-17.2)	**17.4** (15.5-19.0)
20-day	**6.41** (5.98-6.89)	**7.65** (7.14-8.21)	**9.25** (8.61-9.93)	**10.5** (9.78-11.3)	**12.2** (11.3-13.1)	**13.6** (12.6-14.6)	**15.0** (13.8-16.1)	**16.4** (15.0-17.7)	**18.4** (16.7-19.8)	**19.9** (17.9-21.5)
30-day	**7.96** (7.47-8.48)	**9.43** (8.86-10.1)	**11.2** (10.5-11.9)	**12.5** (11.7-13.3)	**14.3** (13.3-15.2)	**15.6** (14.6-16.7)	**17.0** (15.8-18.1)	**18.3** (16.9-19.6)	**20.1** (18.5-21.5)	**21.4** (19.6-22.9)
45-day	**9.99** (9.40-10.6)	**11.8** (11.1-12.5)	**13.8** (13.0-14.7)	**15.3** (14.4-16.3)	**17.3** (16.2-18.3)	**18.8** (17.5-19.9)	**20.2** (18.8-21.4)	**21.6** (20.1-22.9)	**23.3** (21.6-24.9)	**24.6** (22.7-26.3)
60-day	**11.9** (11.2-12.6)	**14.0** (13.2-14.8)	**16.2** (15.3-17.1)	**17.8** (16.8-18.8)	**19.9** (18.7-21.0)	**21.5** (20.2-22.7)	**22.9** (21.5-24.3)	**24.4** (22.8-25.8)	**26.2** (24.4-27.7)	**27.5** (25.5-29.2)

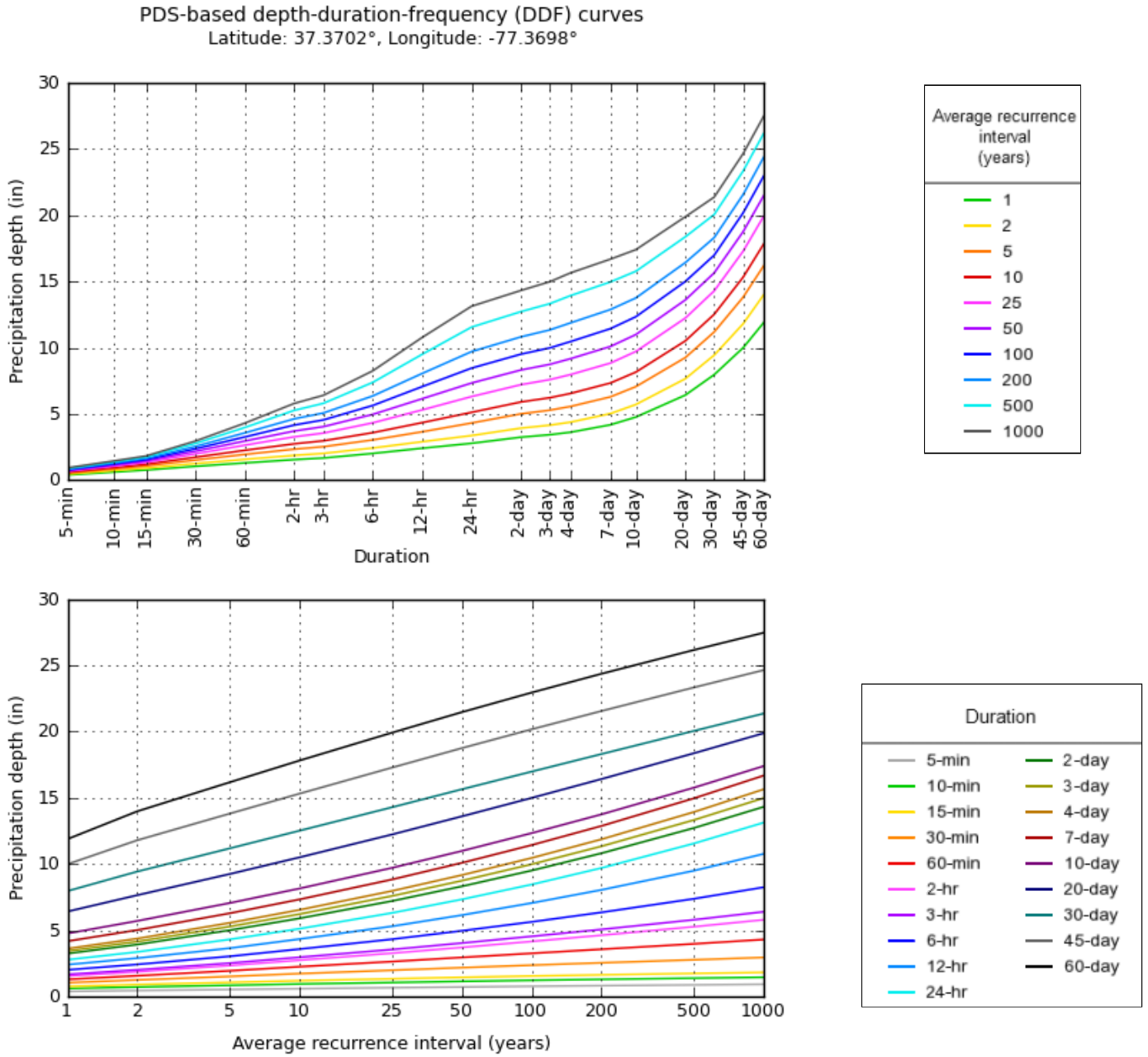
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



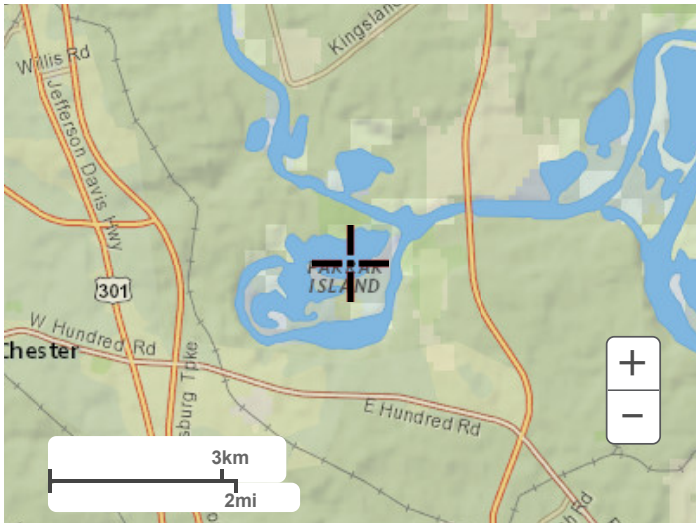
NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Mon Mar 23 16:00:51 2020

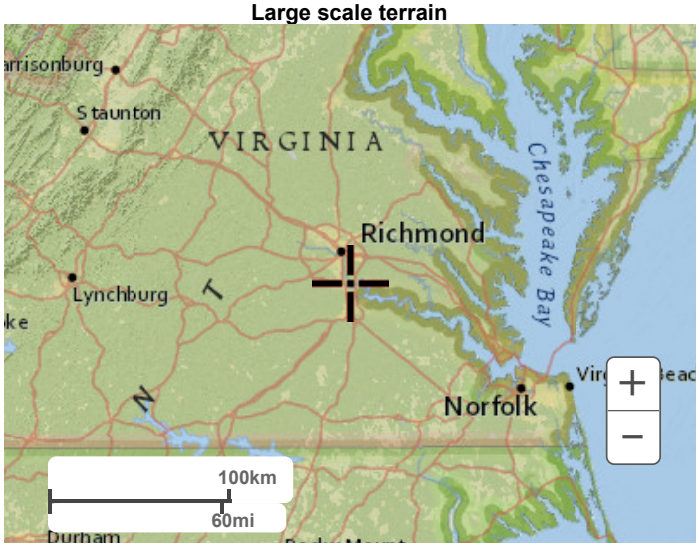
Back to Top

Maps & aerials

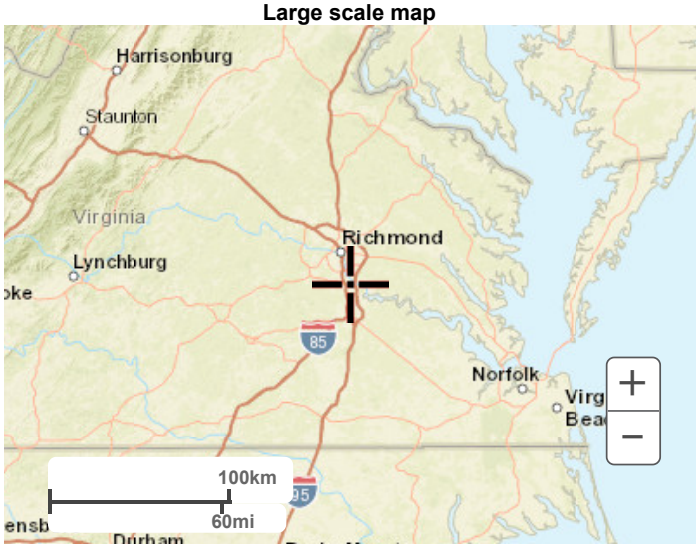
Small scale terrain



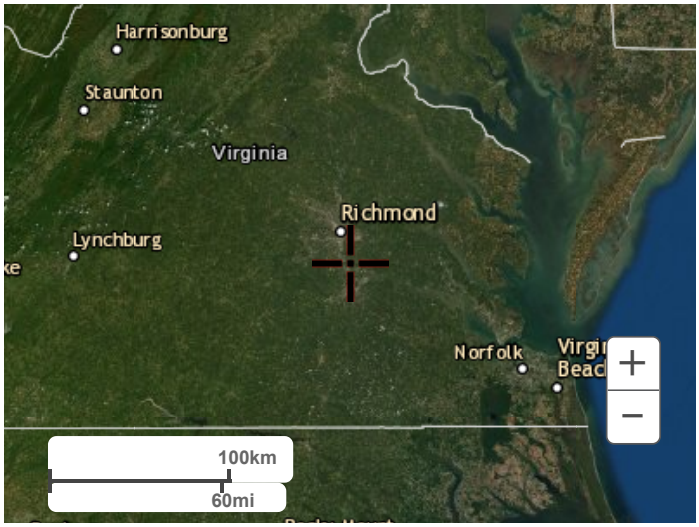
Large scale terrain



Large scale map



Large scale aerial



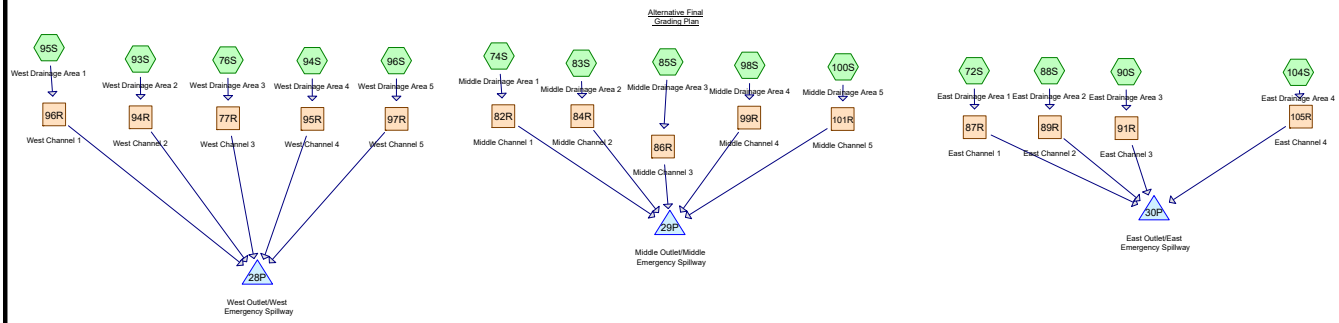
Back to Top

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

Disclaimer

Appendix 2

HydroCAD Inputs and Outputs—Post-Closure Condition



Subcat Reach Pond Link

Routing Diagram for Dominion Chesterfield_Stormwater-UAP-Flexamat

Prepared by AECOM, Printed 6/2/2020

HydroCAD® 10.00-12 s/n 00537 © 2014 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
123.390	84	50-75% Grass cover, Fair, HSG D (72S, 74S, 76S, 83S, 85S, 88S, 90S, 93S, 94S, 95S, 96S, 98S, 100S, 104S)
123.390	**84**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
123.390	HSG D	72S, 74S, 76S, 83S, 85S, 88S, 90S, 93S, 94S, 95S, 96S, 98S, 100S, 104S
0.000	Other	
123.390		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	123.390	0.000	123.390	50-75% Grass cover, Fair	72S, 74S, 76S, 83S, 85S, 88S, 90S, 93S, 94S, 95S, 96S, 98S, 100S, 104S
0.000	**0.000**	**0.000**	**123.390**	**0.000**	**123.390**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	28P	6.00	5.00	205.0	0.0049	0.012	18.0	0.0	0.0
2	29P	7.00	6.00	195.0	0.0051	0.012	18.0	0.0	0.0
3	30P	10.00	9.00	160.0	0.0063	0.012	18.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 72S: East Drainage Area 1 Runoff Area=2.239 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=6.98 cfs 0.339 af

Subcatchment 74S: Middle Drainage Area 1 Runoff Area=5.736 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=17.87 cfs 0.869 af

Subcatchment 76S: West Drainage Area 3 Runoff Area=14.150 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=44.09 cfs 2.143 af

Subcatchment 83S: Middle Drainage Area 2 Runoff Area=12.628 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=39.35 cfs 1.912 af

Subcatchment 85S: Middle Drainage Area 3 Runoff Area=19.614 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=61.12 cfs 2.970 af

Subcatchment 88S: East Drainage Area 2 Runoff Area=4.167 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=12.98 cfs 0.631 af

Subcatchment 90S: East Drainage Area 3 Runoff Area=10.335 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=32.20 cfs 1.565 af

Subcatchment 93S: West Drainage Area 2 Runoff Area=7.233 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=22.54 cfs 1.095 af

Subcatchment 94S: West Drainage Area 4 Runoff Area=11.630 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=36.24 cfs 1.761 af

Subcatchment 95S: West Drainage Area 1 Runoff Area=5.837 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=18.19 cfs 0.884 af

Subcatchment 96S: West Drainage Area 5 Runoff Area=7.290 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=22.72 cfs 1.104 af

Subcatchment 98S: Middle Drainage Area 4 Runoff Area=9.879 ac 0.00% Impervious Runoff Depth=1.82"
Tc=10.0 min CN=84 Runoff=27.15 cfs 1.496 af

Subcatchment 100S: Middle Drainage Area 5 Runoff Area=3.587 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=11.18 cfs 0.543 af

Subcatchment 104S: East Drainage Area 4 Runoff Area=9.065 ac 0.00% Impervious Runoff Depth=1.82"
Tc=6.0 min CN=84 Runoff=28.25 cfs 1.373 af

Reach 77R: West Channel 3 Avg. Flow Depth=0.35' Max Vel=1.19 fps Inflow=44.09 cfs 2.143 af
n=0.060 L=1,600.0' S=0.0100 '/' Capacity=149.49 cfs Outflow=21.48 cfs 2.143 af

Reach 82R: Middle Channel 1 Avg. Flow Depth=0.22' Max Vel=0.89 fps Inflow=17.87 cfs 0.869 af
n=0.060 L=975.0' S=0.0103 '/' Capacity=128.78 cfs Outflow=9.75 cfs 0.869 af

Reach 84R: Middle Channel 2 Avg. Flow Depth=0.38' Max Vel=1.28 fps Inflow=39.35 cfs 1.912 af
n=0.060 L=1,003.0' S=0.0100 '/' Capacity=149.26 cfs Outflow=25.35 cfs 1.912 af

Reach 86R: Middle Channel 3 Avg. Flow Depth=0.46' Max Vel=1.43 fps Inflow=61.12 cfs 2.970 af
n=0.060 L=1,500.0' S=0.0100 '/' Capacity=253.72 cfs Outflow=34.15 cfs 2.970 af

Reach 87R: East Channel 1 Avg. Flow Depth=0.14' Max Vel=0.72 fps Inflow=6.98 cfs 0.339 af
n=0.060 L=423.0' S=0.0118 '/' Capacity=138.25 cfs Outflow=5.06 cfs 0.339 af

Reach 89R: East Channel 2 Avg. Flow Depth=0.19' Max Vel=0.84 fps Inflow=12.98 cfs 0.631 af
n=0.060 L=673.0' S=0.0104 '/' Capacity=129.68 cfs Outflow=8.29 cfs 0.631 af

Reach 91R: East Channel 3 Avg. Flow Depth=0.32' Max Vel=1.14 fps Inflow=32.20 cfs 1.565 af
n=0.060 L=1,100.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=18.78 cfs 1.565 af

Reach 94R: West Channel 2 Avg. Flow Depth=0.27' Max Vel=1.01 fps Inflow=22.54 cfs 1.095 af
n=0.060 L=900.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=13.67 cfs 1.095 af

Reach 95R: West Channel 4 Avg. Flow Depth=0.35' Max Vel=1.21 fps Inflow=36.24 cfs 1.761 af
n=0.060 L=1,093.0' S=0.0101 '/' Capacity=127.57 cfs Outflow=21.86 cfs 1.761 af

Reach 96R: West Channel 1 Avg. Flow Depth=0.24' Max Vel=0.82 fps Inflow=18.19 cfs 0.884 af
n=0.060 L=910.0' S=0.0077 '/' Capacity=111.53 cfs Outflow=9.84 cfs 0.884 af

Reach 97R: West Channel 5 Avg. Flow Depth=0.25' Max Vel=1.04 fps Inflow=22.72 cfs 1.104 af
n=0.060 L=978.0' S=0.0112 '/' Capacity=134.86 cfs Outflow=13.41 cfs 1.104 af

Reach 99R: Middle Channel 4 Avg. Flow Depth=0.31' Max Vel=1.13 fps Inflow=27.15 cfs 1.496 af
n=0.060 L=960.0' S=0.0104 '/' Capacity=129.78 cfs Outflow=17.79 cfs 1.496 af

Reach 101R: Middle Channel 5 Avg. Flow Depth=0.17' Max Vel=0.76 fps Inflow=11.18 cfs 0.543 af
n=0.060 L=760.0' S=0.0105 '/' Capacity=130.46 cfs Outflow=6.41 cfs 0.543 af

Reach 105R: East Channel 4 Avg. Flow Depth=0.36' Max Vel=1.20 fps Inflow=28.25 cfs 1.373 af
n=0.060 L=516.0' S=0.0097 '/' Capacity=125.17 cfs Outflow=22.74 cfs 1.373 af

Pond 28P: West Outlet/West Emergency Peak Elev=8.42' Storage=67,512 cf Inflow=80.13 cfs 6.987 af
Outflow=27.24 cfs 6.987 af

Pond 29P: Middle Outlet/Middle Emergency Peak Elev=9.72' Storage=78,375 cf Inflow=92.13 cfs 7.790 af
Outflow=29.74 cfs 7.790 af

Pond 30P: East Outlet/East Emergency Peak Elev=11.75' Storage=29,819 cf Inflow=54.31 cfs 3.908 af
Outflow=25.56 cfs 3.908 af

Total Runoff Area = 123.390 ac Runoff Volume = 18.685 af Average Runoff Depth = 1.82"
100.00% Pervious = 123.390 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 72S: East Drainage Area 1

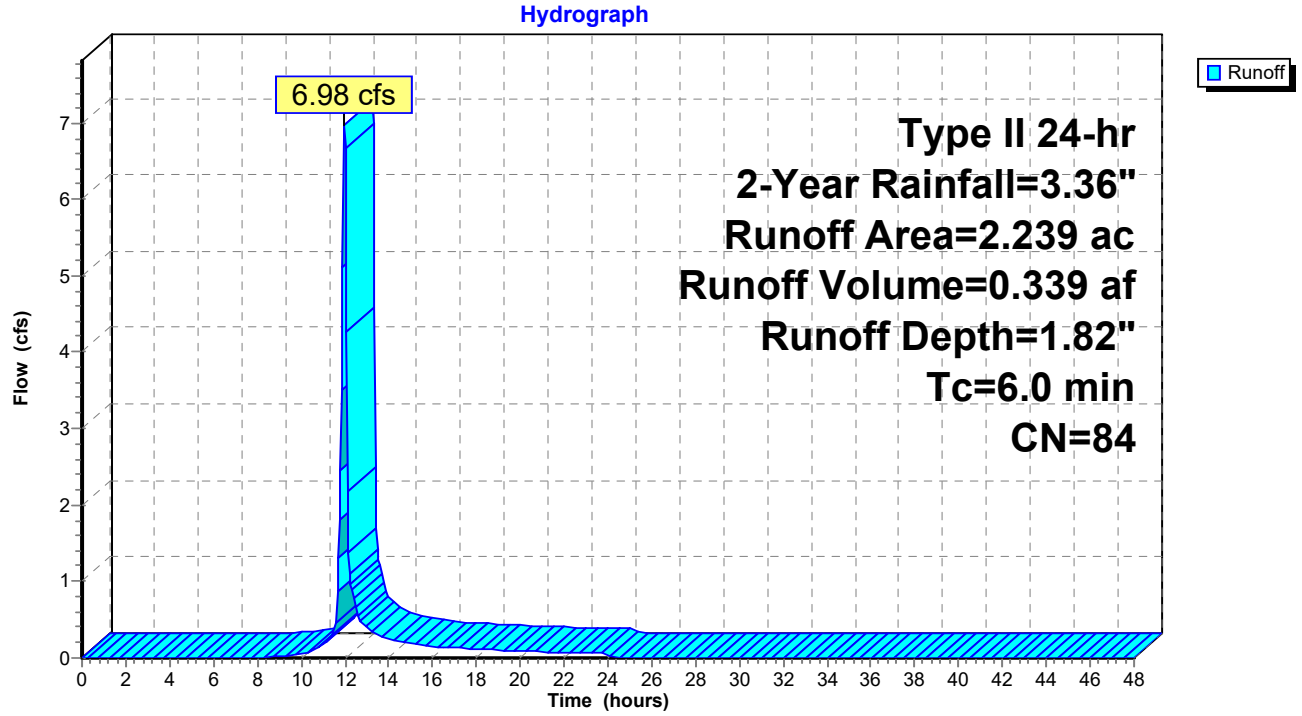
Runoff = 6.98 cfs @ 11.97 hrs, Volume= 0.339 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
2.239	84	50-75% Grass cover, Fair, HSG D
2.239		100.00% Pervious Area

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

Subcatchment 72S: East Drainage Area 1



Summary for Subcatchment 74S: Middle Drainage Area 1

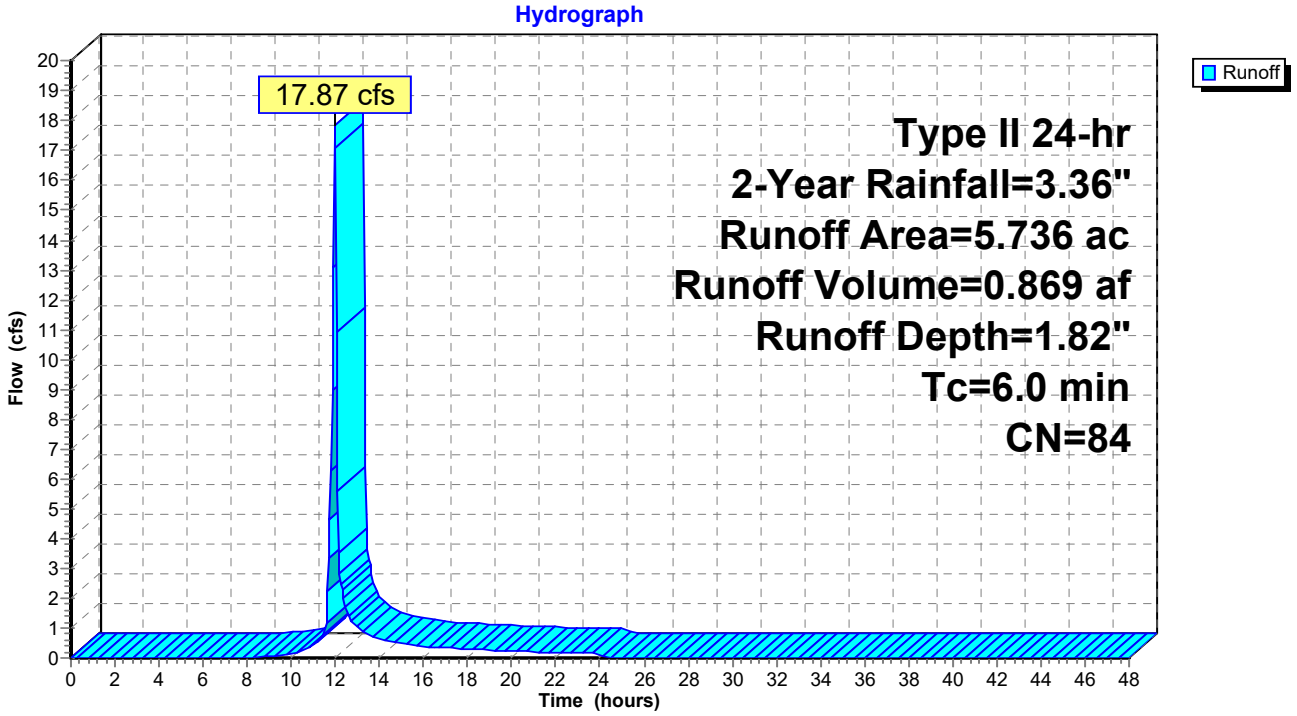
Runoff = 17.87 cfs @ 11.97 hrs, Volume= 0.869 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
5.736	84	50-75% Grass cover, Fair, HSG D
5.736		100.00% Pervious Area

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

Subcatchment 74S: Middle Drainage Area 1



Summary for Subcatchment 76S: West Drainage Area 3

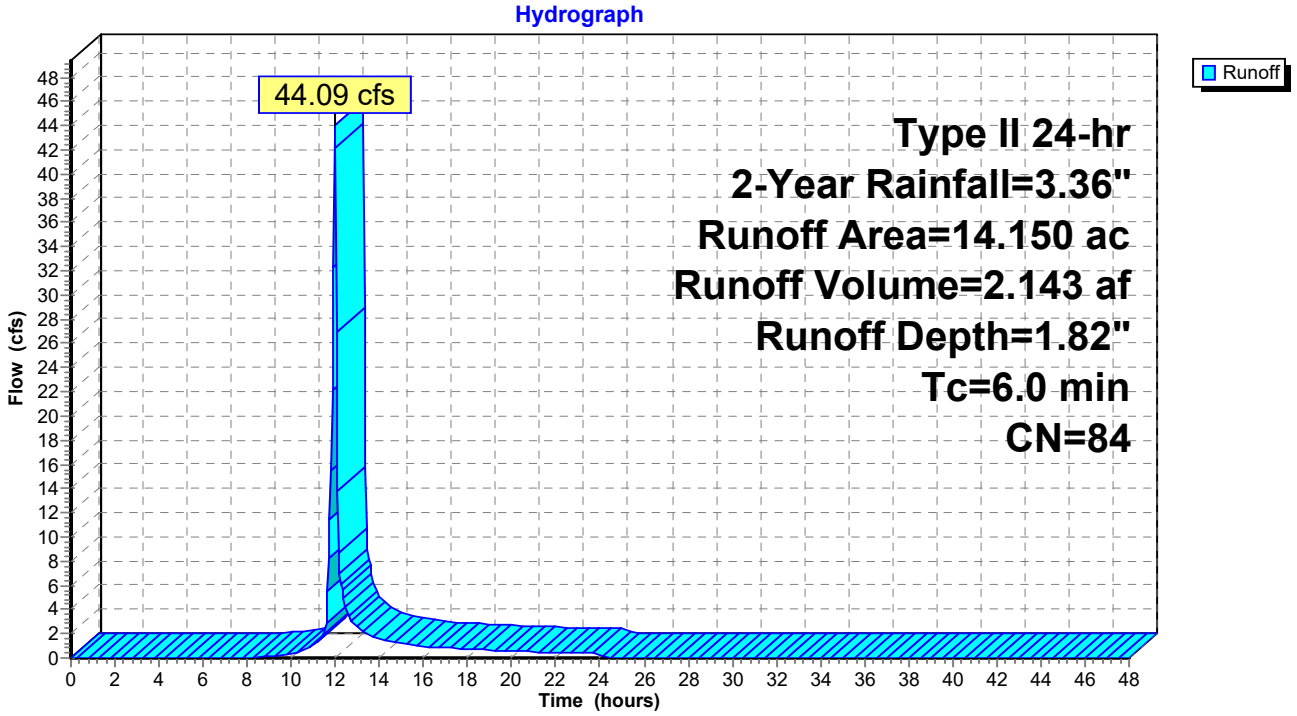
Runoff = 44.09 cfs @ 11.97 hrs, Volume= 2.143 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
14.150	84	50-75% Grass cover, Fair, HSG D
14.150		100.00% Pervious Area

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

Subcatchment 76S: West Drainage Area 3



Summary for Subcatchment 83S: Middle Drainage Area 2

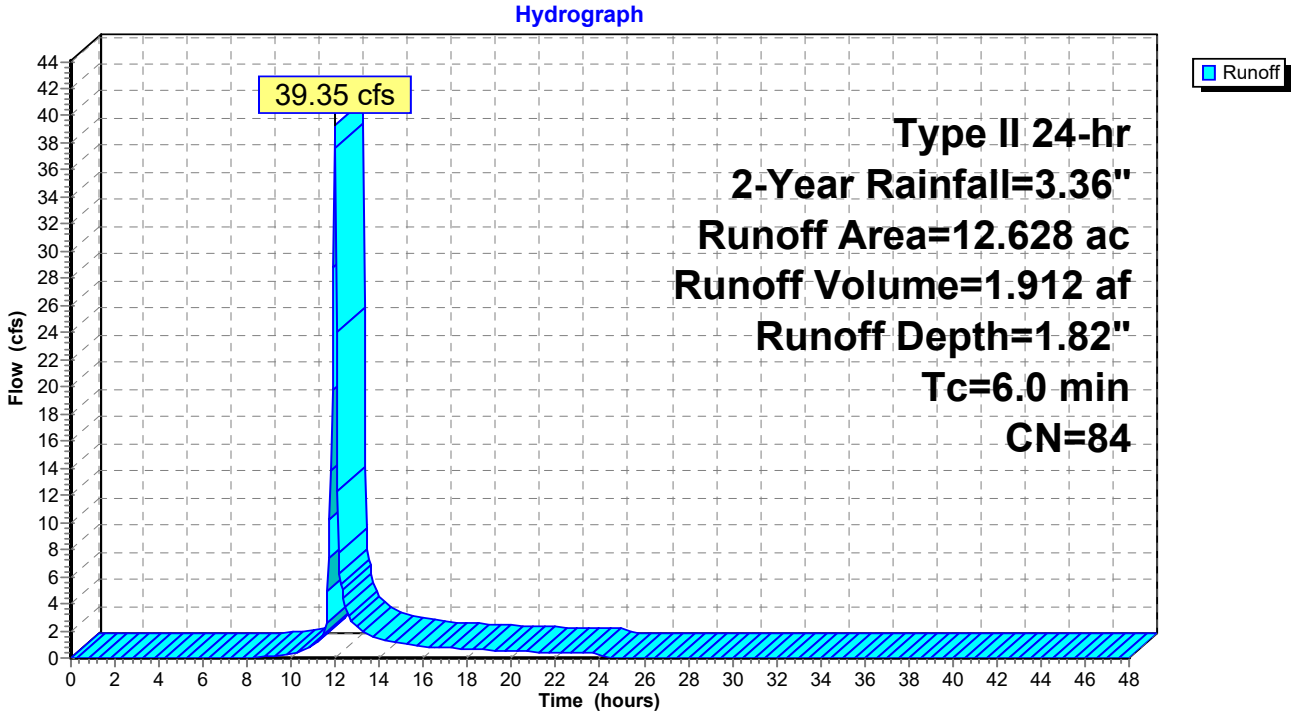
Runoff = 39.35 cfs @ 11.97 hrs, Volume= 1.912 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
12.628	84	50-75% Grass cover, Fair, HSG D
12.628		100.00% Pervious Area

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

Subcatchment 83S: Middle Drainage Area 2



Summary for Subcatchment 85S: Middle Drainage Area 3

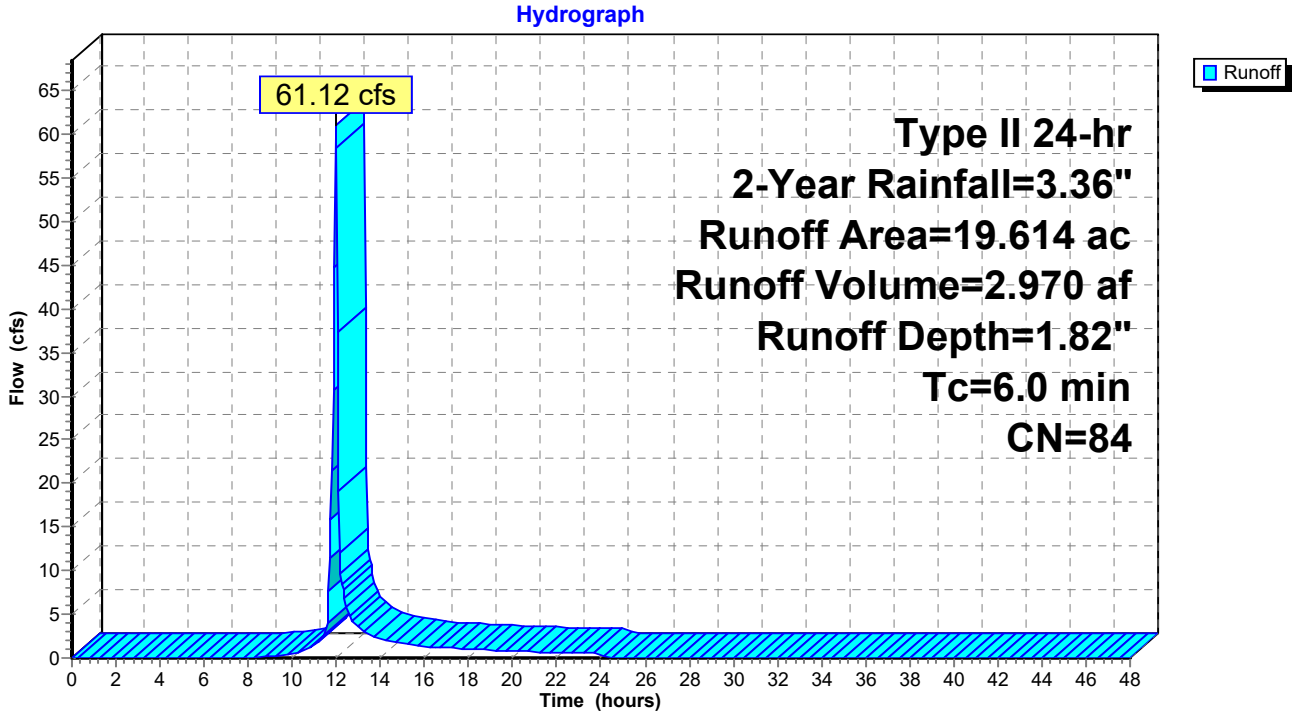
Runoff = 61.12 cfs @ 11.97 hrs, Volume= 2.970 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
19.614	84	50-75% Grass cover, Fair, HSG D
19.614		100.00% Pervious Area

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

Subcatchment 85S: Middle Drainage Area 3



Summary for Subcatchment 88S: East Drainage Area 2

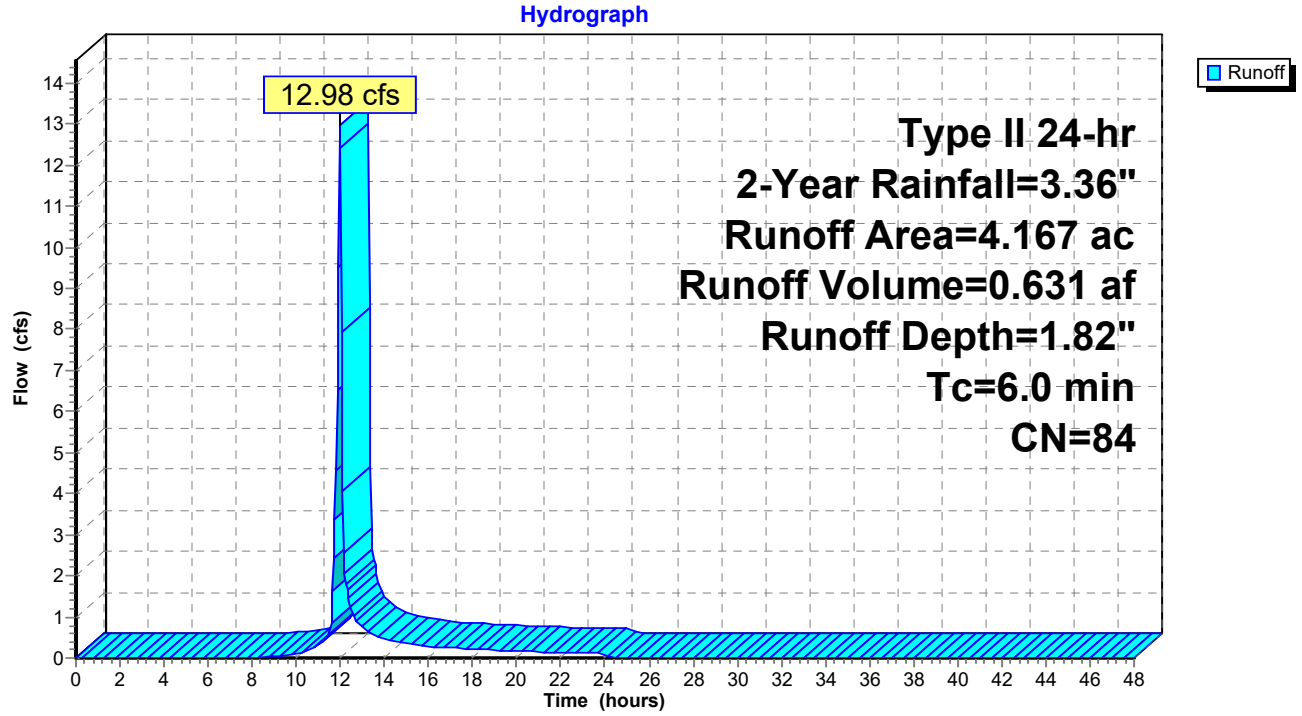
Runoff = 12.98 cfs @ 11.97 hrs, Volume= 0.631 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
4.167	84	50-75% Grass cover, Fair, HSG D
4.167		100.00% Pervious Area

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

Subcatchment 88S: East Drainage Area 2



Summary for Subcatchment 90S: East Drainage Area 3

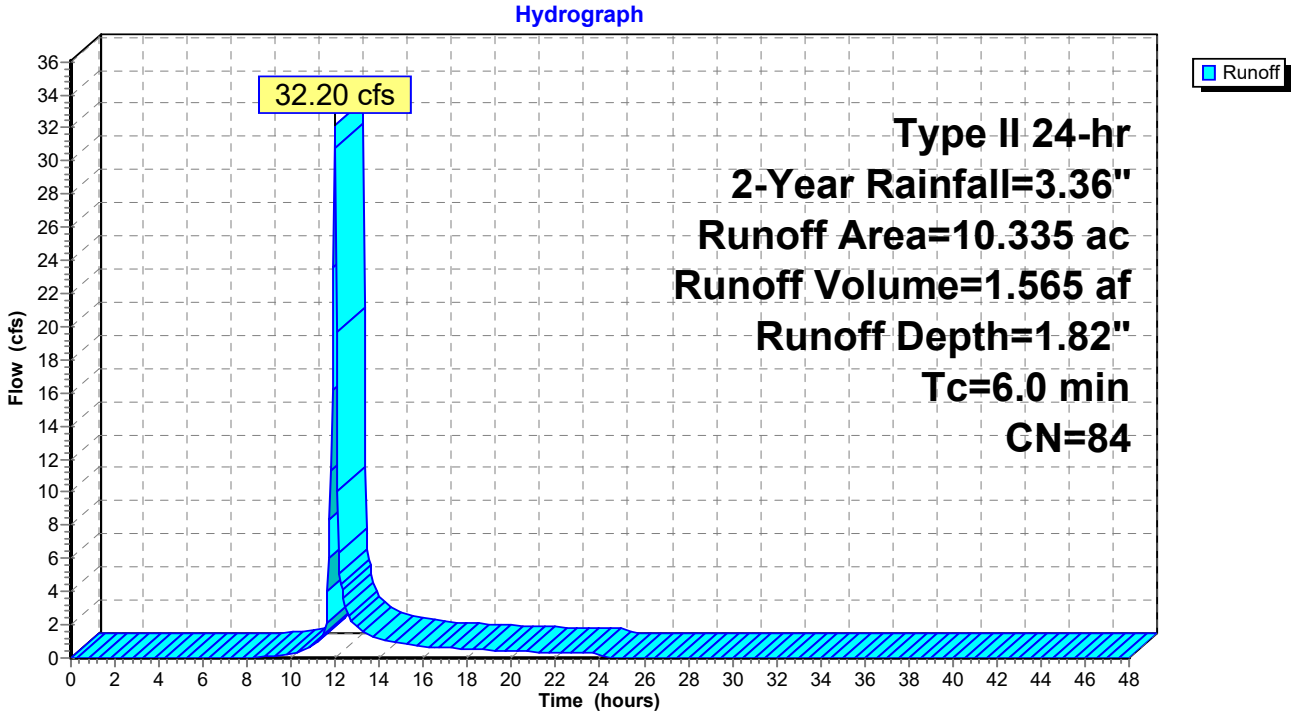
Runoff = 32.20 cfs @ 11.97 hrs, Volume= 1.565 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
10.335	84	50-75% Grass cover, Fair, HSG D
10.335		100.00% Pervious Area

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

Subcatchment 90S: East Drainage Area 3



Summary for Subcatchment 93S: West Drainage Area 2

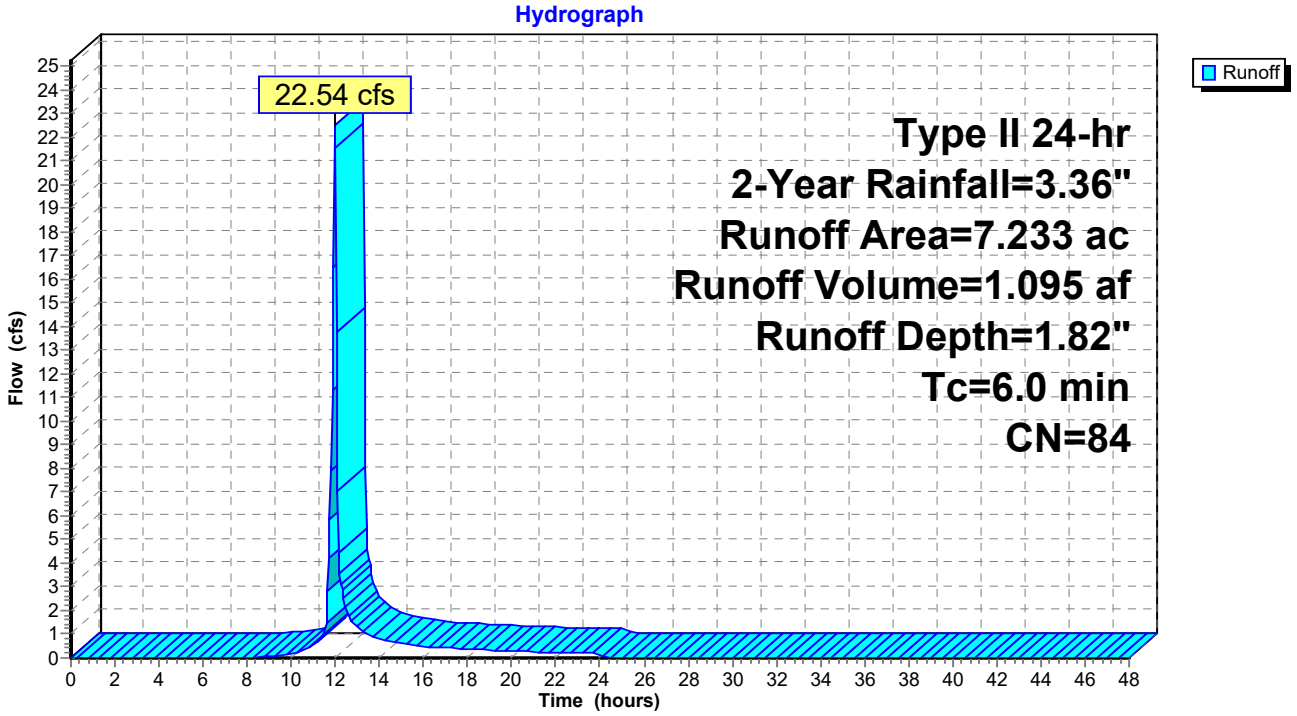
Runoff = 22.54 cfs @ 11.97 hrs, Volume= 1.095 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
7.233	84	50-75% Grass cover, Fair, HSG D
7.233		100.00% Pervious Area

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

Subcatchment 93S: West Drainage Area 2



Summary for Subcatchment 94S: West Drainage Area 4

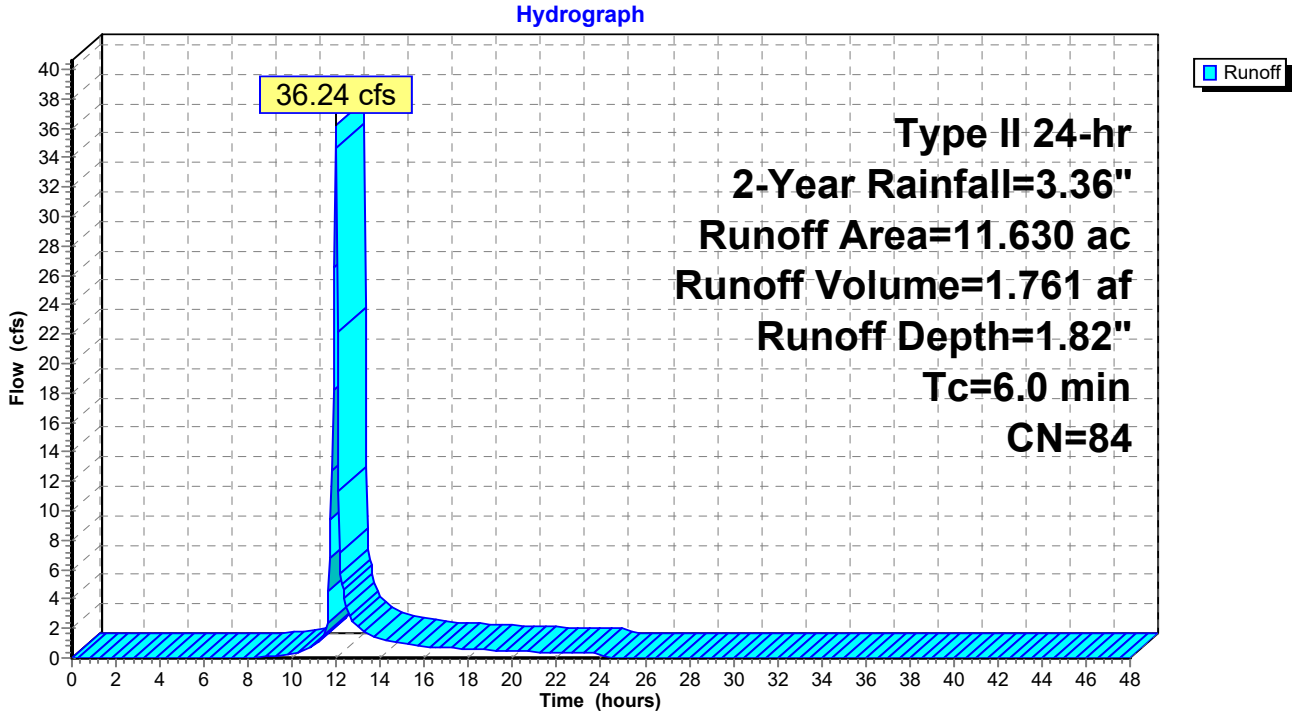
Runoff = 36.24 cfs @ 11.97 hrs, Volume= 1.761 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
11.630	84	50-75% Grass cover, Fair, HSG D
11.630		100.00% Pervious Area

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

Subcatchment 94S: West Drainage Area 4



Summary for Subcatchment 95S: West Drainage Area 1

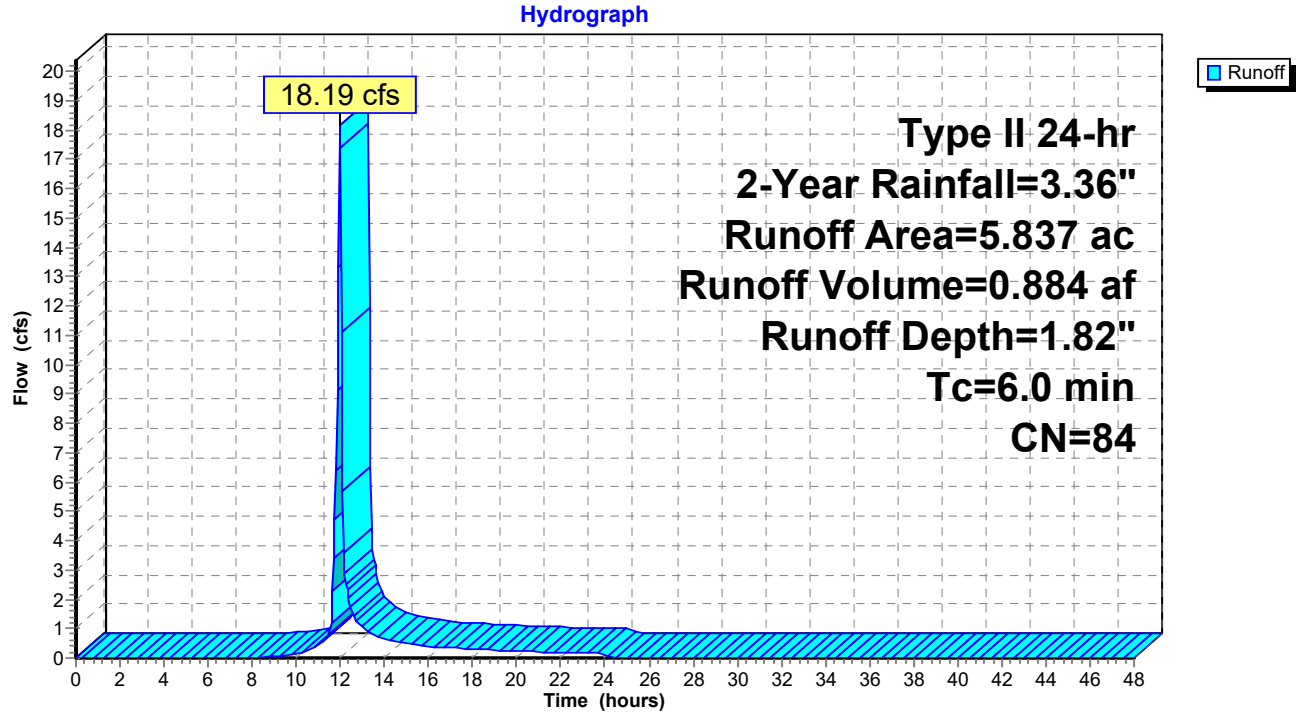
Runoff = 18.19 cfs @ 11.97 hrs, Volume= 0.884 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
5.837	84	50-75% Grass cover, Fair, HSG D
5.837		100.00% Pervious Area

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

Subcatchment 95S: West Drainage Area 1



Summary for Subcatchment 96S: West Drainage Area 5

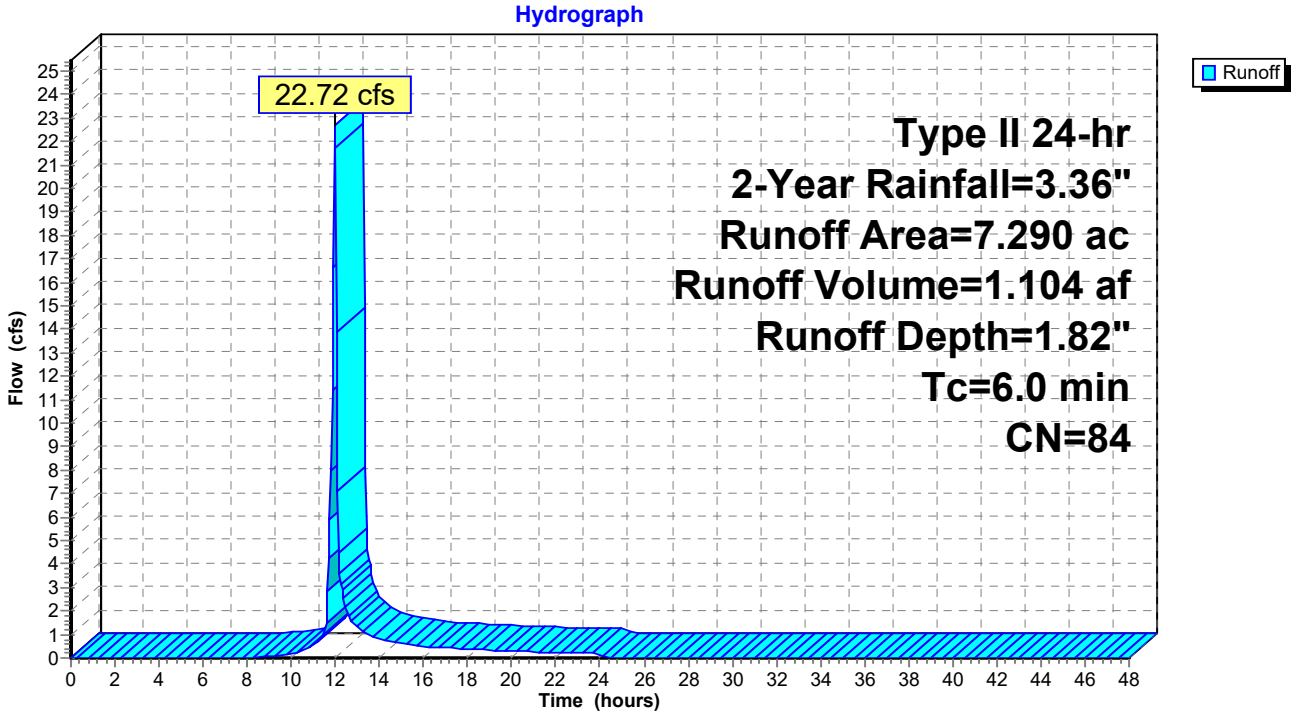
Runoff = 22.72 cfs @ 11.97 hrs, Volume= 1.104 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
7.290	84	50-75% Grass cover, Fair, HSG D
7.290		100.00% Pervious Area

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

Subcatchment 96S: West Drainage Area 5



Summary for Subcatchment 98S: Middle Drainage Area 4

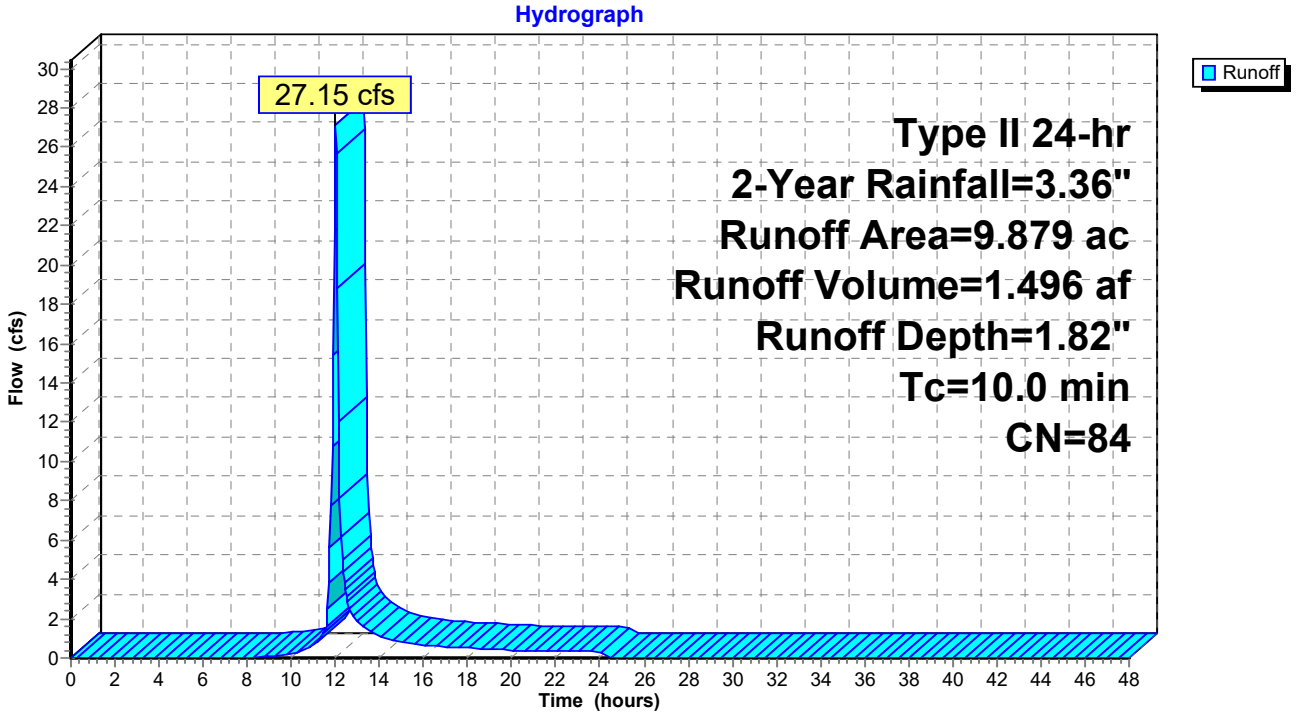
Runoff = 27.15 cfs @ 12.02 hrs, Volume= 1.496 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
9.879	84	50-75% Grass cover, Fair, HSG D
9.879		100.00% Pervious Area

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

Subcatchment 98S: Middle Drainage Area 4



Summary for Subcatchment 100S: Middle Drainage Area 5

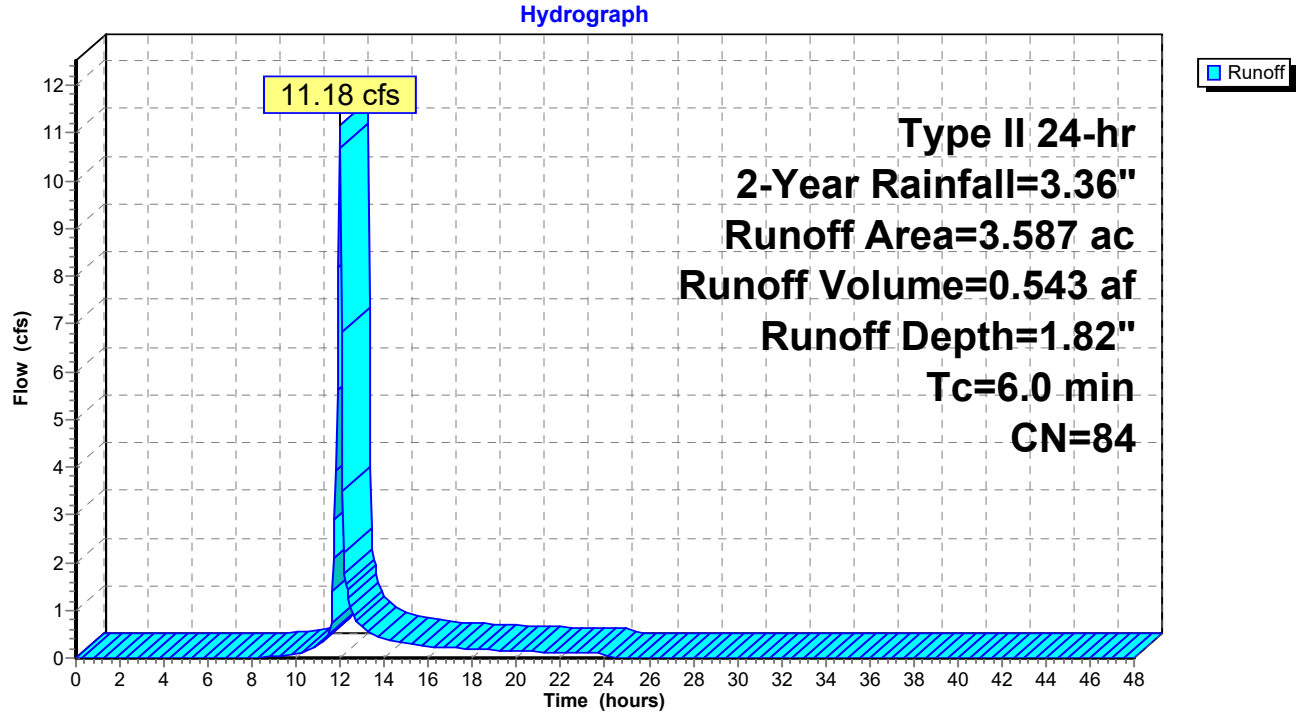
Runoff = 11.18 cfs @ 11.97 hrs, Volume= 0.543 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
3.587	84	50-75% Grass cover, Fair, HSG D
3.587		100.00% Pervious Area

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

Subcatchment 100S: Middle Drainage Area 5



Summary for Subcatchment 104S: East Drainage Area 4

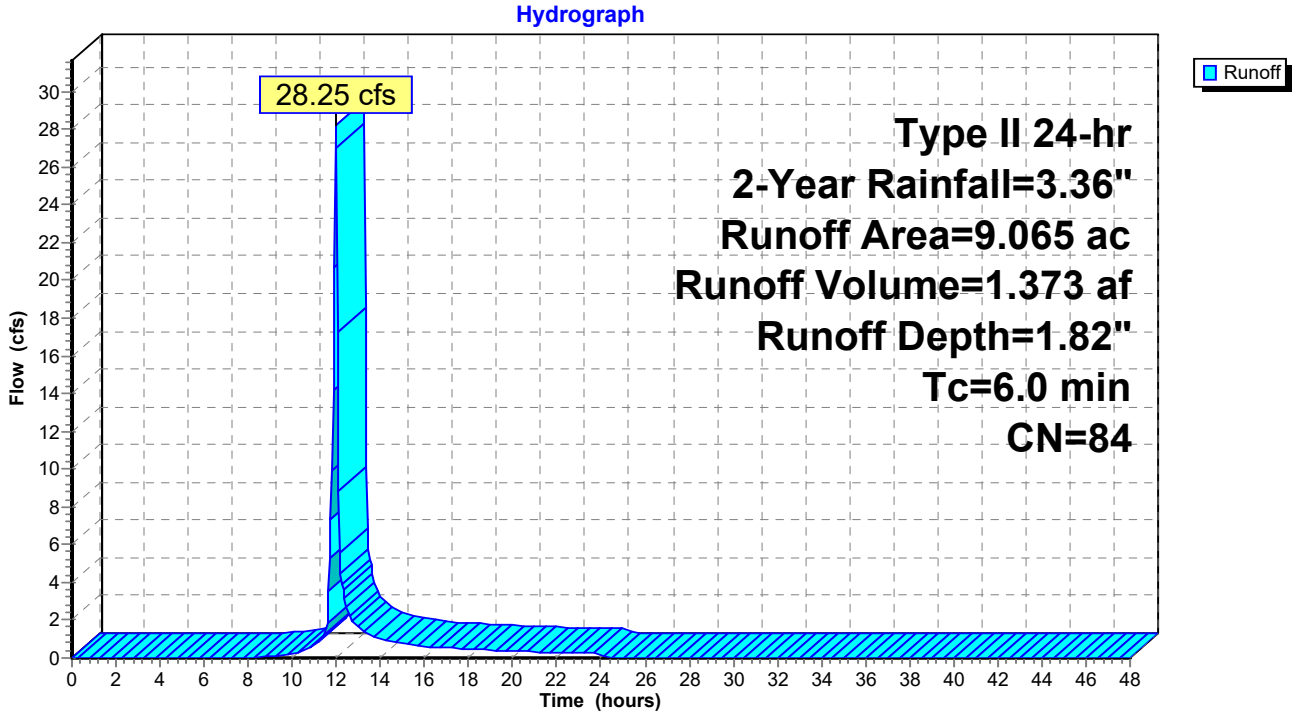
Runoff = 28.25 cfs @ 11.97 hrs, Volume= 1.373 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.36"

Area (ac)	CN	Description
9.065	84	50-75% Grass cover, Fair, HSG D
9.065		100.00% Pervious Area

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

Subcatchment 104S: East Drainage Area 4



Summary for Reach 77R: West Channel 3

Inflow Area = 14.150 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 44.09 cfs @ 11.97 hrs, Volume= 2.143 af
Outflow = 21.48 cfs @ 12.07 hrs, Volume= 2.143 af, Atten= 51%, Lag= 6.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.19 fps, Min. Travel Time= 22.3 min
Avg. Velocity = 0.22 fps, Avg. Travel Time= 122.6 min

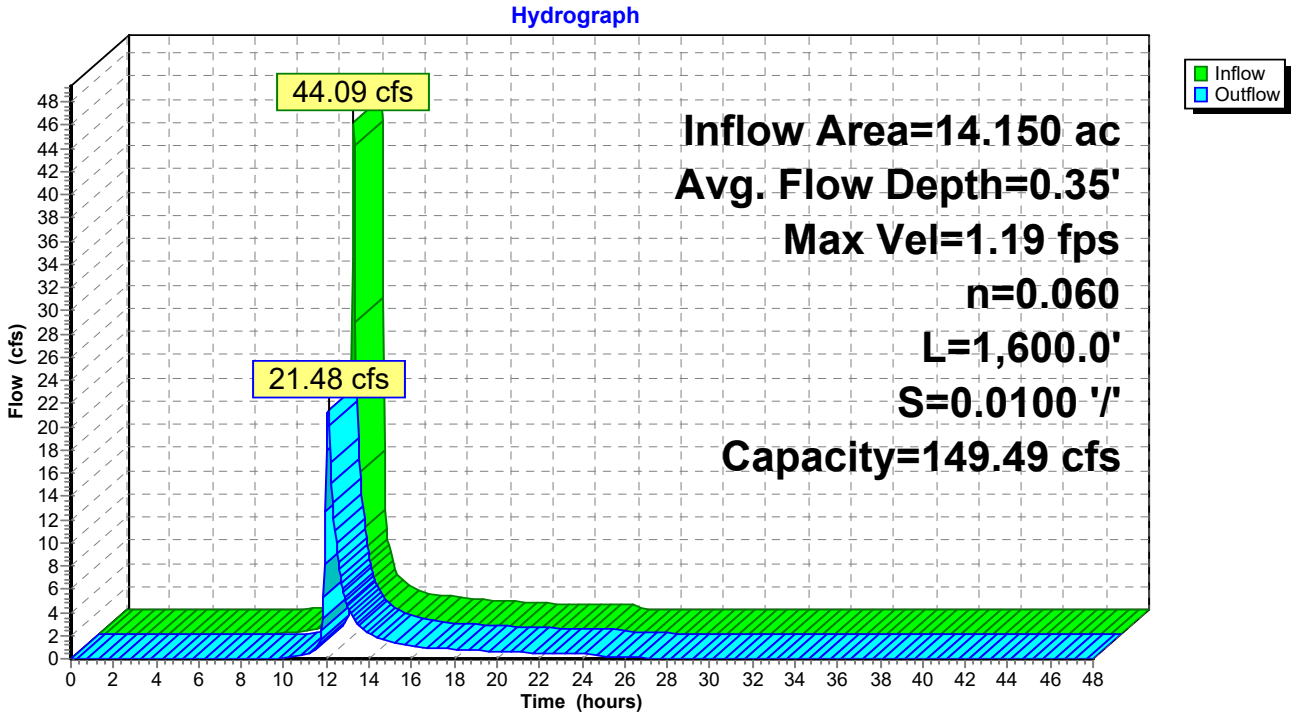
Peak Storage= 28,601 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.49 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,600.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 7.00'



‡

Reach 77R: West Channel 3



Summary for Reach 82R: Middle Channel 1

Inflow Area = 5.736 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 17.87 cfs @ 11.97 hrs, Volume= 0.869 af
Outflow = 9.75 cfs @ 12.06 hrs, Volume= 0.869 af, Atten= 45%, Lag= 5.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 0.89 fps, Min. Travel Time= 18.3 min
Avg. Velocity = 0.18 fps, Avg. Travel Time= 92.8 min

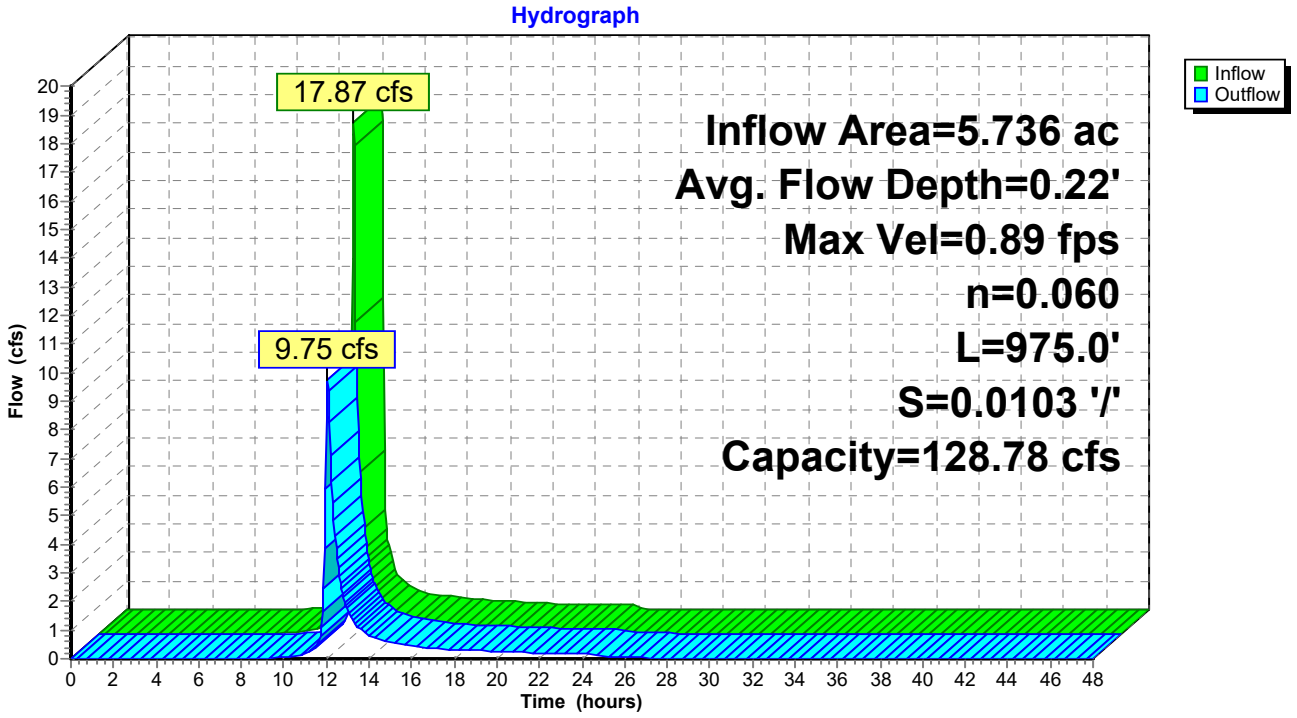
Peak Storage= 10,679 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 128.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 975.0' Slope= 0.0103 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 82R: Middle Channel 1



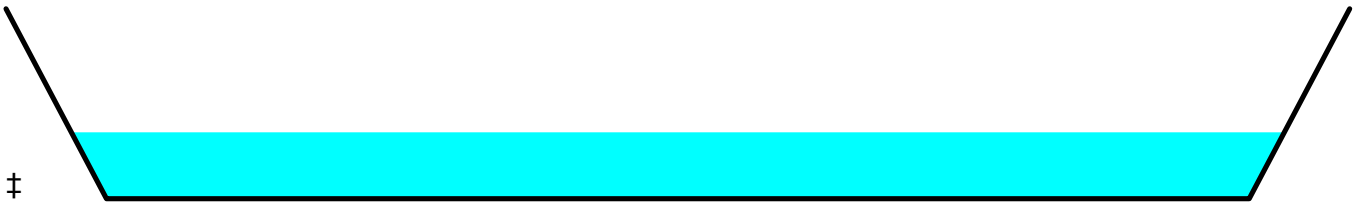
Summary for Reach 84R: Middle Channel 2

Inflow Area = 12.628 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 39.35 cfs @ 11.97 hrs, Volume= 1.912 af
Outflow = 25.35 cfs @ 12.05 hrs, Volume= 1.912 af, Atten= 36%, Lag= 4.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.28 fps, Min. Travel Time= 13.1 min
Avg. Velocity = 0.21 fps, Avg. Travel Time= 77.8 min

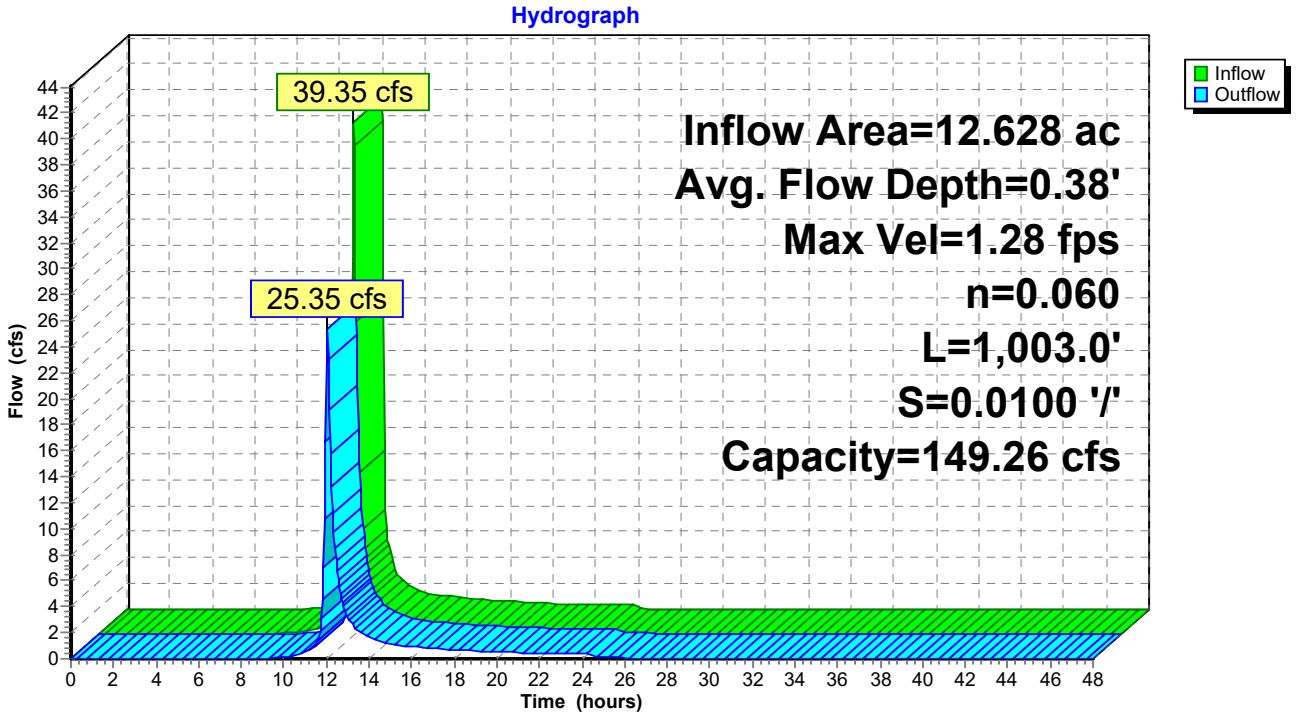
Peak Storage= 19,860 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.26 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,003.0' Slope= 0.0100 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 84R: Middle Channel 2



Summary for Reach 86R: Middle Channel 3

Changed depth to 0.6 feet to meet 100-year storm

Inflow Area = 19.614 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 61.12 cfs @ 11.97 hrs, Volume= 2.970 af
Outflow = 34.15 cfs @ 12.06 hrs, Volume= 2.970 af, Atten= 44%, Lag= 5.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.43 fps, Min. Travel Time= 17.4 min
Avg. Velocity = 0.25 fps, Avg. Travel Time= 98.9 min

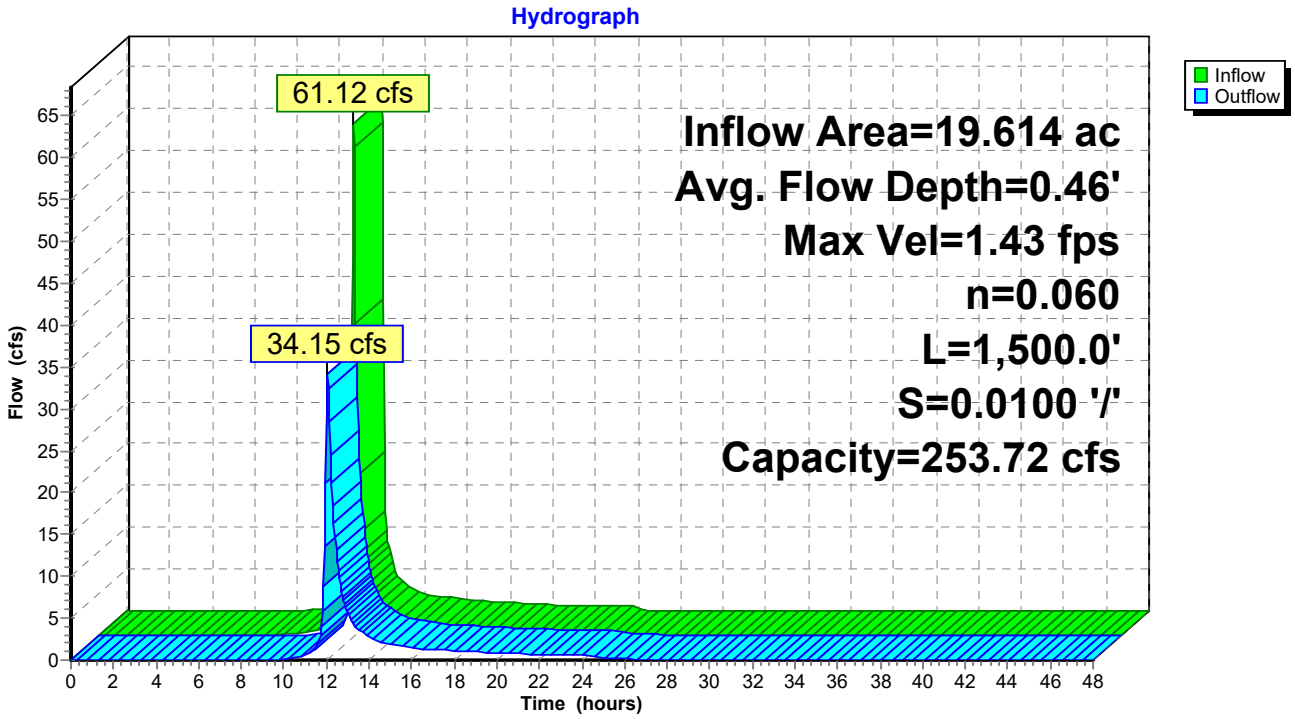
Peak Storage= 35,654 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.50' Flow Area= 84.0 sf, Capacity= 253.72 cfs

50.00' x 1.50' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 62.00'
Length= 1,500.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 8.00'



‡

Reach 86R: Middle Channel 3



Summary for Reach 87R: East Channel 1

Inflow Area = 2.239 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 6.98 cfs @ 11.97 hrs, Volume= 0.339 af
Outflow = 5.06 cfs @ 12.04 hrs, Volume= 0.339 af, Atten= 28%, Lag= 4.1 min

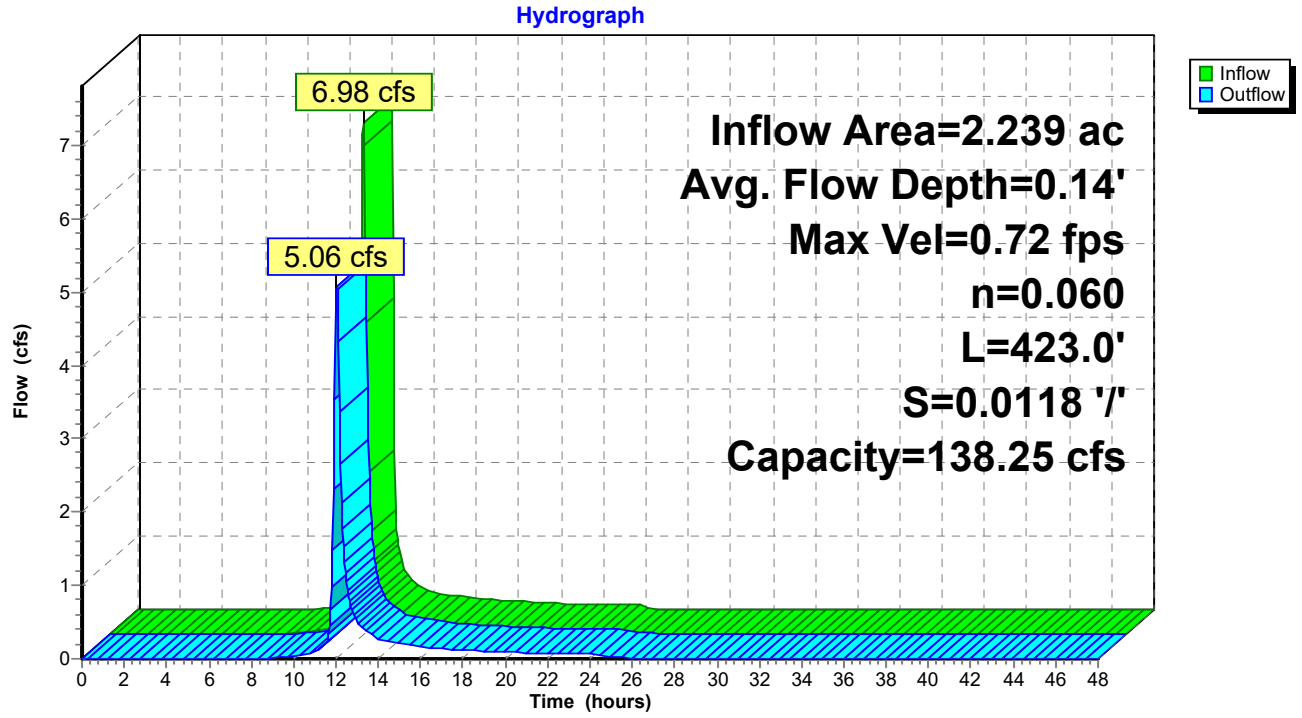
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 0.72 fps, Min. Travel Time= 9.8 min
Avg. Velocity = 0.17 fps, Avg. Travel Time= 42.6 min

Peak Storage= 2,979 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 138.25 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 423.0' Slope= 0.0118 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡



Summary for Reach 89R: East Channel 2

Inflow Area = 4.167 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 12.98 cfs @ 11.97 hrs, Volume= 0.631 af
Outflow = 8.29 cfs @ 12.05 hrs, Volume= 0.631 af, Atten= 36%, Lag= 4.9 min

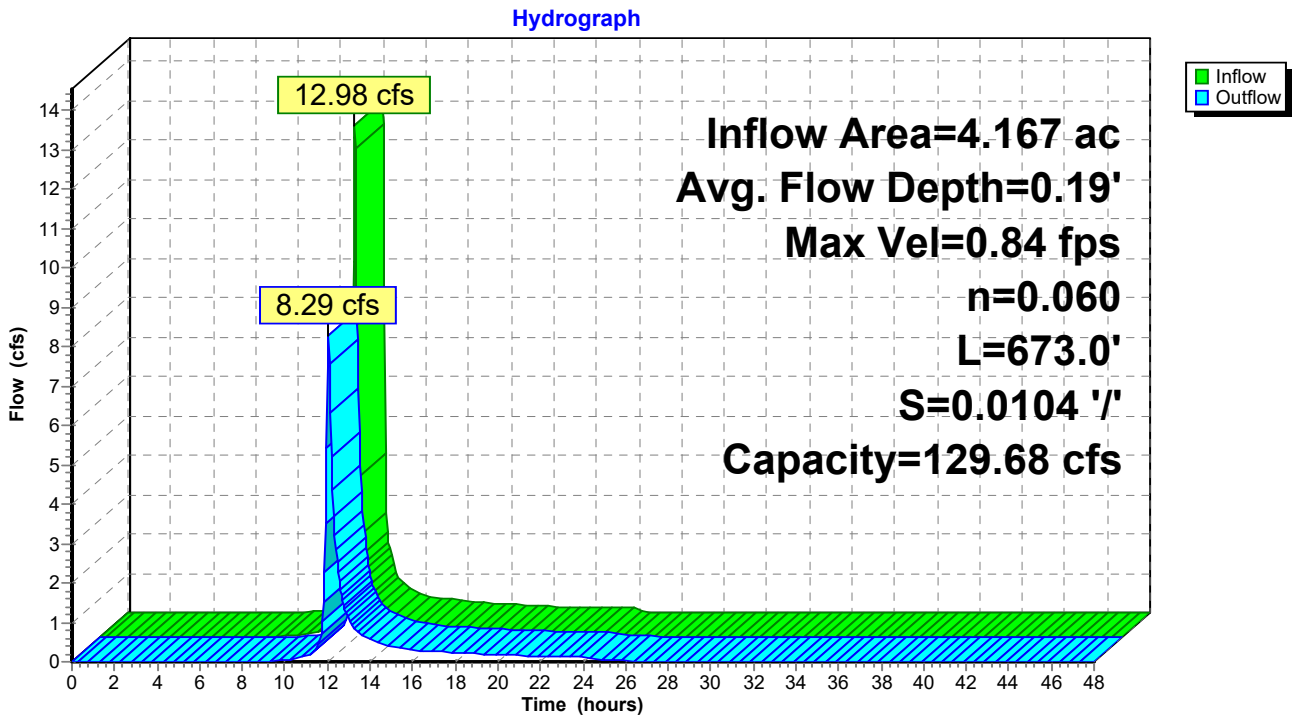
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 0.84 fps, Min. Travel Time= 13.4 min
Avg. Velocity = 0.17 fps, Avg. Travel Time= 64.6 min

Peak Storage= 6,648 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.68 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 673.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 11.00'



‡



Summary for Reach 91R: East Channel 3

Inflow Area = 10.335 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 32.20 cfs @ 11.97 hrs, Volume= 1.565 af
Outflow = 18.78 cfs @ 12.06 hrs, Volume= 1.565 af, Atten= 42%, Lag= 5.3 min

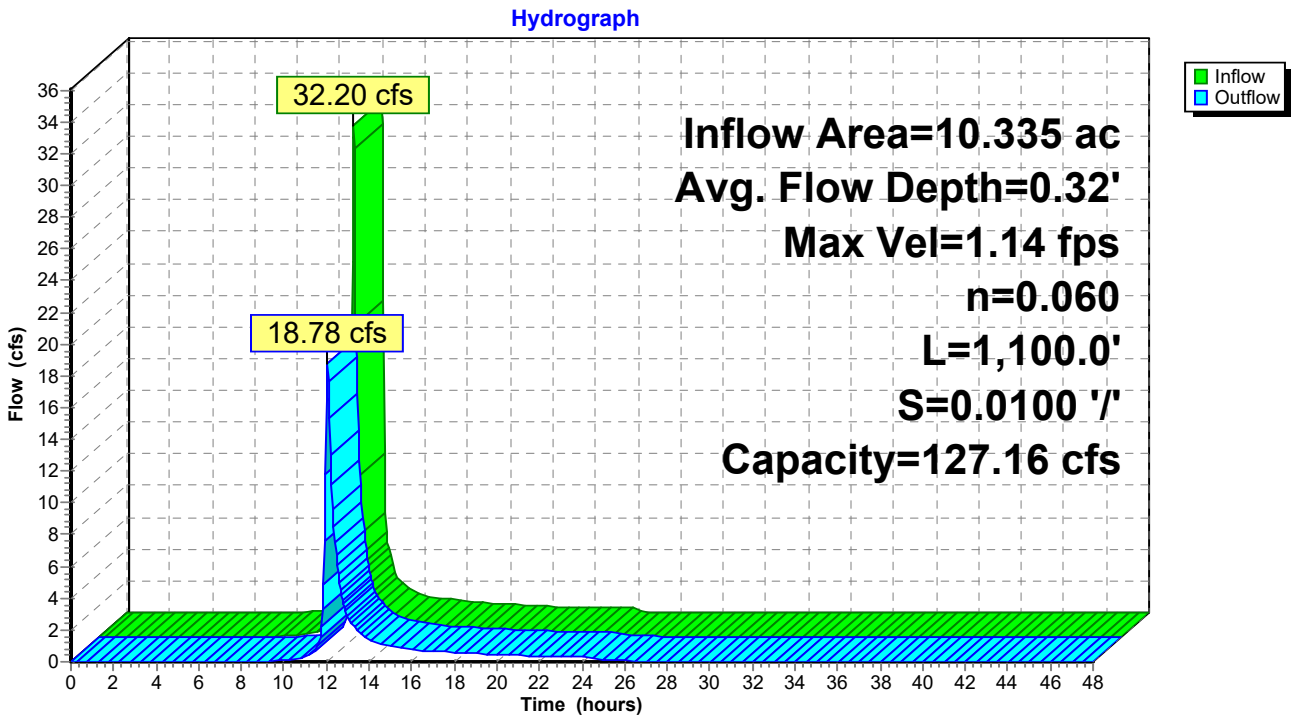
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.14 fps, Min. Travel Time= 16.1 min
Avg. Velocity = 0.19 fps, Avg. Travel Time= 94.1 min

Peak Storage= 18,110 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,100.0' Slope= 0.0100 '/'
Inlet Invert= 22.00', Outlet Invert= 11.00'



‡



Summary for Reach 94R: West Channel 2

Inflow Area = 7.233 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 22.54 cfs @ 11.97 hrs, Volume= 1.095 af
Outflow = 13.67 cfs @ 12.06 hrs, Volume= 1.095 af, Atten= 39%, Lag= 5.1 min

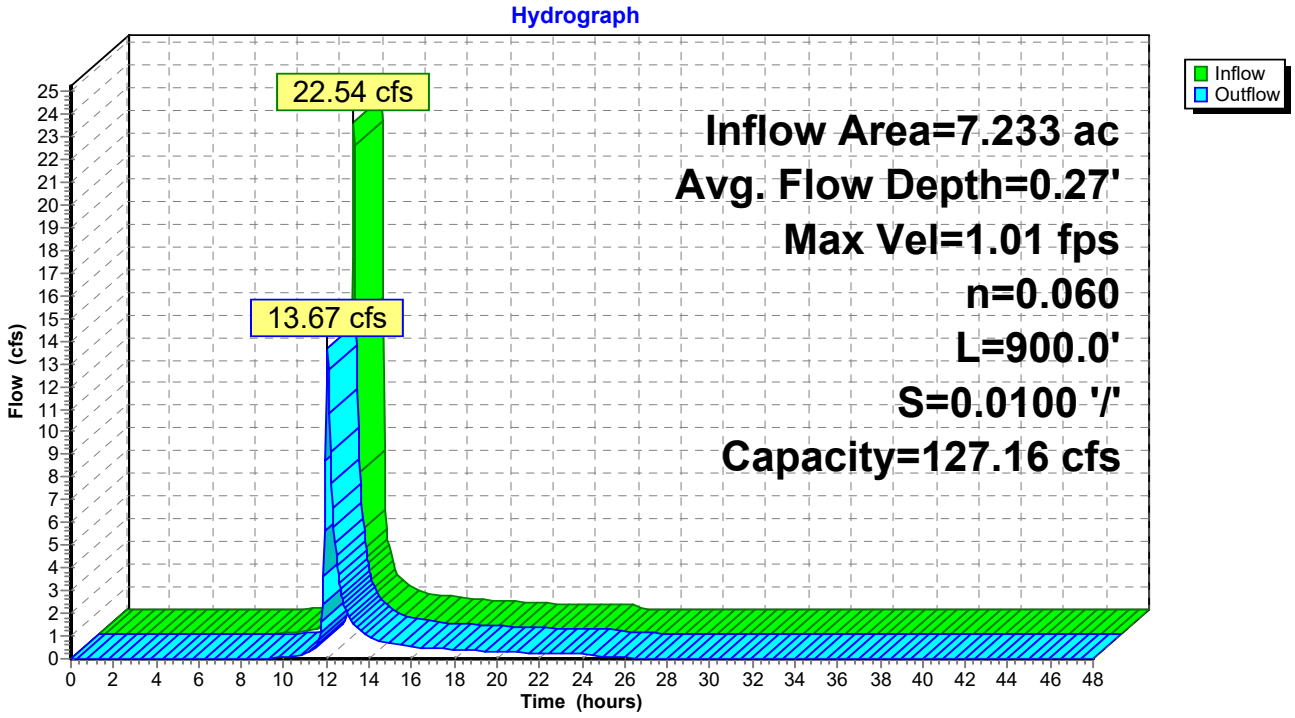
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.01 fps, Min. Travel Time= 14.9 min
Avg. Velocity = 0.19 fps, Avg. Travel Time= 80.9 min

Peak Storage= 12,201 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 900.0' Slope= 0.0100 '/'
Inlet Invert= 16.00', Outlet Invert= 7.00'



‡



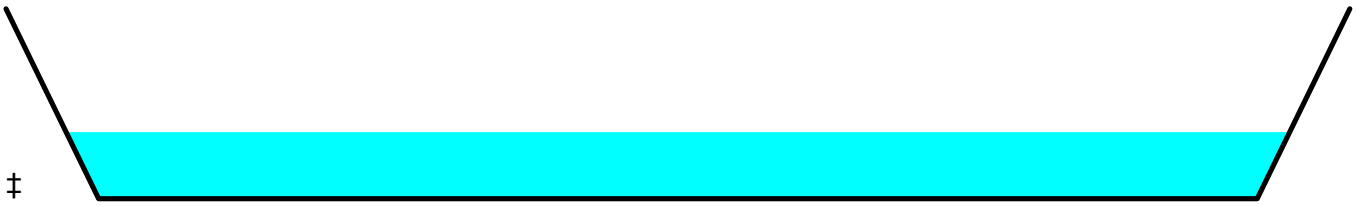
Summary for Reach 95R: West Channel 4

Inflow Area = 11.630 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 36.24 cfs @ 11.97 hrs, Volume= 1.761 af
Outflow = 21.86 cfs @ 12.06 hrs, Volume= 1.761 af, Atten= 40%, Lag= 5.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.21 fps, Min. Travel Time= 15.0 min
Avg. Velocity = 0.20 fps, Avg. Travel Time= 90.6 min

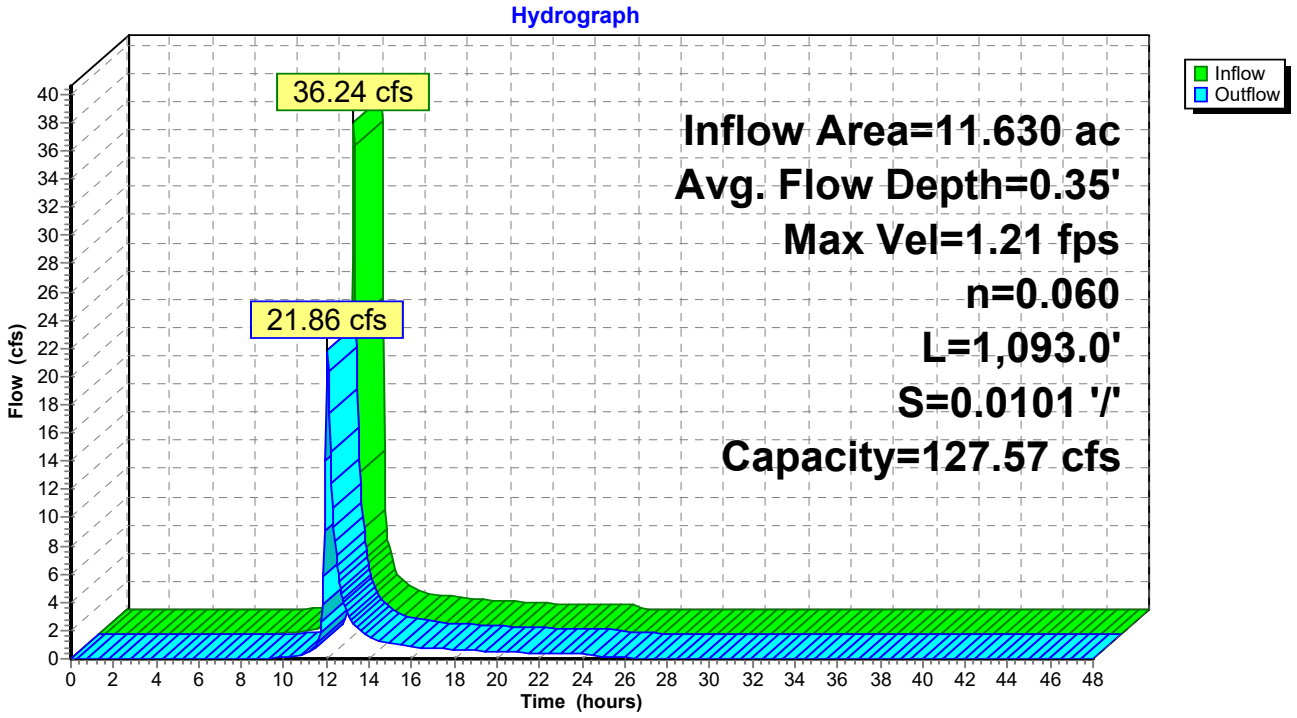
Peak Storage= 19,706 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.57 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,093.0' Slope= 0.0101 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 95R: West Channel 4



Summary for Reach 96R: West Channel 1

Inflow Area = 5.837 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 18.19 cfs @ 11.97 hrs, Volume= 0.884 af
Outflow = 9.84 cfs @ 12.07 hrs, Volume= 0.884 af, Atten= 46%, Lag= 5.6 min

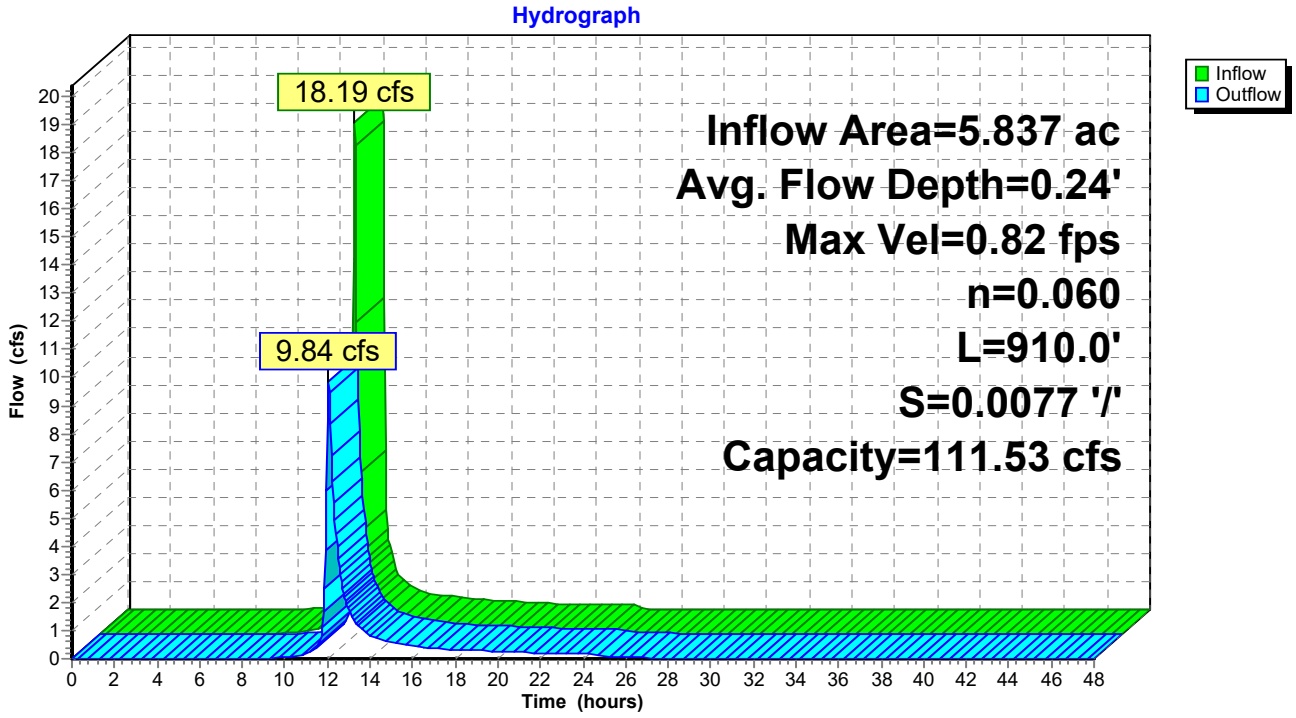
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 0.82 fps, Min. Travel Time= 18.6 min
Avg. Velocity = 0.16 fps, Avg. Travel Time= 97.7 min

Peak Storage= 10,939 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 111.53 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 910.0' Slope= 0.0077 '/'
Inlet Invert= 14.00', Outlet Invert= 7.00'



Reach 96R: West Channel 1



Summary for Reach 97R: West Channel 5

Inflow Area = 7.290 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 22.72 cfs @ 11.97 hrs, Volume= 1.104 af
Outflow = 13.41 cfs @ 12.06 hrs, Volume= 1.104 af, Atten= 41%, Lag= 5.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.04 fps, Min. Travel Time= 15.7 min
Avg. Velocity = 0.19 fps, Avg. Travel Time= 84.3 min

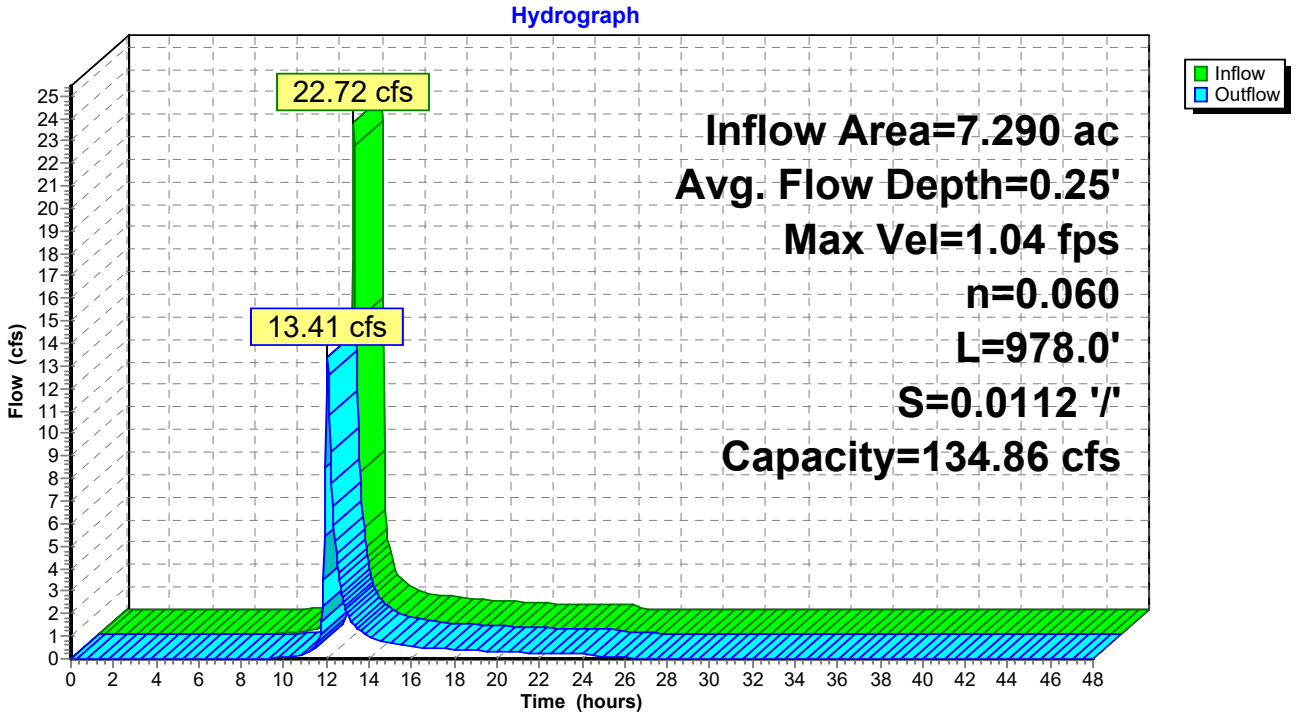
Peak Storage= 12,642 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 134.86 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 978.0' Slope= 0.0112 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 97R: West Channel 5



Summary for Reach 99R: Middle Channel 4

Inflow Area = 9.879 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 27.15 cfs @ 12.02 hrs, Volume= 1.496 af
Outflow = 17.79 cfs @ 12.11 hrs, Volume= 1.496 af, Atten= 34%, Lag= 5.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.13 fps, Min. Travel Time= 14.2 min
Avg. Velocity = 0.20 fps, Avg. Travel Time= 79.4 min

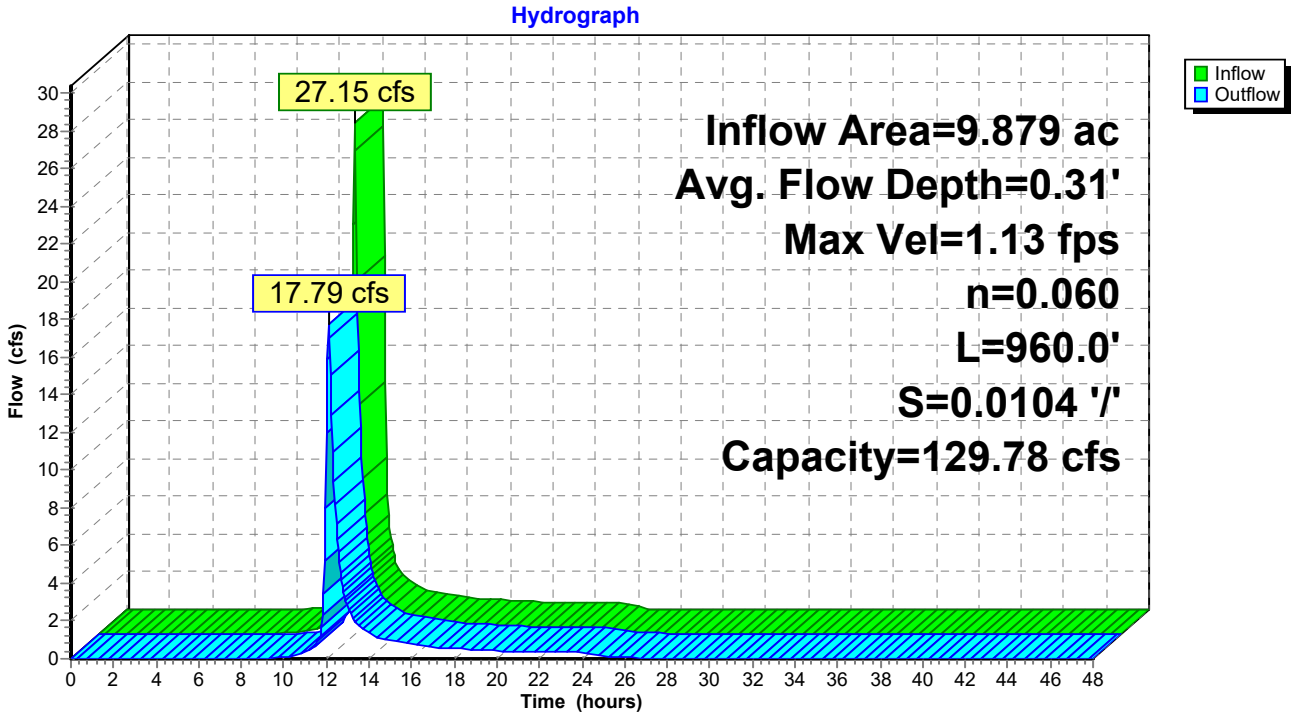
Peak Storage= 15,098 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 960.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 99R: Middle Channel 4



Summary for Reach 101R: Middle Channel 5

Inflow Area = 3.587 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 11.18 cfs @ 11.97 hrs, Volume= 0.543 af
Outflow = 6.41 cfs @ 12.06 hrs, Volume= 0.543 af, Atten= 43%, Lag= 5.4 min

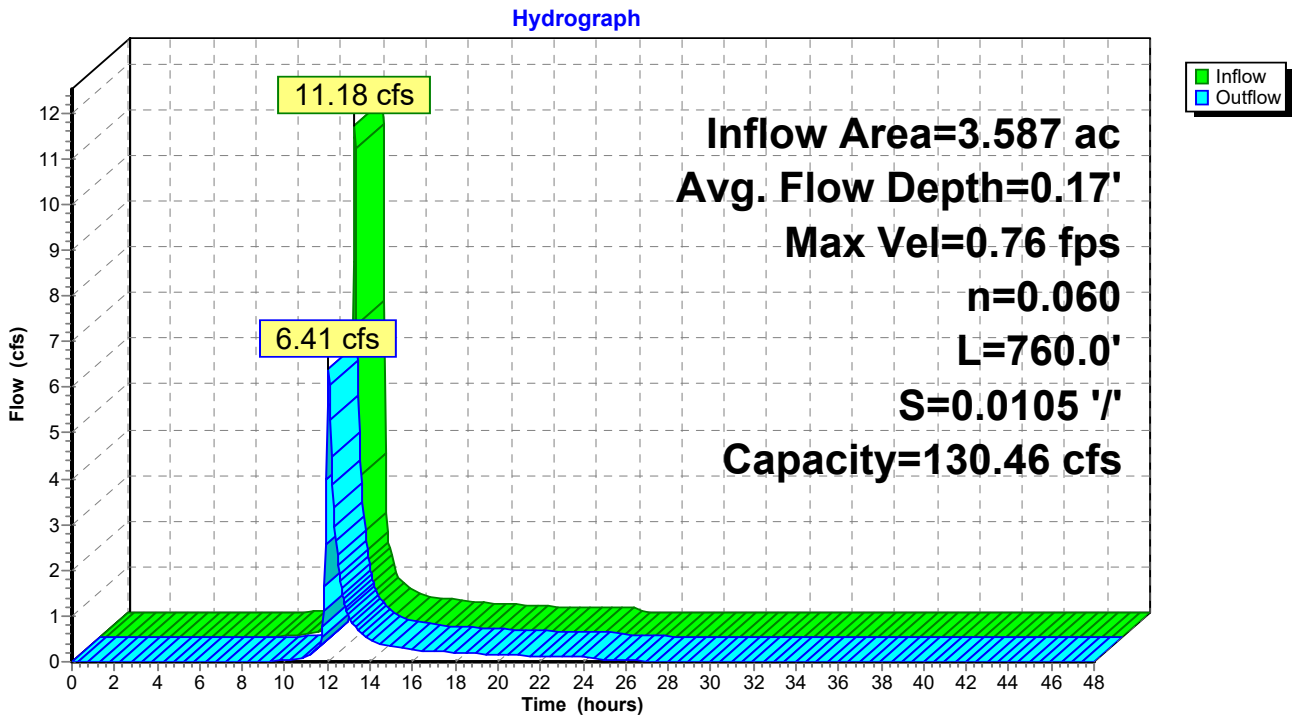
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 0.76 fps, Min. Travel Time= 16.7 min
Avg. Velocity = 0.17 fps, Avg. Travel Time= 76.3 min

Peak Storage= 6,398 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 130.46 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 760.0' Slope= 0.0105 '/'
Inlet Invert= 16.00', Outlet Invert= 8.00'



‡



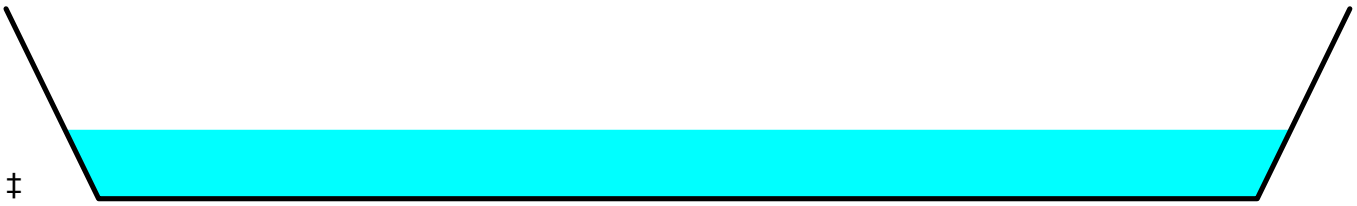
Summary for Reach 105R: East Channel 4

Inflow Area = 9.065 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 28.25 cfs @ 11.97 hrs, Volume= 1.373 af
Outflow = 22.74 cfs @ 12.02 hrs, Volume= 1.373 af, Atten= 20%, Lag= 3.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.20 fps, Min. Travel Time= 7.1 min
Avg. Velocity = 0.22 fps, Avg. Travel Time= 39.8 min

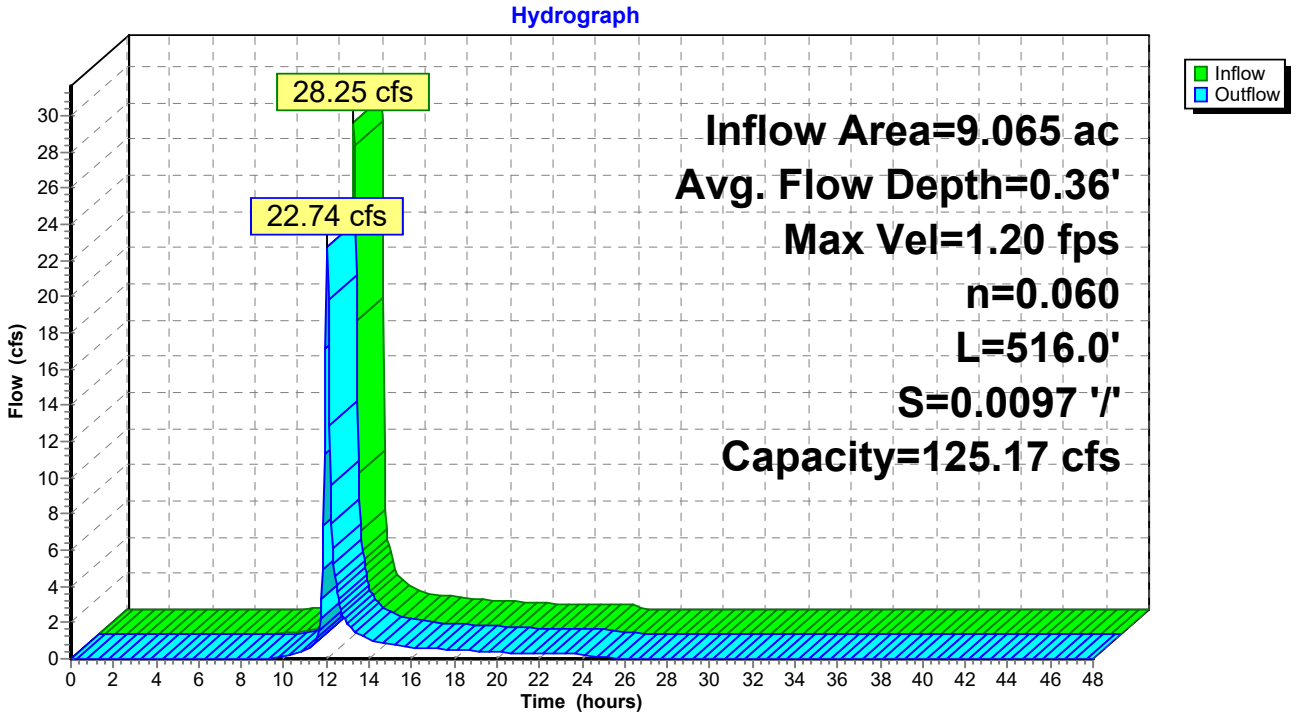
Peak Storage= 9,650 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 125.17 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 516.0' Slope= 0.0097 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡

Reach 105R: East Channel 4



Summary for Pond 28P: West Outlet/West Emergency Spillway

[62] Hint: Exceeded Reach 77R OUTLET depth by 1.23' @ 12.60 hrs
[62] Hint: Exceeded Reach 94R OUTLET depth by 1.30' @ 12.55 hrs
[62] Hint: Exceeded Reach 95R OUTLET depth by 1.26' @ 12.60 hrs
[62] Hint: Exceeded Reach 96R OUTLET depth by 1.30' @ 12.55 hrs
[62] Hint: Exceeded Reach 97R OUTLET depth by 1.30' @ 12.55 hrs

Inflow Area = 46.140 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 80.13 cfs @ 12.06 hrs, Volume= 6.987 af
Outflow = 27.24 cfs @ 12.51 hrs, Volume= 6.987 af, Atten= 66%, Lag= 26.8 min
Primary = 27.24 cfs @ 12.51 hrs, Volume= 6.987 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 8.42' @ 12.51 hrs Surf.Area= 73,113 sf Storage= 67,512 cf

Plug-Flow detention time= 19.4 min calculated for 6.980 af (100% of inflow)
Center-of-Mass det. time= 19.3 min (887.3 - 868.0)

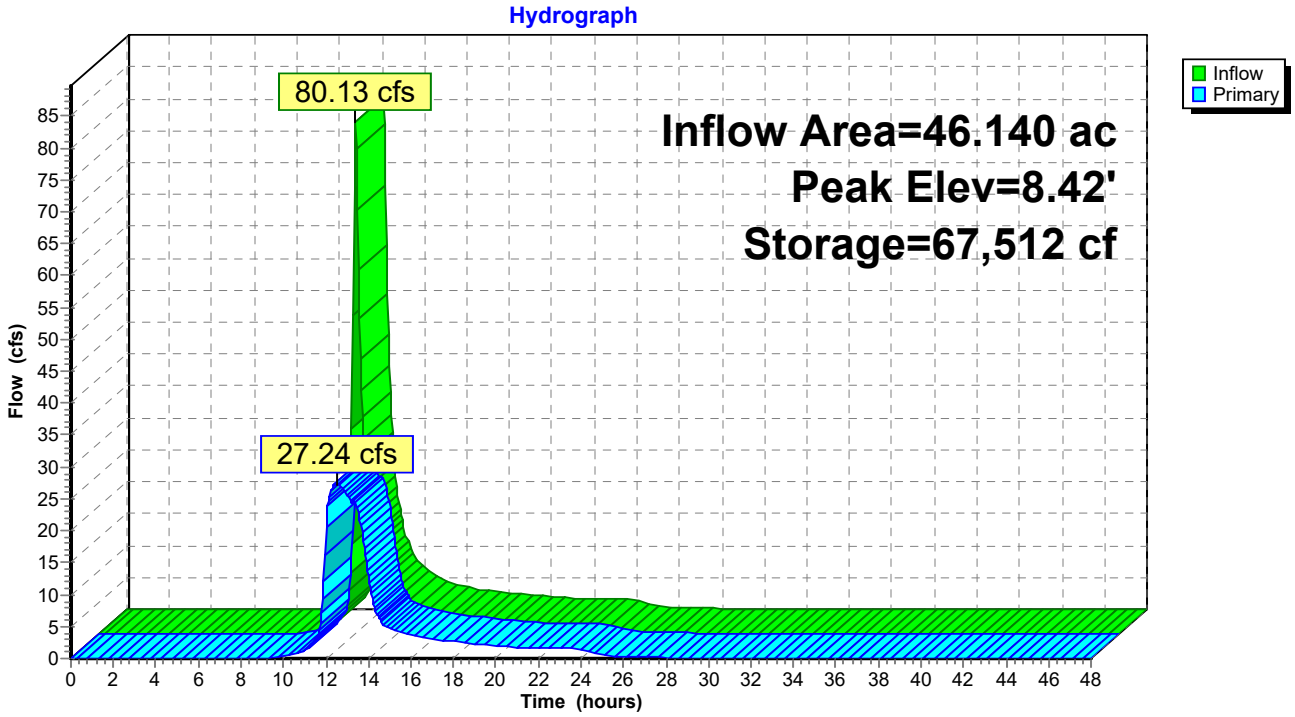
Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	786,184 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	25	25.0	0	0	25
7.00	17,893	714.0	6,196	6,196	40,545
8.00	54,145	1,528.0	34,388	40,584	185,777
9.00	103,329	2,053.0	77,424	118,008	335,396
10.00	171,483	2,546.0	135,975	253,983	515,837
11.00	261,382	2,995.0	214,859	468,842	713,838
12.00	376,810	3,340.0	317,342	786,184	887,789

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**18.0" Round Culvert X 3.00** L= 205.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0049 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	11.00'	**100.0' long x 155.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=27.24 cfs @ 12.51 hrs HW=8.42' (Free Discharge)
1=Culvert (Barrel Controls 27.24 cfs @ 5.14 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 28P: West Outlet/West Emergency Spillway



Summary for Pond 29P: Middle Outlet/Middle Emergency Spillway

[62] Hint: Exceeded Reach 82R OUTLET depth by 1.61' @ 12.55 hrs
[62] Hint: Exceeded Reach 84R OUTLET depth by 1.55' @ 12.60 hrs
[62] Hint: Exceeded Reach 86R OUTLET depth by 1.49' @ 12.60 hrs
[62] Hint: Exceeded Reach 99R OUTLET depth by 1.56' @ 12.60 hrs
[62] Hint: Exceeded Reach 101R OUTLET depth by 1.64' @ 12.55 hrs

Inflow Area = 51.444 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 92.13 cfs @ 12.07 hrs, Volume= 7.790 af
Outflow = 29.74 cfs @ 12.51 hrs, Volume= 7.790 af, Atten= 68%, Lag= 26.9 min
Primary = 29.74 cfs @ 12.51 hrs, Volume= 7.790 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 9.72' @ 12.51 hrs Surf.Area= 82,189 sf Storage= 78,375 cf

Plug-Flow detention time= 19.5 min calculated for 7.790 af (100% of inflow)
Center-of-Mass det. time= 19.5 min (883.6 - 864.1)

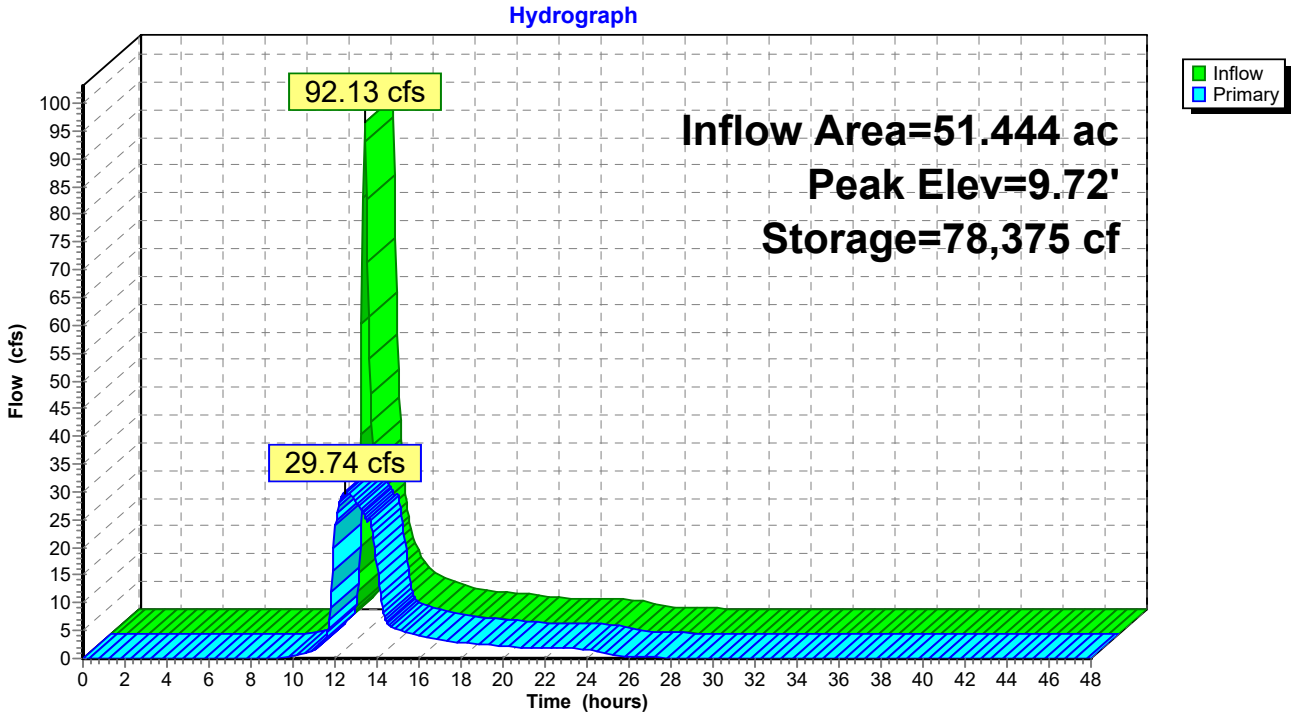
Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,236,409 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	25	25.0	0	0	25
8.00	10,947	460.0	3,832	3,832	16,816
9.00	49,342	1,391.0	27,843	31,675	153,953
10.00	97,395	1,948.0	72,020	103,695	301,963
11.00	168,546	2,477.0	131,355	235,050	488,253
12.00	261,632	2,967.0	213,390	448,440	700,548
13.00	390,402	3,366.0	323,877	772,317	901,654
14.00	541,914	3,757.0	464,092	1,236,409	1,123,314

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	**18.0" Round Culvert X 3.00** L= 195.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 7.00' / 6.00' S= 0.0051 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	12.50'	**100.0' long x 105.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=29.73 cfs @ 12.51 hrs HW=9.72' (Free Discharge)
1=Culvert (Barrel Controls 29.73 cfs @ 5.61 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 29P: Middle Outlet/Middle Emergency Spillway



Summary for Pond 30P: East Outlet/East Emergency Spillway

[62] Hint: Exceeded Reach 87R OUTLET depth by 0.67' @ 12.25 hrs
[62] Hint: Exceeded Reach 89R OUTLET depth by 0.63' @ 12.30 hrs
[62] Hint: Exceeded Reach 91R OUTLET depth by 0.53' @ 12.30 hrs
[62] Hint: Exceeded Reach 105R OUTLET depth by 0.58' @ 12.30 hrs

Inflow Area = 25.806 ac, 0.00% Impervious, Inflow Depth = 1.82" for 2-Year event
Inflow = 54.31 cfs @ 12.04 hrs, Volume= 3.908 af
Outflow = 25.56 cfs @ 12.25 hrs, Volume= 3.908 af, Atten= 53%, Lag= 12.5 min
Primary = 25.56 cfs @ 12.25 hrs, Volume= 3.908 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 11.75' @ 12.25 hrs Surf.Area= 45,679 sf Storage= 29,819 cf

Plug-Flow detention time= 9.6 min calculated for 3.904 af (100% of inflow)
Center-of-Mass det. time= 9.6 min (864.4 - 854.9)

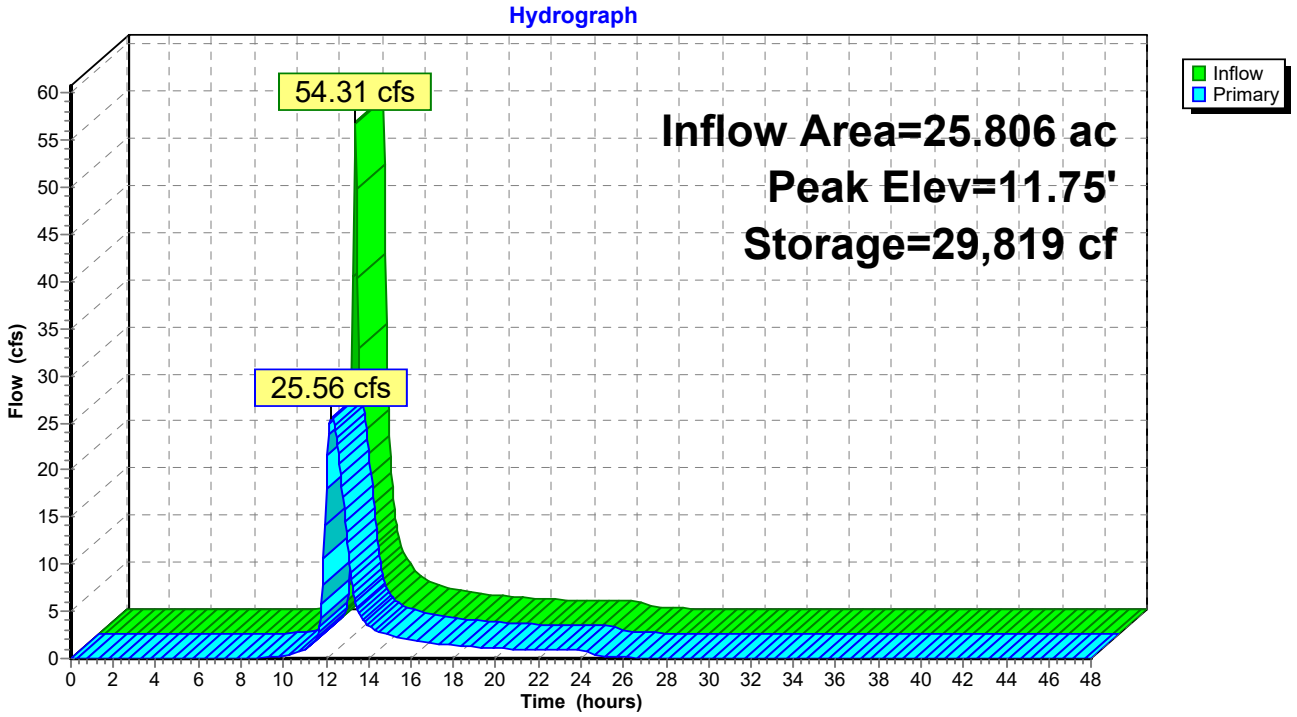
Volume	Invert	Avail.Storage	Storage Description
#1	10.00'	451,099 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
10.00	25	25.0	0	0	25
11.00	18,449	600.0	6,384	6,384	28,625
12.00	57,145	1,325.0	36,021	42,406	139,689
13.00	100,293	1,787.0	77,714	120,120	254,112
14.00	160,181	2,277.0	129,074	249,194	412,592
15.00	246,734	2,722.0	201,906	451,099	589,634

Device	Routing	Invert	Outlet Devices
#1	Primary	10.00'	**18.0" Round Culvert X 3.00** L= 160.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 10.00' / 9.00' S= 0.0063 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	14.00'	**100.0' long x 127.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=25.56 cfs @ 12.25 hrs HW=11.75' (Free Discharge)
1=Culvert (Barrel Controls 25.56 cfs @ 5.18 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 30P: East Outlet/East Emergency Spillway



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 72S: East Drainage Area 1 Runoff Area=2.239 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=12.66 cfs 0.629 af

Subcatchment 74S: Middle Drainage Area 1 Runoff Area=5.736 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=32.43 cfs 1.611 af

Subcatchment 76S: West Drainage Area 3 Runoff Area=14.150 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=80.01 cfs 3.975 af

Subcatchment 83S: Middle Drainage Area 2 Runoff Area=12.628 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=71.40 cfs 3.548 af

Subcatchment 85S: Middle Drainage Area 3 Runoff Area=19.614 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=110.90 cfs 5.510 af

Subcatchment 88S: East Drainage Area 2 Runoff Area=4.167 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=23.56 cfs 1.171 af

Subcatchment 90S: East Drainage Area 3 Runoff Area=10.335 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=58.44 cfs 2.903 af

Subcatchment 93S: West Drainage Area 2 Runoff Area=7.233 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=40.90 cfs 2.032 af

Subcatchment 94S: West Drainage Area 4 Runoff Area=11.630 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=65.76 cfs 3.267 af

Subcatchment 95S: West Drainage Area 1 Runoff Area=5.837 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=33.00 cfs 1.640 af

Subcatchment 96S: West Drainage Area 5 Runoff Area=7.290 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=41.22 cfs 2.048 af

Subcatchment 98S: Middle Drainage Area 4 Runoff Area=9.879 ac 0.00% Impervious Runoff Depth=3.37"
Tc=10.0 min CN=84 Runoff=49.53 cfs 2.775 af

Subcatchment 100S: Middle Drainage Area 5 Runoff Area=3.587 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=20.28 cfs 1.008 af

Subcatchment 104S: East Drainage Area 4 Runoff Area=9.065 ac 0.00% Impervious Runoff Depth=3.37"
Tc=6.0 min CN=84 Runoff=51.26 cfs 2.547 af

Reach 77R: West Channel 3 Avg. Flow Depth=0.56' Max Vel=1.63 fps Inflow=80.01 cfs 3.975 af
n=0.060 L=1,600.0' S=0.0100 '/' Capacity=149.49 cfs Outflow=47.36 cfs 3.975 af

Reach 82R: Middle Channel 1 Avg. Flow Depth=0.34' Max Vel=1.20 fps Inflow=32.43 cfs 1.611 af
n=0.060 L=975.0' S=0.0103 '/' Capacity=128.78 cfs Outflow=21.03 cfs 1.611 af

Reach 84R: Middle Channel 2 Avg. Flow Depth=0.59' Max Vel=1.68 fps Inflow=71.40 cfs 3.548 af
n=0.060 L=1,003.0' S=0.0100 '/' Capacity=149.26 cfs Outflow=52.20 cfs 3.548 af

Reach 86R: Middle Channel 3 Avg. Flow Depth=0.72' Max Vel=1.91 fps Inflow=110.90 cfs 5.510 af
n=0.060 L=1,500.0' S=0.0100 '/' Capacity=253.72 cfs Outflow=72.75 cfs 5.510 af

Reach 87R: East Channel 1 Avg. Flow Depth=0.21' Max Vel=0.94 fps Inflow=12.66 cfs 0.629 af
n=0.060 L=423.0' S=0.0118 '/' Capacity=138.25 cfs Outflow=10.17 cfs 0.629 af

Reach 89R: East Channel 2 Avg. Flow Depth=0.30' Max Vel=1.11 fps Inflow=23.56 cfs 1.171 af
n=0.060 L=673.0' S=0.0104 '/' Capacity=129.68 cfs Outflow=17.18 cfs 1.171 af

Reach 91R: East Channel 3 Avg. Flow Depth=0.50' Max Vel=1.52 fps Inflow=58.44 cfs 2.903 af
n=0.060 L=1,100.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=39.73 cfs 2.903 af

Reach 94R: West Channel 2 Avg. Flow Depth=0.41' Max Vel=1.34 fps Inflow=40.90 cfs 2.032 af
n=0.060 L=900.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=28.67 cfs 2.032 af

Reach 95R: West Channel 4 Avg. Flow Depth=0.55' Max Vel=1.61 fps Inflow=65.76 cfs 3.267 af
n=0.060 L=1,093.0' S=0.0101 '/' Capacity=127.57 cfs Outflow=45.81 cfs 3.267 af

Reach 96R: West Channel 1 Avg. Flow Depth=0.37' Max Vel=1.10 fps Inflow=33.00 cfs 1.640 af
n=0.060 L=910.0' S=0.0077 '/' Capacity=111.53 cfs Outflow=21.25 cfs 1.640 af

Reach 97R: West Channel 5 Avg. Flow Depth=0.40' Max Vel=1.39 fps Inflow=41.22 cfs 2.048 af
n=0.060 L=978.0' S=0.0112 '/' Capacity=134.86 cfs Outflow=28.32 cfs 2.048 af

Reach 99R: Middle Channel 4 Avg. Flow Depth=0.47' Max Vel=1.50 fps Inflow=49.53 cfs 2.775 af
n=0.060 L=960.0' S=0.0104 '/' Capacity=129.78 cfs Outflow=36.77 cfs 2.775 af

Reach 101R: Middle Channel 5 Avg. Flow Depth=0.26' Max Vel=1.02 fps Inflow=20.28 cfs 1.008 af
n=0.060 L=760.0' S=0.0105 '/' Capacity=130.46 cfs Outflow=13.67 cfs 1.008 af

Reach 105R: East Channel 4 Avg. Flow Depth=0.54' Max Vel=1.57 fps Inflow=51.26 cfs 2.547 af
n=0.060 L=516.0' S=0.0097 '/' Capacity=125.17 cfs Outflow=44.35 cfs 2.547 af

Pond 28P: West Outlet/West Emergency Peak Elev=9.53' Storage=180,932 cf Inflow=171.15 cfs 12.962 af
Outflow=34.15 cfs 12.962 af

Pond 29P: Middle Outlet/Middle Peak Elev=10.83' Storage=207,094 cf Inflow=194.05 cfs 14.452 af
Outflow=36.43 cfs 14.452 af

Pond 30P: East Outlet/East Emergency Peak Elev=12.59' Storage=82,946 cf Inflow=110.10 cfs 7.250 af
Outflow=30.77 cfs 7.250 af

Total Runoff Area = 123.390 ac Runoff Volume = 34.664 af Average Runoff Depth = 3.37"
100.00% Pervious = 123.390 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 72S: East Drainage Area 1

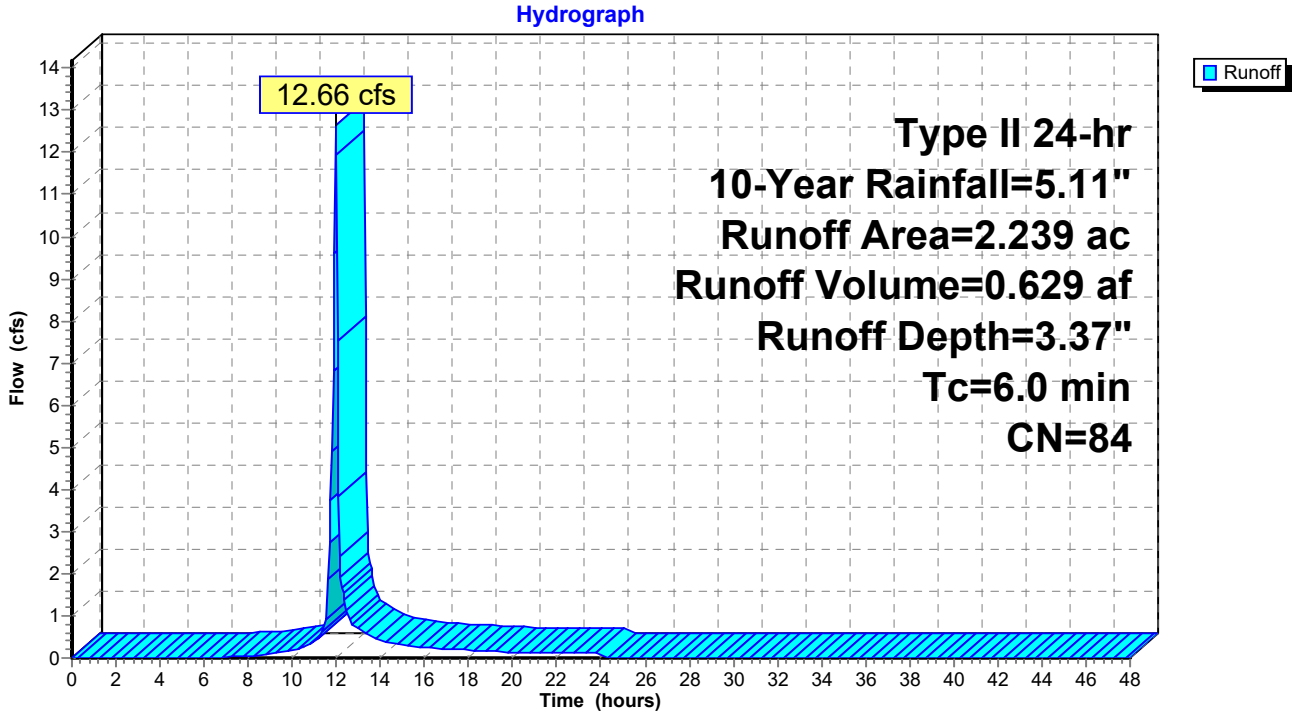
Runoff = 12.66 cfs @ 11.97 hrs, Volume= 0.629 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
2.239	84	50-75% Grass cover, Fair, HSG D
2.239		100.00% Pervious Area

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

Subcatchment 72S: East Drainage Area 1



Summary for Subcatchment 74S: Middle Drainage Area 1

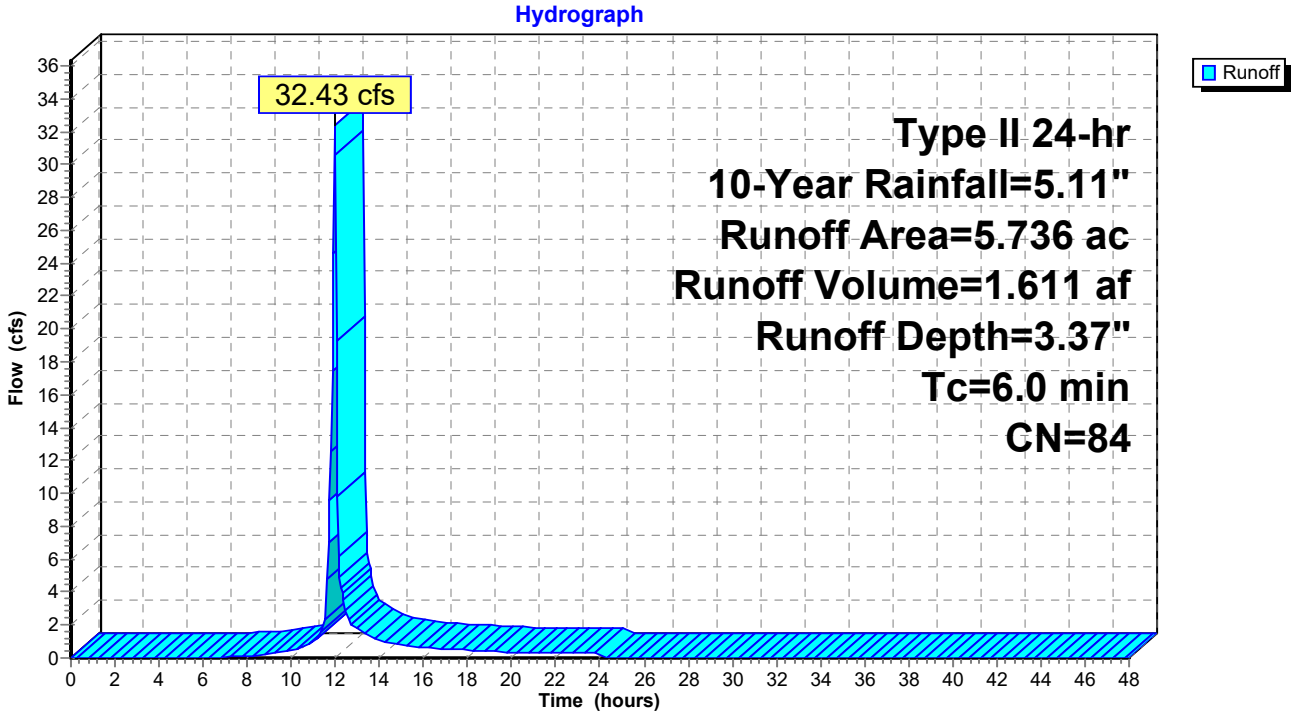
Runoff = 32.43 cfs @ 11.97 hrs, Volume= 1.611 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
5.736	84	50-75% Grass cover, Fair, HSG D
5.736		100.00% Pervious Area

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

Subcatchment 74S: Middle Drainage Area 1



Summary for Subcatchment 76S: West Drainage Area 3

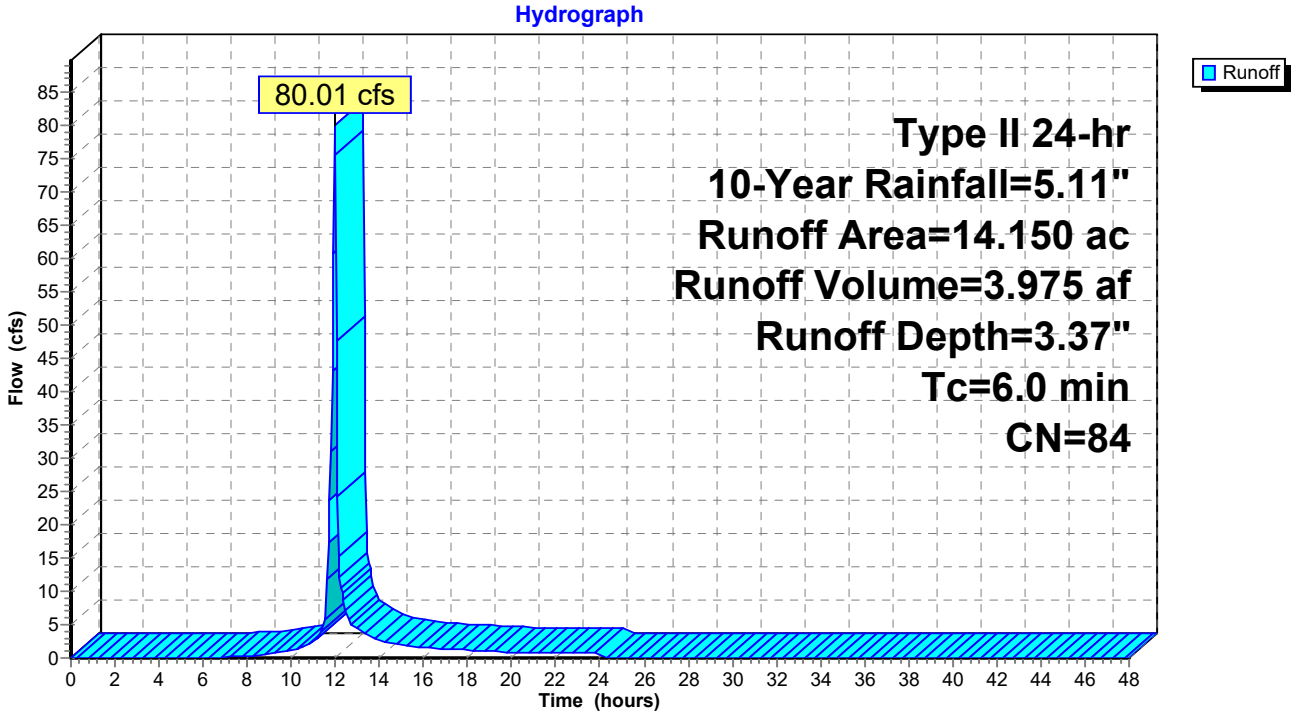
Runoff = 80.01 cfs @ 11.97 hrs, Volume= 3.975 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
14.150	84	50-75% Grass cover, Fair, HSG D
14.150		100.00% Pervious Area

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

Subcatchment 76S: West Drainage Area 3



Summary for Subcatchment 83S: Middle Drainage Area 2

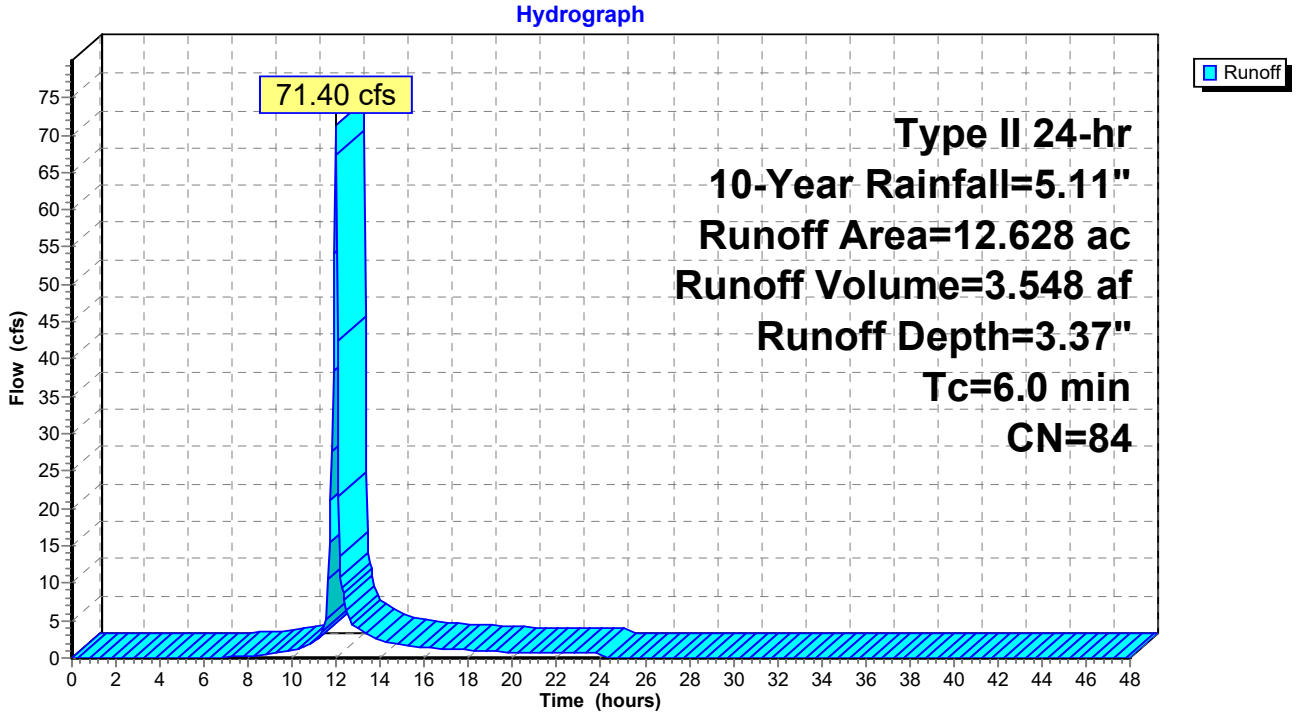
Runoff = 71.40 cfs @ 11.97 hrs, Volume= 3.548 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
12.628	84	50-75% Grass cover, Fair, HSG D
12.628		100.00% Pervious Area

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

Subcatchment 83S: Middle Drainage Area 2



Summary for Subcatchment 85S: Middle Drainage Area 3

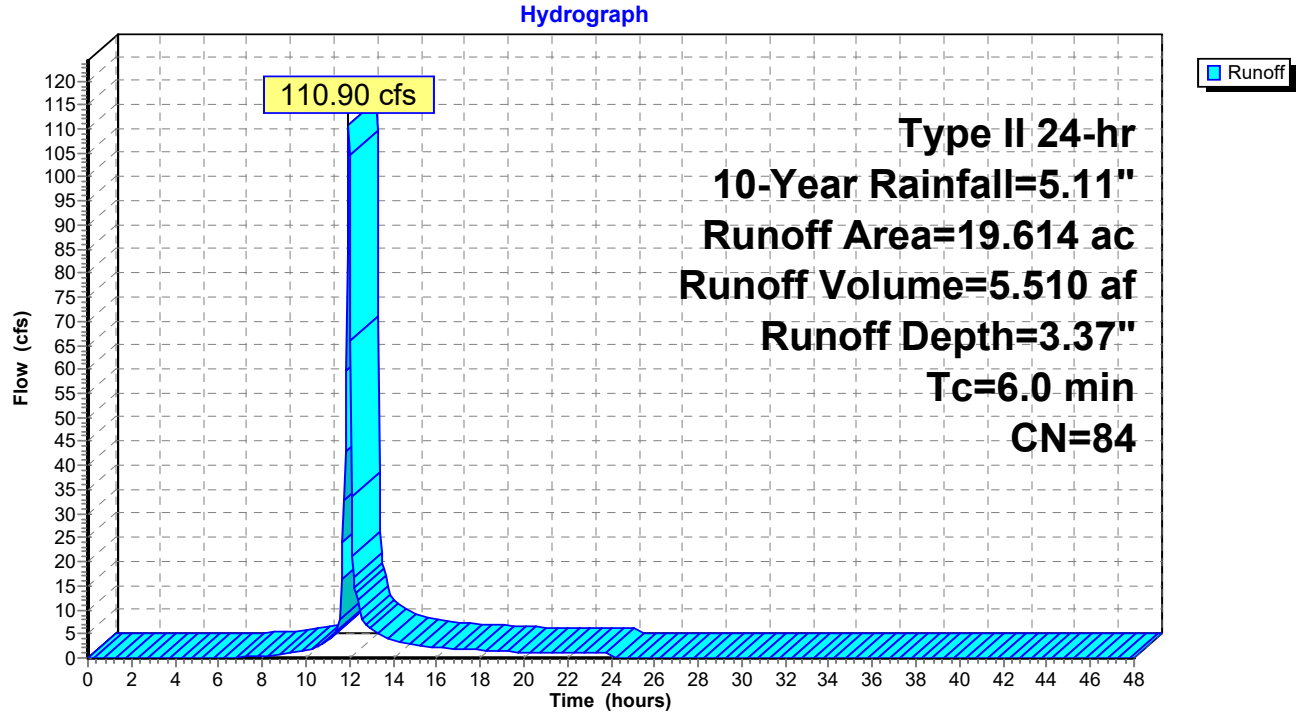
Runoff = 110.90 cfs @ 11.97 hrs, Volume= 5.510 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
19.614	84	50-75% Grass cover, Fair, HSG D
19.614		100.00% Pervious Area

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

Subcatchment 85S: Middle Drainage Area 3



Summary for Subcatchment 88S: East Drainage Area 2

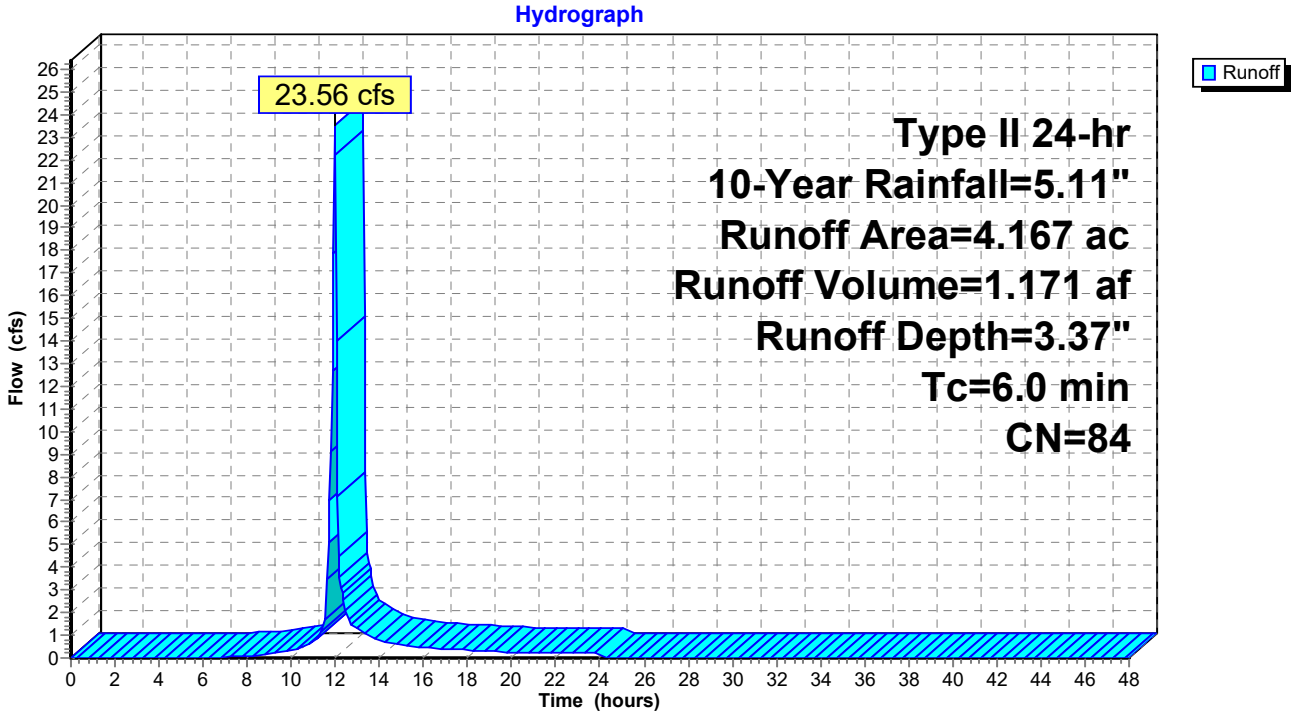
Runoff = 23.56 cfs @ 11.97 hrs, Volume= 1.171 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
4.167	84	50-75% Grass cover, Fair, HSG D
4.167		100.00% Pervious Area

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

Subcatchment 88S: East Drainage Area 2



Summary for Subcatchment 90S: East Drainage Area 3

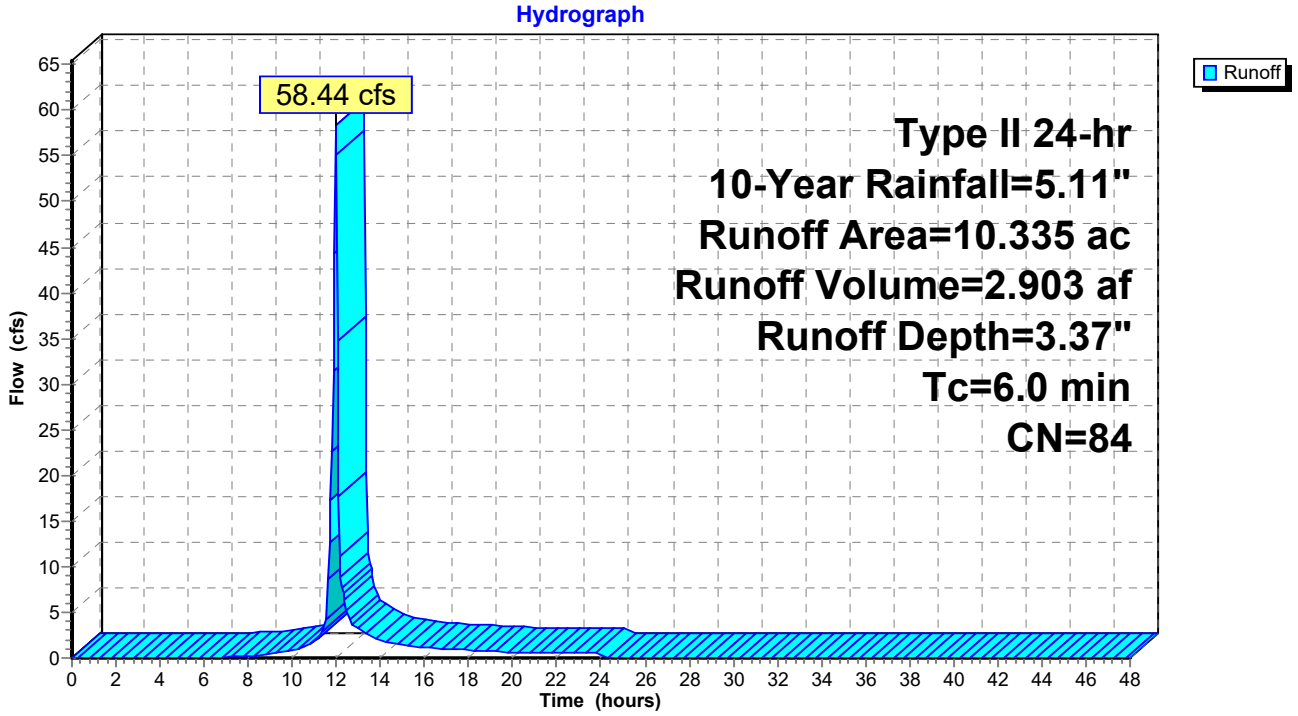
Runoff = 58.44 cfs @ 11.97 hrs, Volume= 2.903 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
10.335	84	50-75% Grass cover, Fair, HSG D
10.335		100.00% Pervious Area

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

Subcatchment 90S: East Drainage Area 3



Summary for Subcatchment 93S: West Drainage Area 2

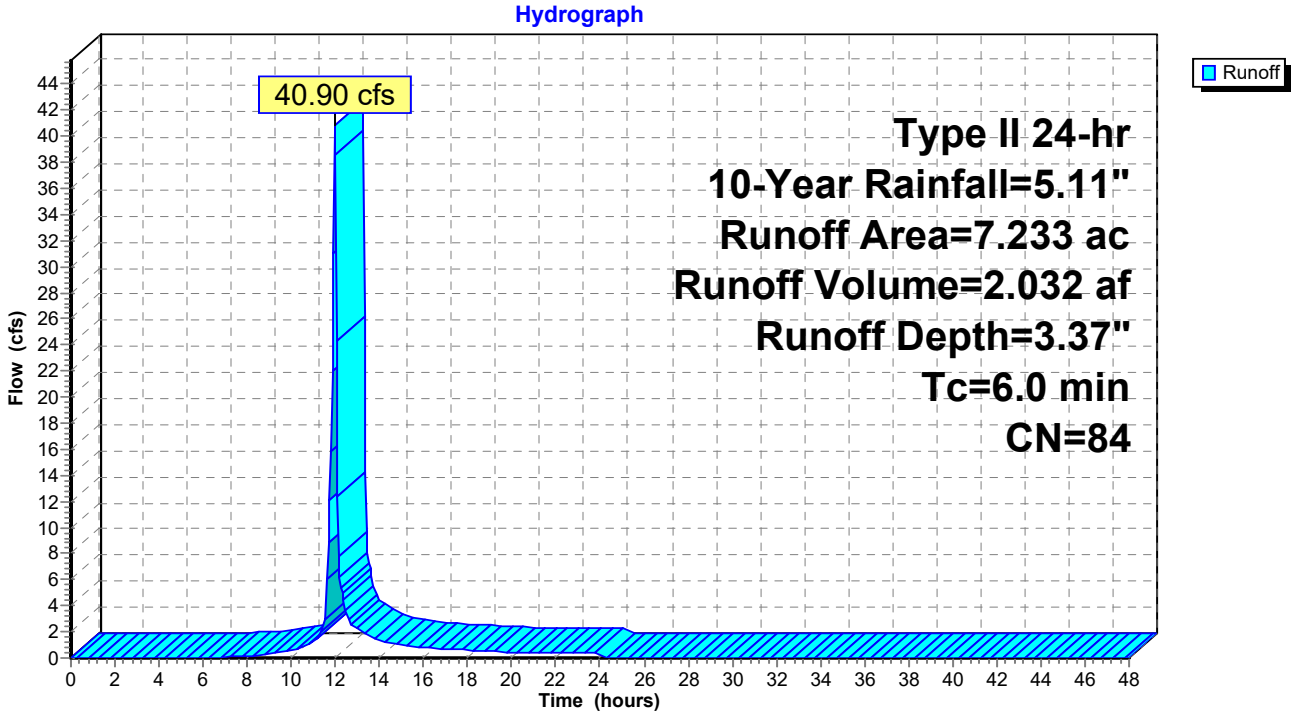
Runoff = 40.90 cfs @ 11.97 hrs, Volume= 2.032 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
7.233	84	50-75% Grass cover, Fair, HSG D
7.233		100.00% Pervious Area

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

Subcatchment 93S: West Drainage Area 2



Summary for Subcatchment 94S: West Drainage Area 4

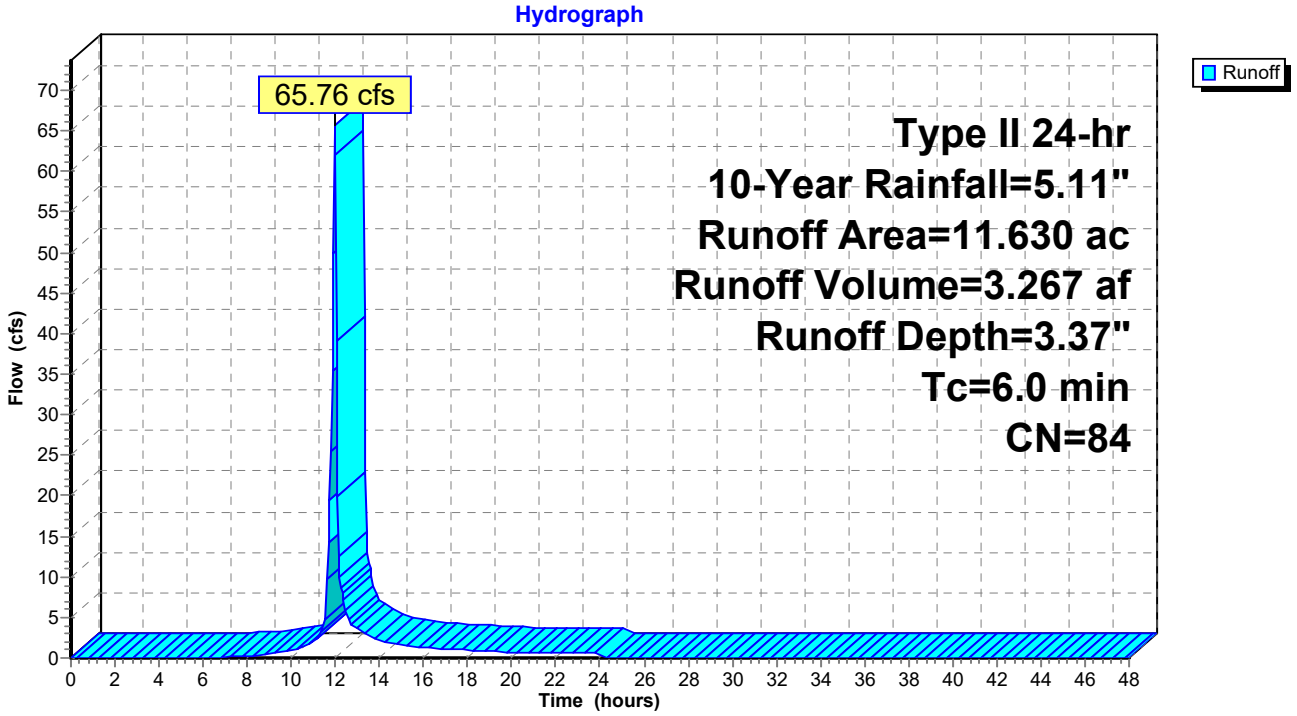
Runoff = 65.76 cfs @ 11.97 hrs, Volume= 3.267 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
11.630	84	50-75% Grass cover, Fair, HSG D
11.630		100.00% Pervious Area

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

Subcatchment 94S: West Drainage Area 4



Summary for Subcatchment 95S: West Drainage Area 1

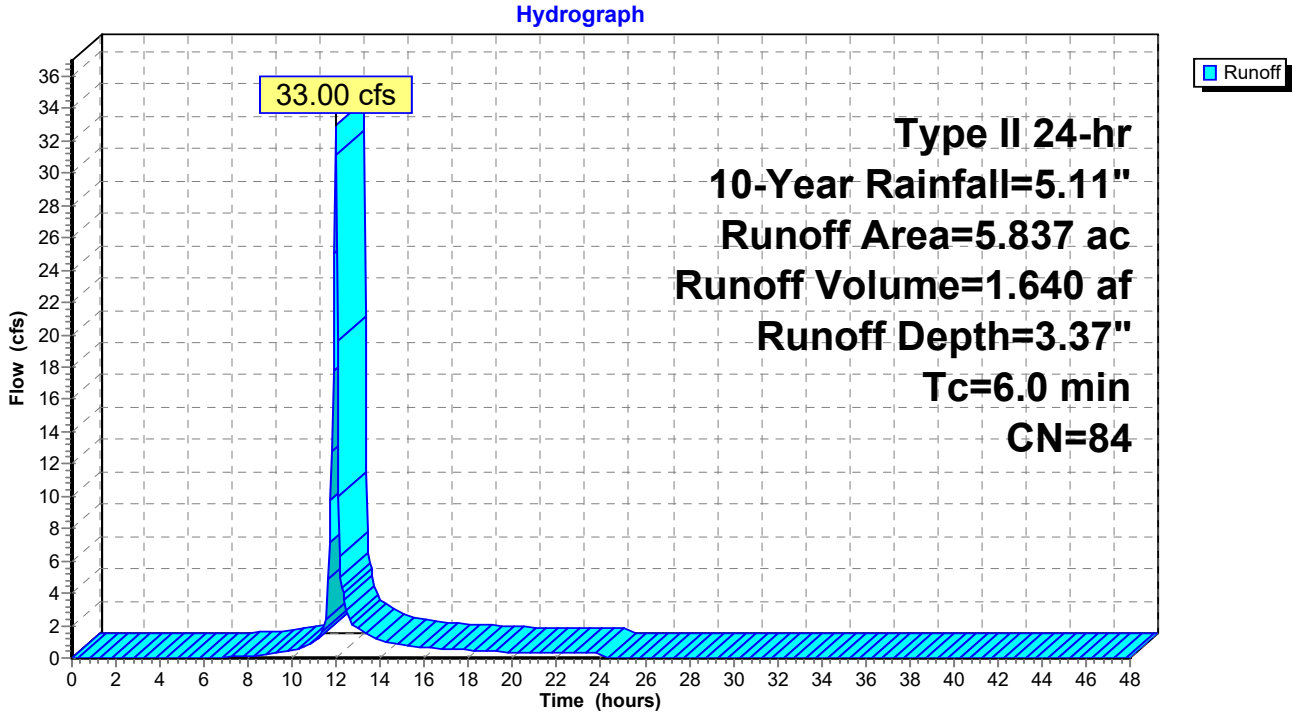
Runoff = 33.00 cfs @ 11.97 hrs, Volume= 1.640 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
5.837	84	50-75% Grass cover, Fair, HSG D
5.837		100.00% Pervious Area

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

Subcatchment 95S: West Drainage Area 1



Summary for Subcatchment 96S: West Drainage Area 5

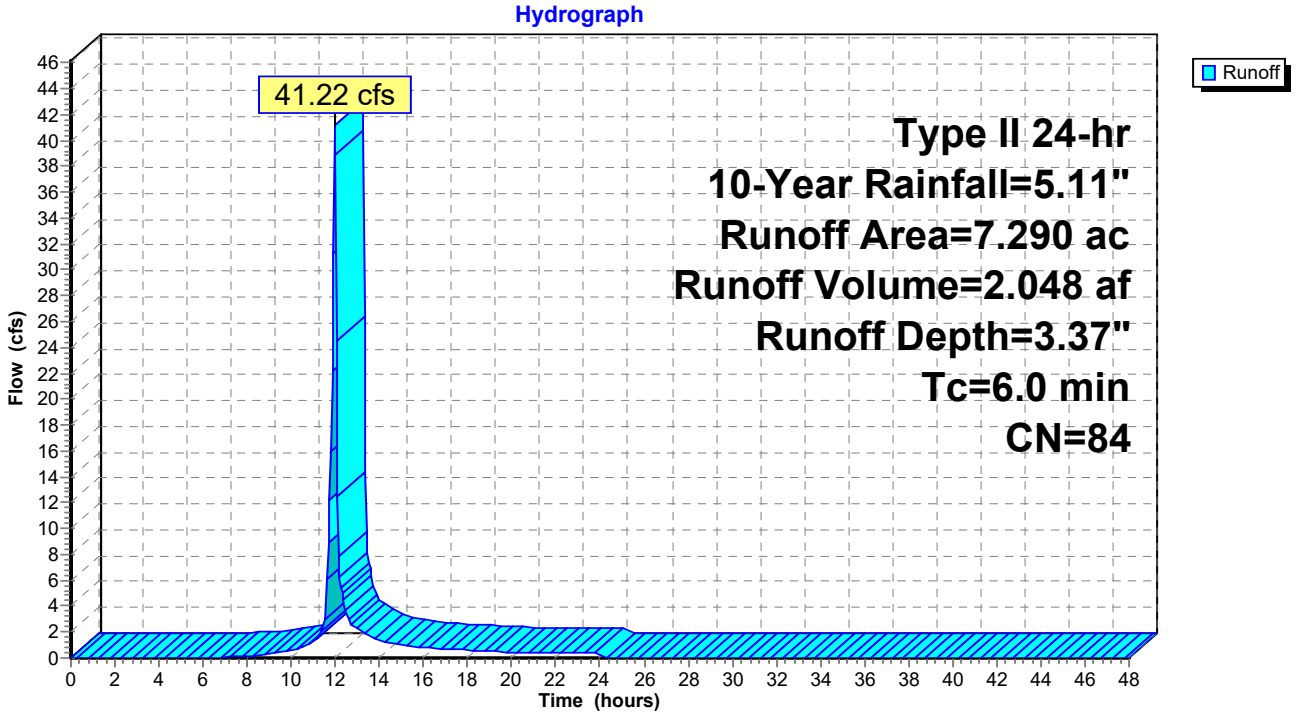
Runoff = 41.22 cfs @ 11.97 hrs, Volume= 2.048 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
7.290	84	50-75% Grass cover, Fair, HSG D
7.290		100.00% Pervious Area

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

Subcatchment 96S: West Drainage Area 5



Summary for Subcatchment 98S: Middle Drainage Area 4

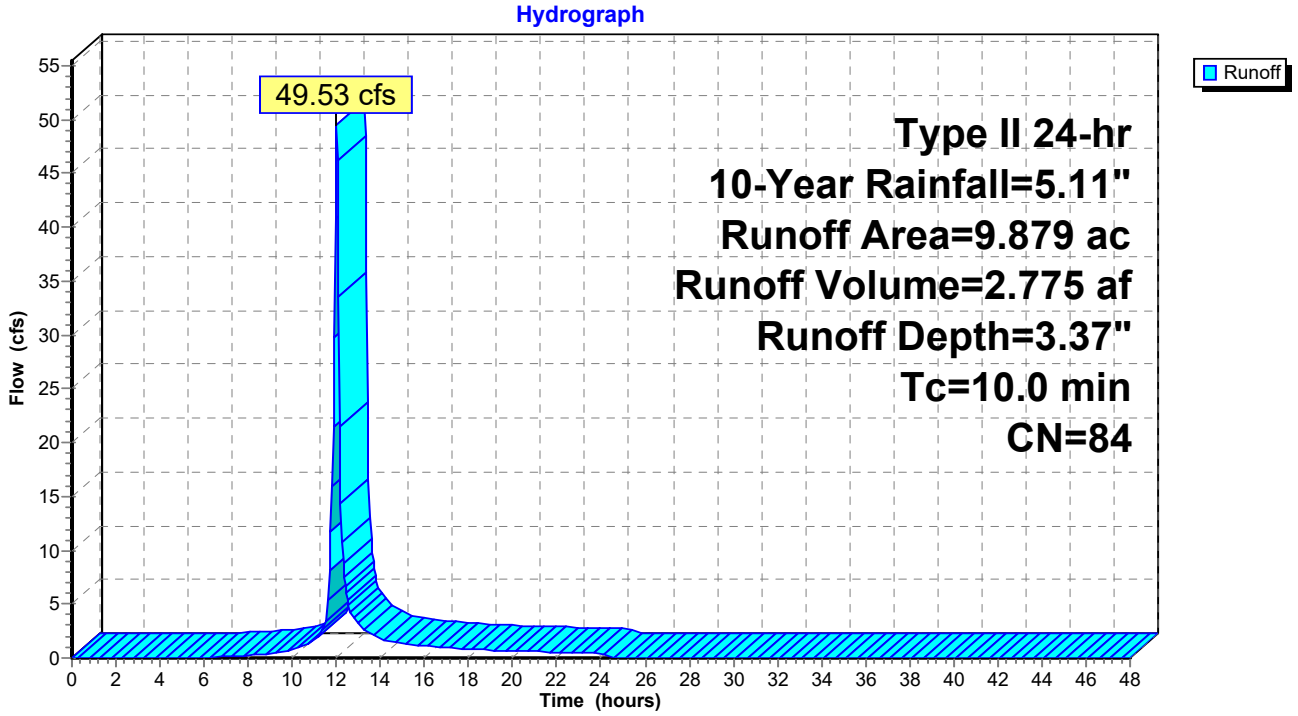
Runoff = 49.53 cfs @ 12.01 hrs, Volume= 2.775 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
9.879	84	50-75% Grass cover, Fair, HSG D
9.879		100.00% Pervious Area

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

Subcatchment 98S: Middle Drainage Area 4



Summary for Subcatchment 100S: Middle Drainage Area 5

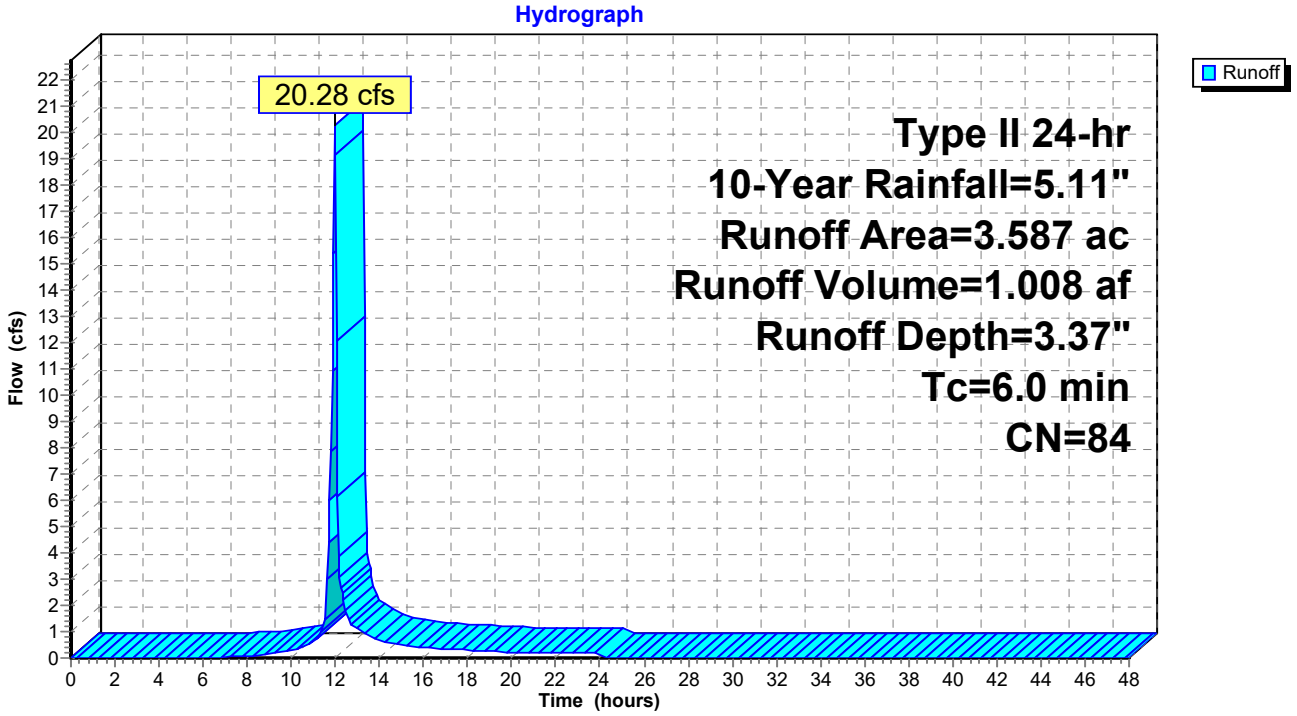
Runoff = 20.28 cfs @ 11.97 hrs, Volume= 1.008 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
3.587	84	50-75% Grass cover, Fair, HSG D
3.587		100.00% Pervious Area

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

Subcatchment 100S: Middle Drainage Area 5



Summary for Subcatchment 104S: East Drainage Area 4

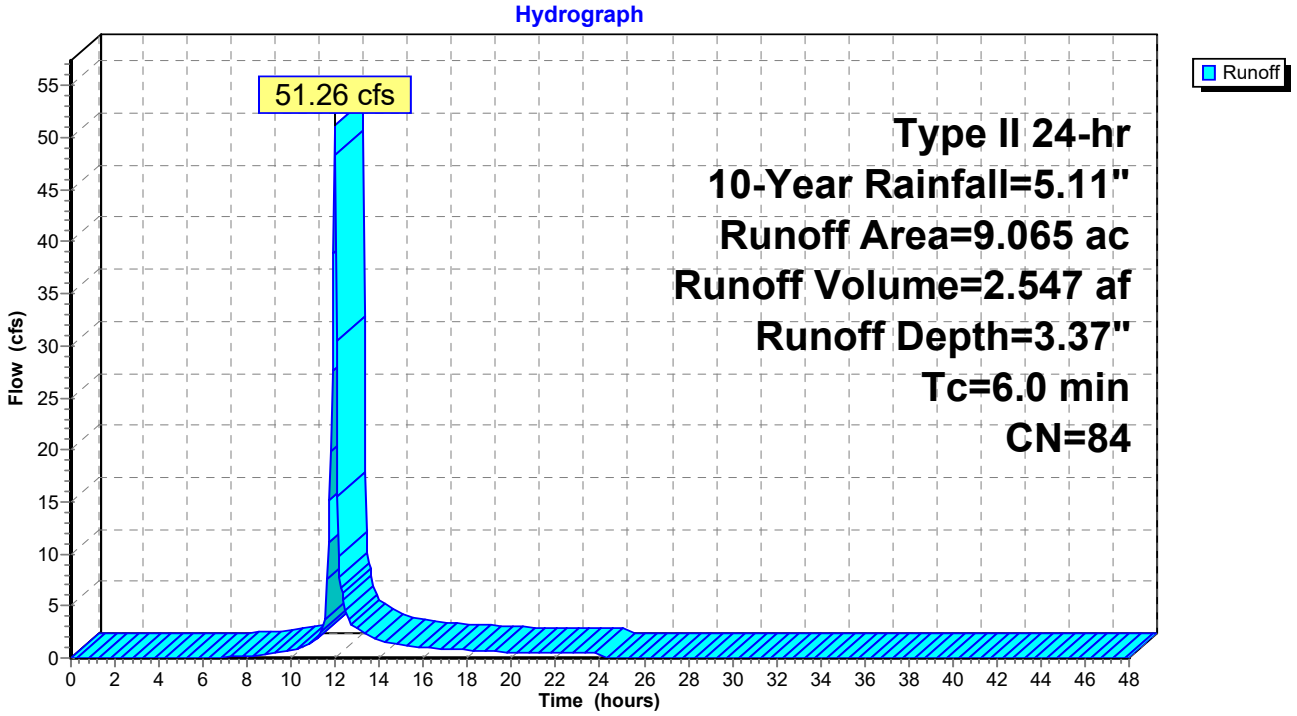
Runoff = 51.26 cfs @ 11.97 hrs, Volume= 2.547 af, Depth= 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.11"

Area (ac)	CN	Description
9.065	84	50-75% Grass cover, Fair, HSG D
9.065		100.00% Pervious Area

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

Subcatchment 104S: East Drainage Area 4



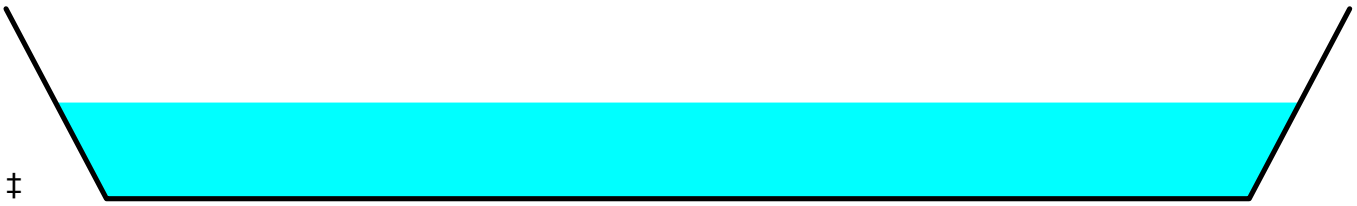
Summary for Reach 77R: West Channel 3

Inflow Area = 14.150 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 80.01 cfs @ 11.97 hrs, Volume= 3.975 af
Outflow = 47.36 cfs @ 12.06 hrs, Volume= 3.975 af, Atten= 41%, Lag= 5.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.63 fps, Min. Travel Time= 16.4 min
Avg. Velocity = 0.25 fps, Avg. Travel Time= 105.3 min

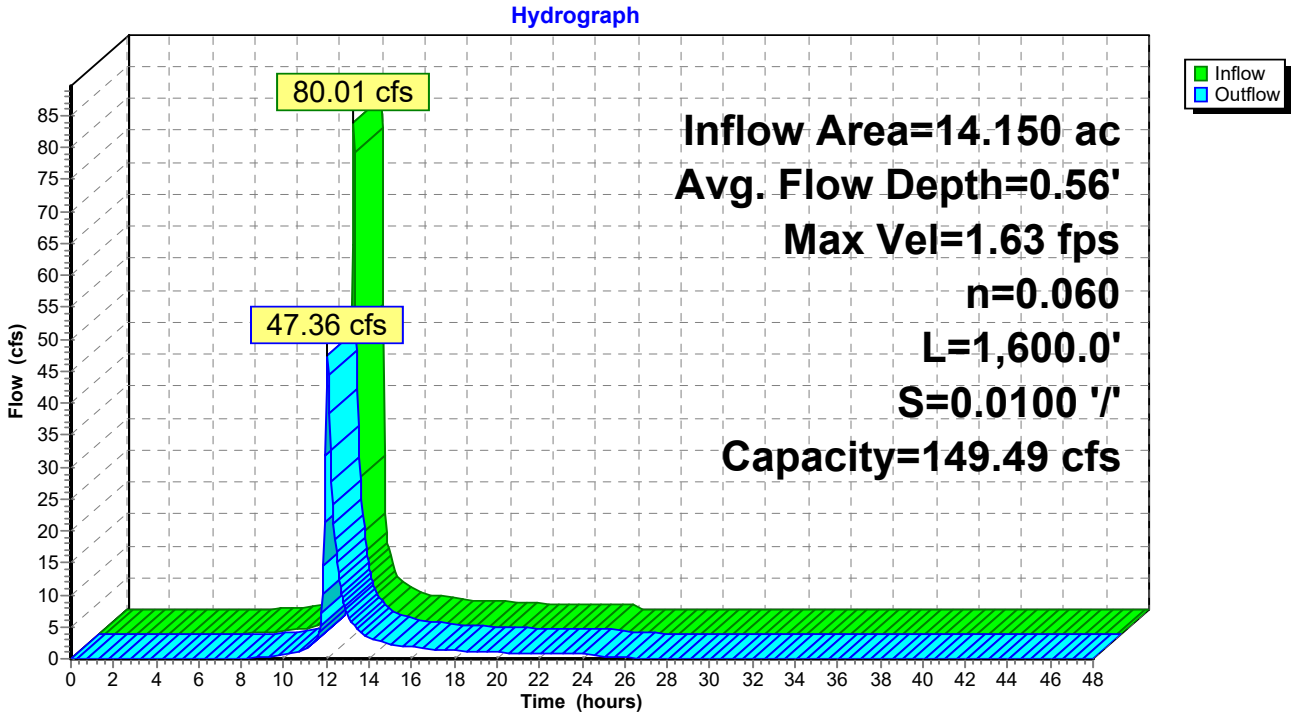
Peak Storage= 46,548 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.49 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,600.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 7.00'



‡

Reach 77R: West Channel 3



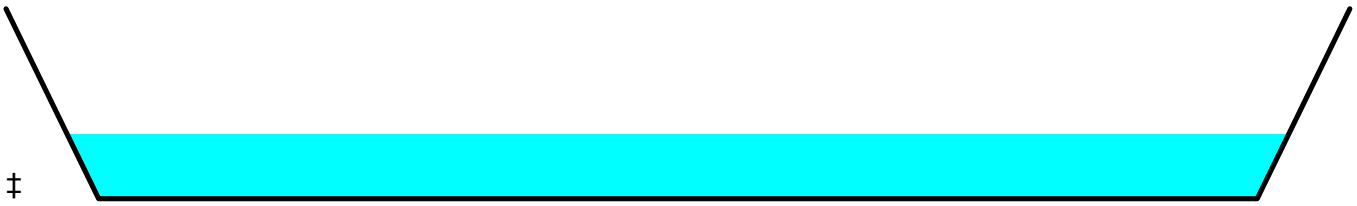
Summary for Reach 82R: Middle Channel 1

Inflow Area = 5.736 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 32.43 cfs @ 11.97 hrs, Volume= 1.611 af
Outflow = 21.03 cfs @ 12.05 hrs, Volume= 1.611 af, Atten= 35%, Lag= 4.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.20 fps, Min. Travel Time= 13.5 min
Avg. Velocity = 0.20 fps, Avg. Travel Time= 81.3 min

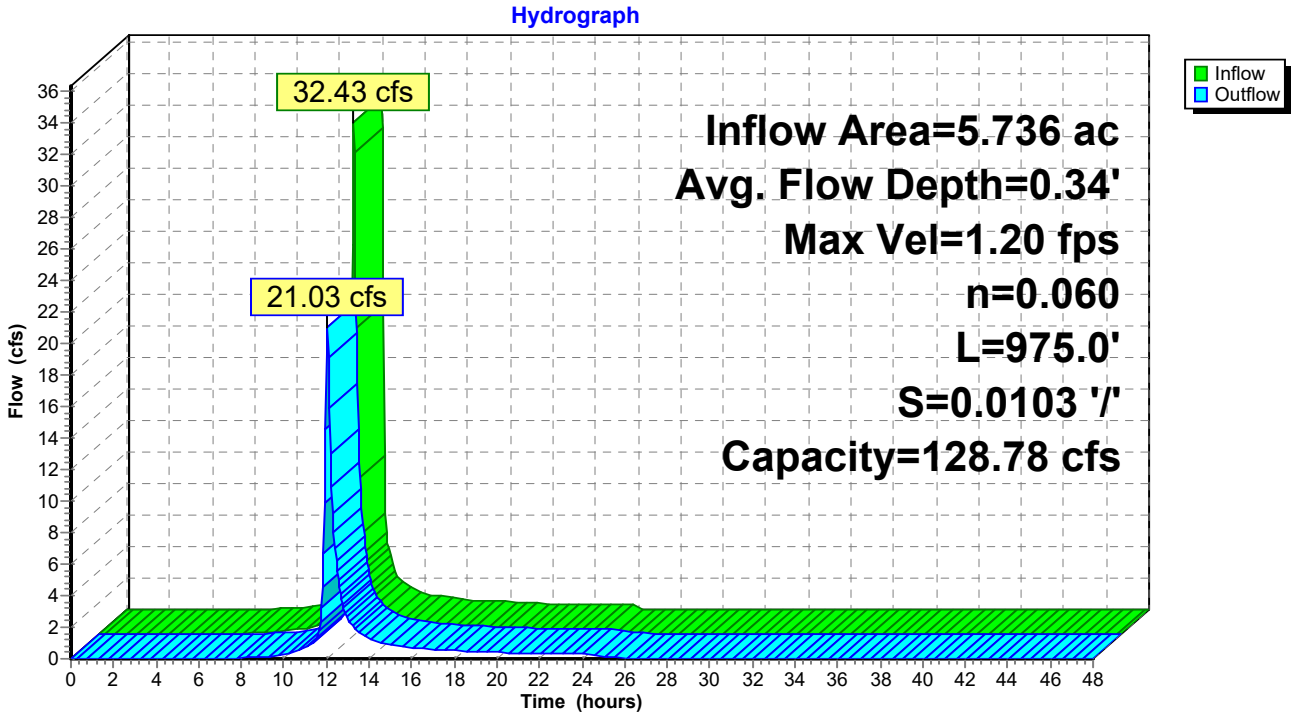
Peak Storage= 17,066 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 128.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 975.0' Slope= 0.0103 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 82R: Middle Channel 1



Summary for Reach 84R: Middle Channel 2

Inflow Area = 12.628 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 71.40 cfs @ 11.97 hrs, Volume= 3.548 af
Outflow = 52.20 cfs @ 12.04 hrs, Volume= 3.548 af, Atten= 27%, Lag= 4.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.68 fps, Min. Travel Time= 9.9 min
Avg. Velocity = 0.25 fps, Avg. Travel Time= 66.9 min

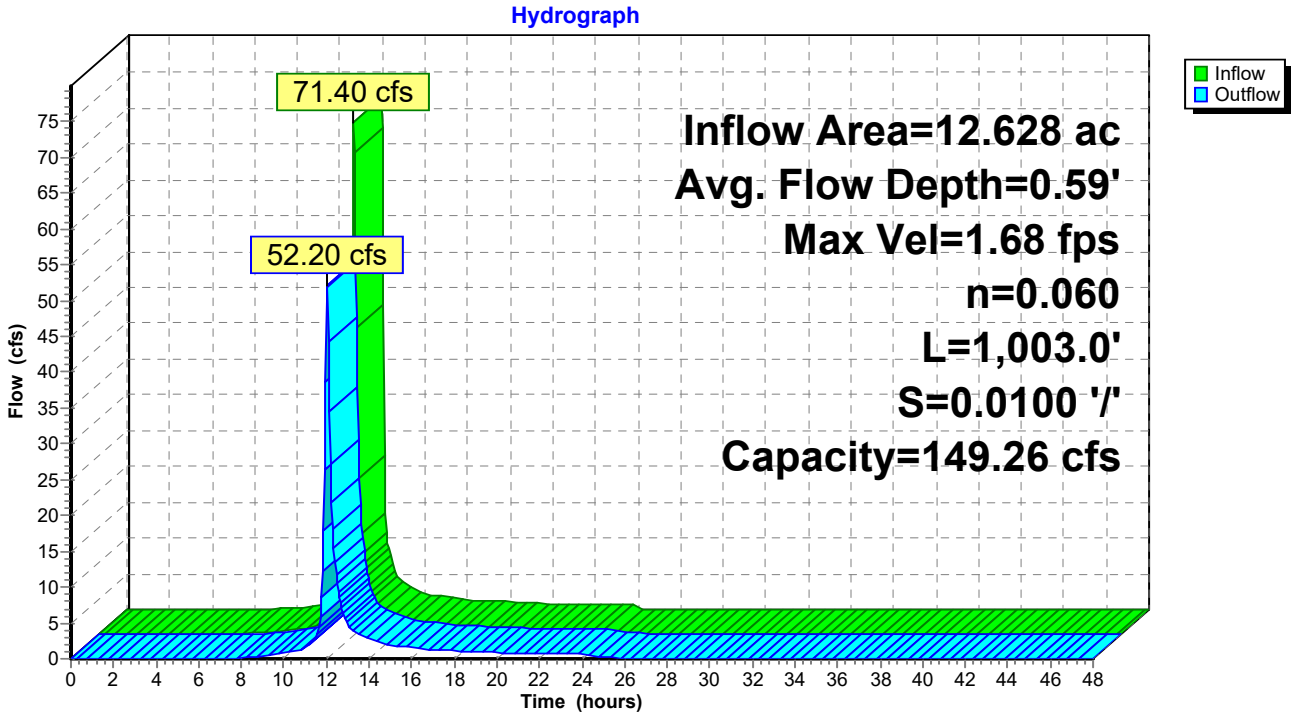
Peak Storage= 31,031 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.26 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,003.0' Slope= 0.0100 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 84R: Middle Channel 2



Summary for Reach 86R: Middle Channel 3

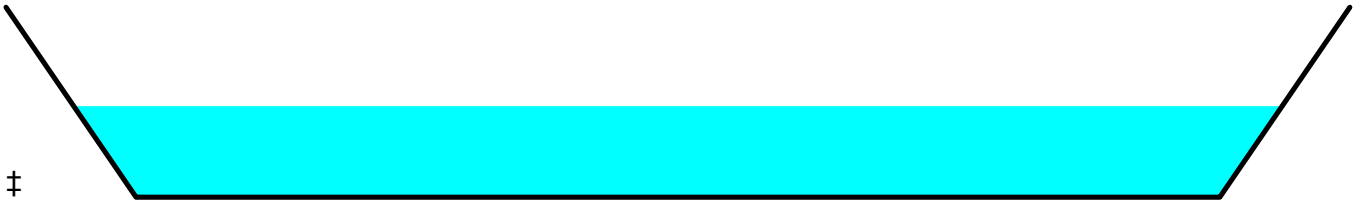
Changed depth to 0.6 feet to meet 100-year storm

Inflow Area = 19.614 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 110.90 cfs @ 11.97 hrs, Volume= 5.510 af
Outflow = 72.75 cfs @ 12.05 hrs, Volume= 5.510 af, Atten= 34%, Lag= 4.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.91 fps, Min. Travel Time= 13.1 min
Avg. Velocity = 0.29 fps, Avg. Travel Time= 85.3 min

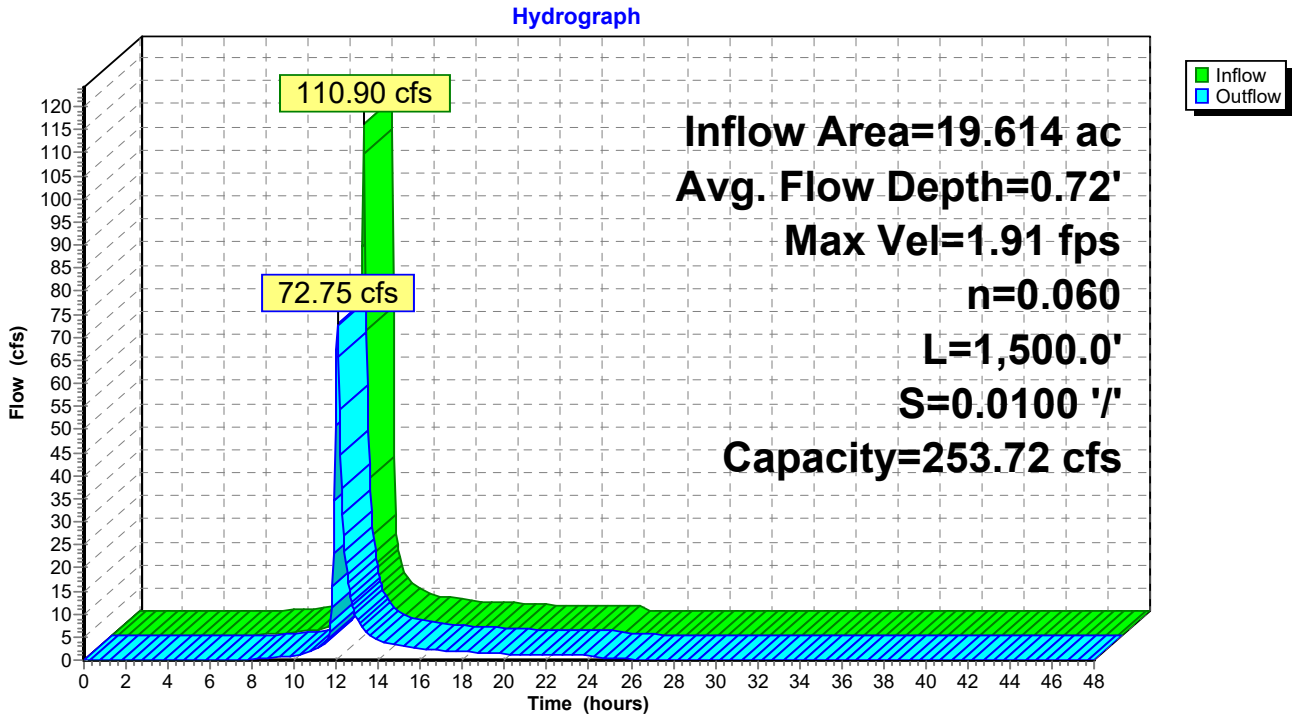
Peak Storage= 57,005 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.50' Flow Area= 84.0 sf, Capacity= 253.72 cfs

50.00' x 1.50' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 62.00'
Length= 1,500.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 8.00'



‡

Reach 86R: Middle Channel 3



Summary for Reach 87R: East Channel 1

Inflow Area = 2.239 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 12.66 cfs @ 11.97 hrs, Volume= 0.629 af
Outflow = 10.17 cfs @ 12.02 hrs, Volume= 0.629 af, Atten= 20%, Lag= 3.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 0.94 fps, Min. Travel Time= 7.5 min
Avg. Velocity = 0.19 fps, Avg. Travel Time= 37.2 min

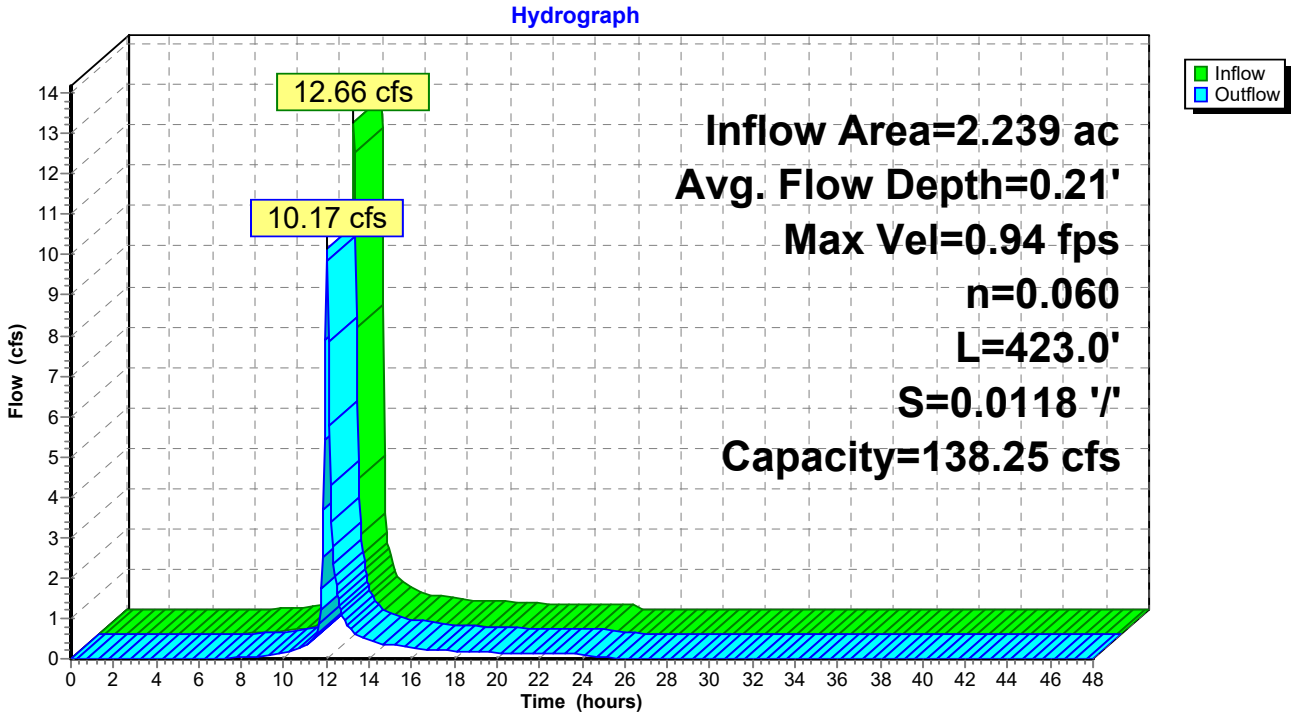
Peak Storage= 4,554 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.21'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 138.25 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 423.0' Slope= 0.0118 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡

Reach 87R: East Channel 1



Summary for Reach 89R: East Channel 2

Inflow Area = 4.167 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 23.56 cfs @ 11.97 hrs, Volume= 1.171 af
Outflow = 17.18 cfs @ 12.04 hrs, Volume= 1.171 af, Atten= 27%, Lag= 4.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.11 fps, Min. Travel Time= 10.1 min
Avg. Velocity = 0.20 fps, Avg. Travel Time= 56.4 min

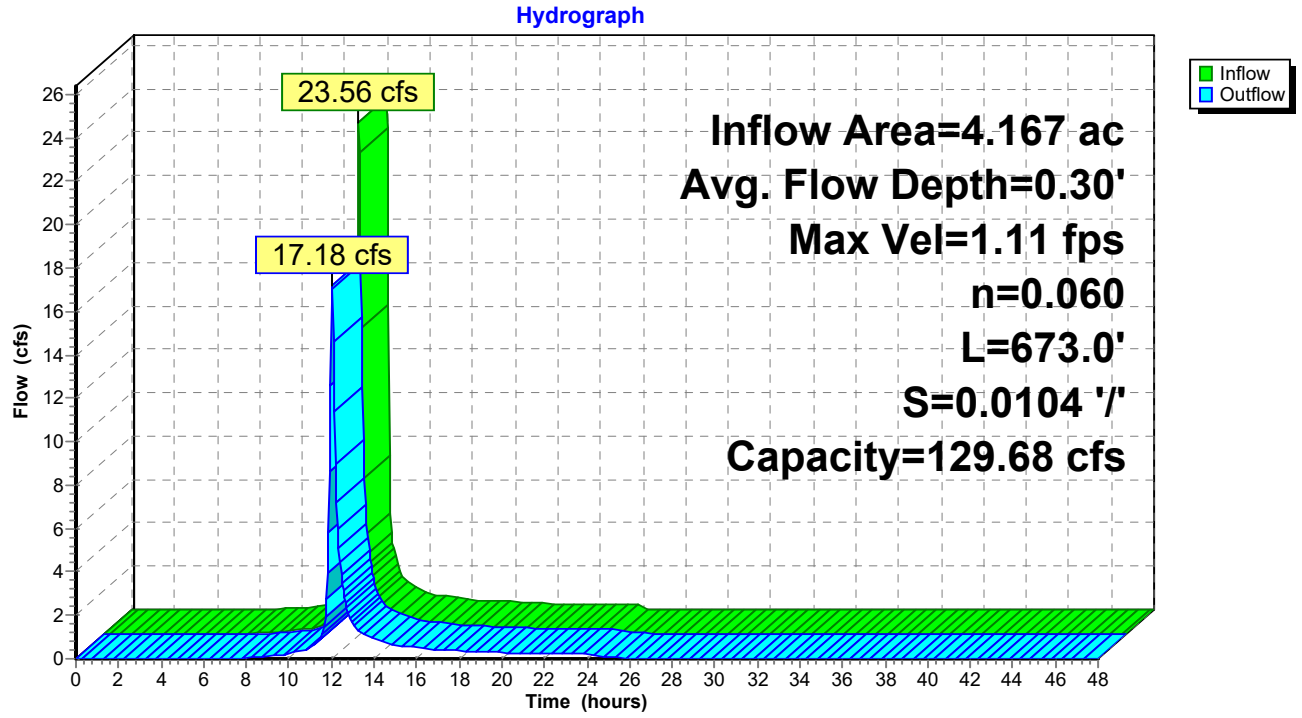
Peak Storage= 10,367 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.68 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 673.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 11.00'



‡

Reach 89R: East Channel 2



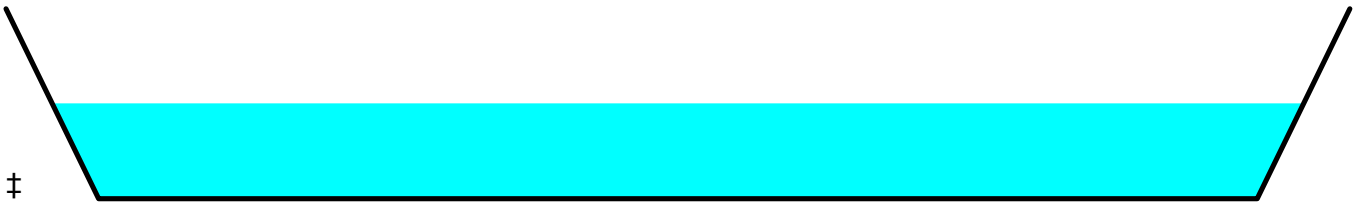
Summary for Reach 91R: East Channel 3

Inflow Area = 10.335 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 58.44 cfs @ 11.97 hrs, Volume= 2.903 af
Outflow = 39.73 cfs @ 12.04 hrs, Volume= 2.903 af, Atten= 32%, Lag= 4.6 min

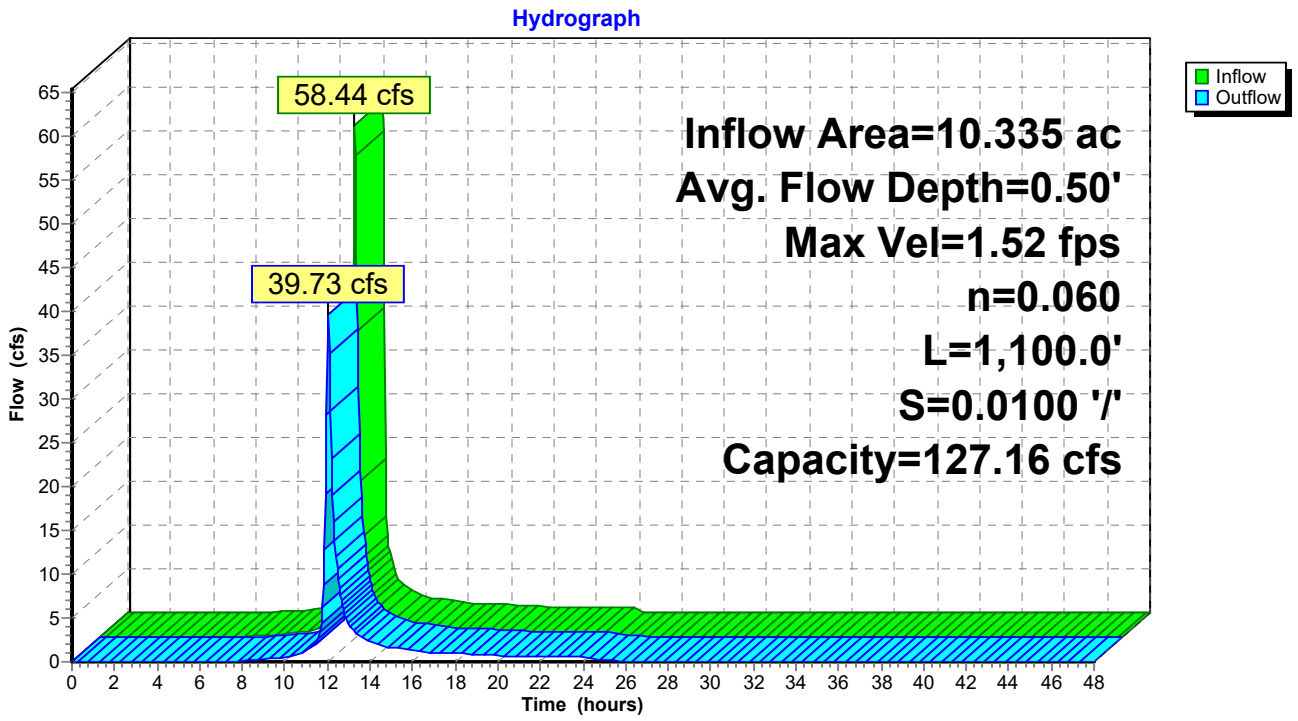
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.52 fps, Min. Travel Time= 12.0 min
Avg. Velocity = 0.23 fps, Avg. Travel Time= 81.1 min

Peak Storage= 28,704 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.50'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,100.0' Slope= 0.0100 '/'
Inlet Invert= 22.00', Outlet Invert= 11.00'



‡



Summary for Reach 94R: West Channel 2

Inflow Area = 7.233 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 40.90 cfs @ 11.97 hrs, Volume= 2.032 af
Outflow = 28.67 cfs @ 12.04 hrs, Volume= 2.032 af, Atten= 30%, Lag= 4.4 min

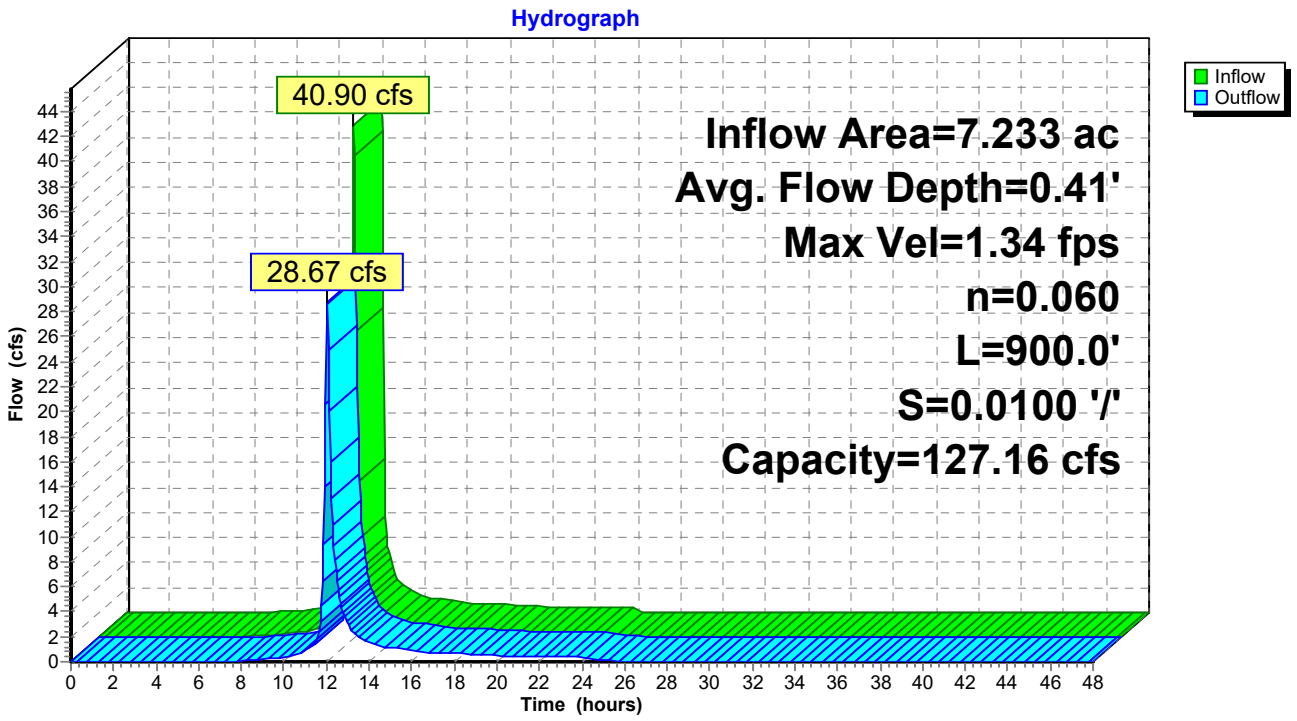
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.34 fps, Min. Travel Time= 11.2 min
Avg. Velocity = 0.21 fps, Avg. Travel Time= 70.3 min

Peak Storage= 19,205 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 900.0' Slope= 0.0100 '/'
Inlet Invert= 16.00', Outlet Invert= 7.00'



‡



Summary for Reach 95R: West Channel 4

Inflow Area = 11.630 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 65.76 cfs @ 11.97 hrs, Volume= 3.267 af
Outflow = 45.81 cfs @ 12.04 hrs, Volume= 3.267 af, Atten= 30%, Lag= 4.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.61 fps, Min. Travel Time= 11.3 min
Avg. Velocity = 0.23 fps, Avg. Travel Time= 77.7 min

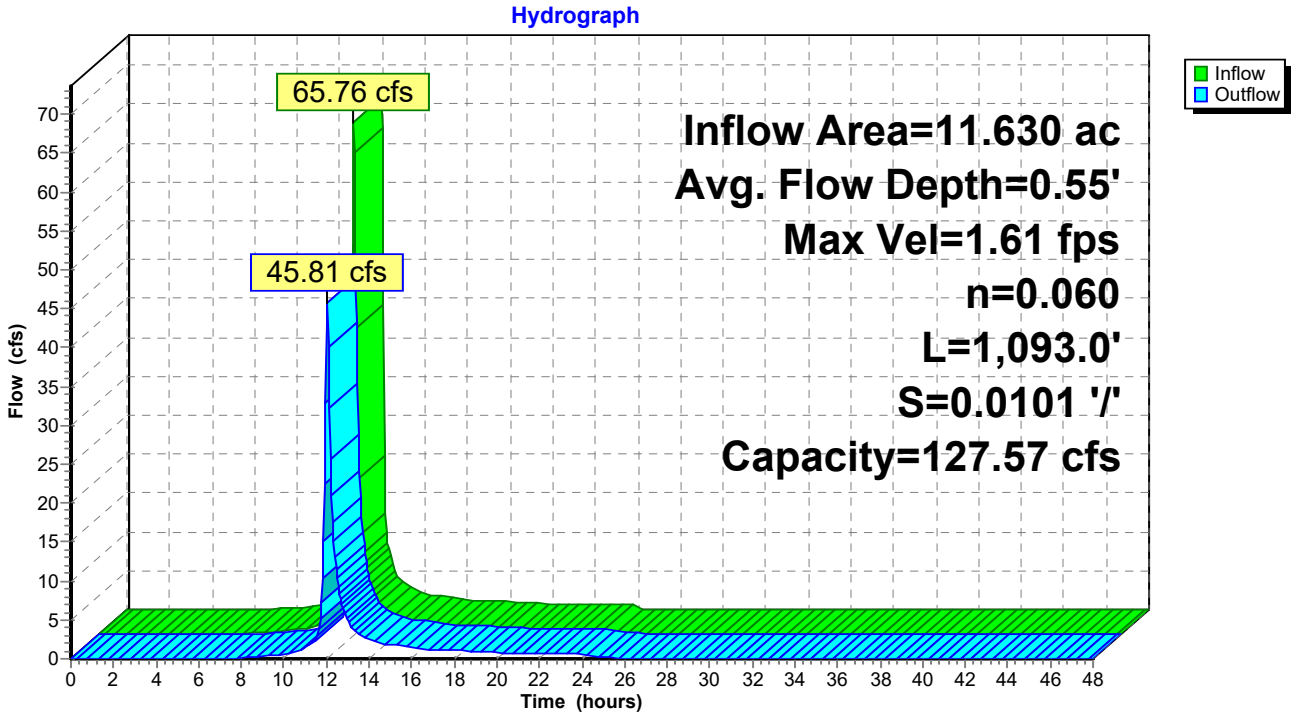
Peak Storage= 31,089 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.55'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.57 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,093.0' Slope= 0.0101 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 95R: West Channel 4



Summary for Reach 96R: West Channel 1

Inflow Area = 5.837 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 33.00 cfs @ 11.97 hrs, Volume= 1.640 af
Outflow = 21.25 cfs @ 12.05 hrs, Volume= 1.640 af, Atten= 36%, Lag= 4.9 min

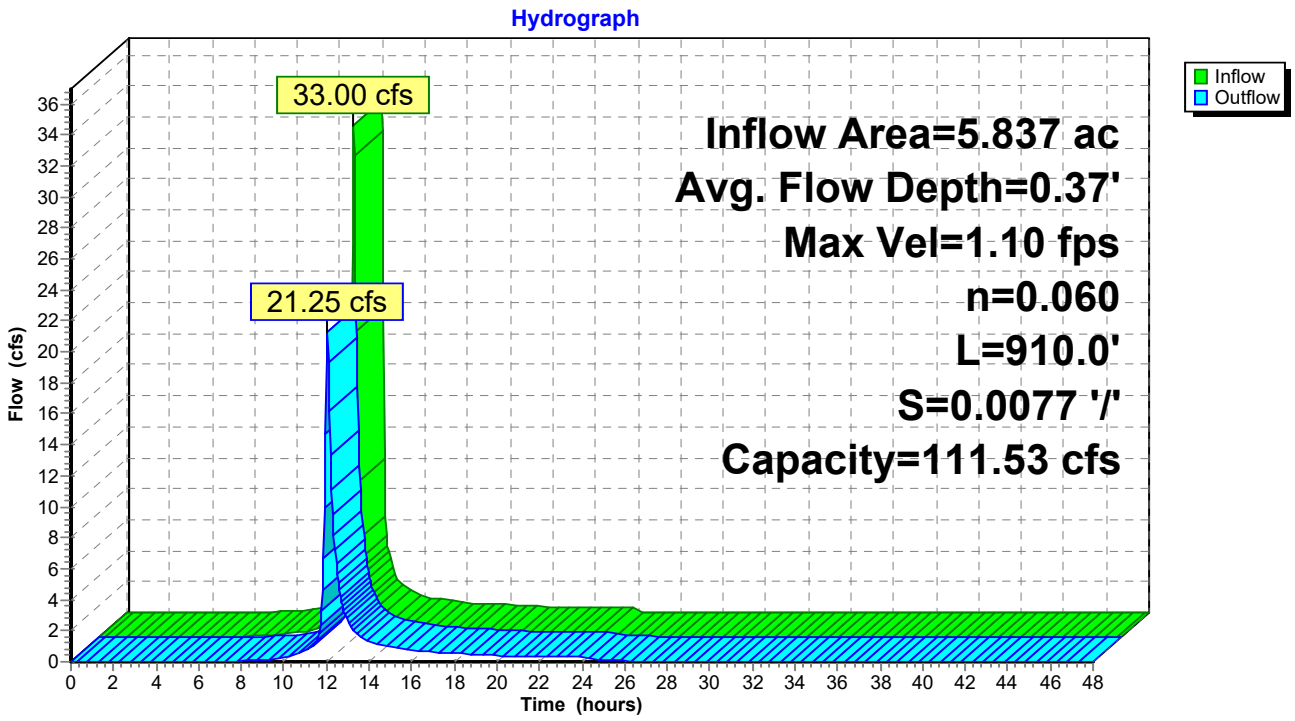
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.10 fps, Min. Travel Time= 13.7 min
Avg. Velocity = 0.18 fps, Avg. Travel Time= 85.5 min

Peak Storage= 17,510 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 111.53 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 910.0' Slope= 0.0077 '/'
Inlet Invert= 14.00', Outlet Invert= 7.00'



‡



Summary for Reach 97R: West Channel 5

Inflow Area = 7.290 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 41.22 cfs @ 11.97 hrs, Volume= 2.048 af
Outflow = 28.32 cfs @ 12.04 hrs, Volume= 2.048 af, Atten= 31%, Lag= 4.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.39 fps, Min. Travel Time= 11.8 min
Avg. Velocity = 0.22 fps, Avg. Travel Time= 73.4 min

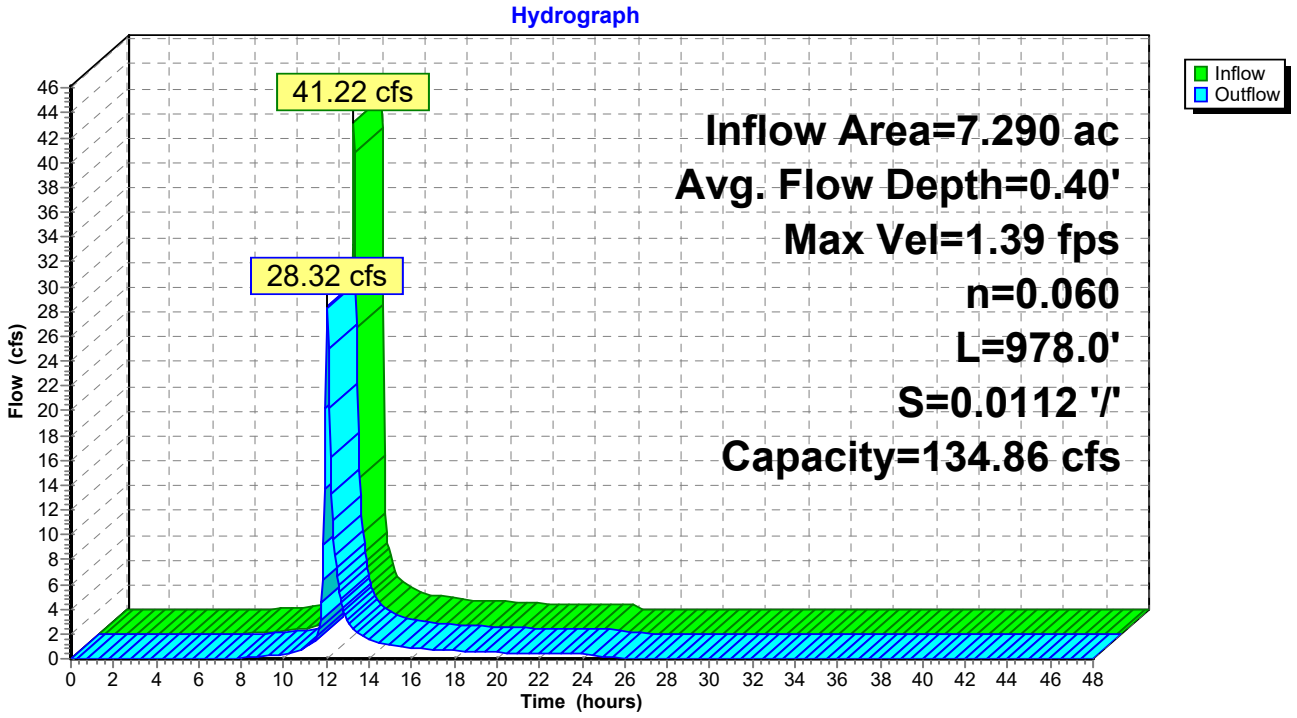
Peak Storage= 19,979 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 134.86 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 978.0' Slope= 0.0112 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 97R: West Channel 5



Summary for Reach 99R: Middle Channel 4

Inflow Area = 9.879 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 49.53 cfs @ 12.01 hrs, Volume= 2.775 af
Outflow = 36.77 cfs @ 12.09 hrs, Volume= 2.775 af, Atten= 26%, Lag= 4.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.50 fps, Min. Travel Time= 10.7 min
Avg. Velocity = 0.23 fps, Avg. Travel Time= 68.5 min

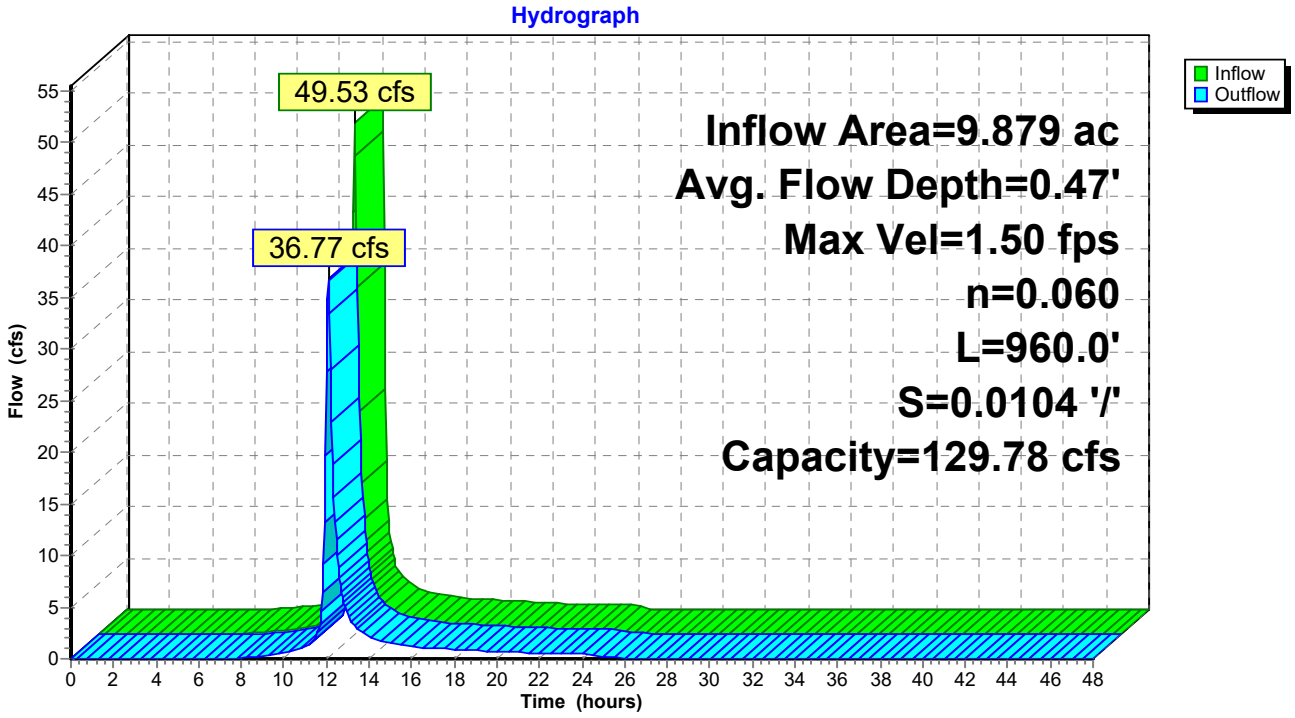
Peak Storage= 23,580 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.47'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 960.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 99R: Middle Channel 4



Summary for Reach 101R: Middle Channel 5

Inflow Area = 3.587 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 20.28 cfs @ 11.97 hrs, Volume= 1.008 af
Outflow = 13.67 cfs @ 12.04 hrs, Volume= 1.008 af, Atten= 33%, Lag= 4.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.02 fps, Min. Travel Time= 12.4 min
Avg. Velocity = 0.19 fps, Avg. Travel Time= 67.3 min

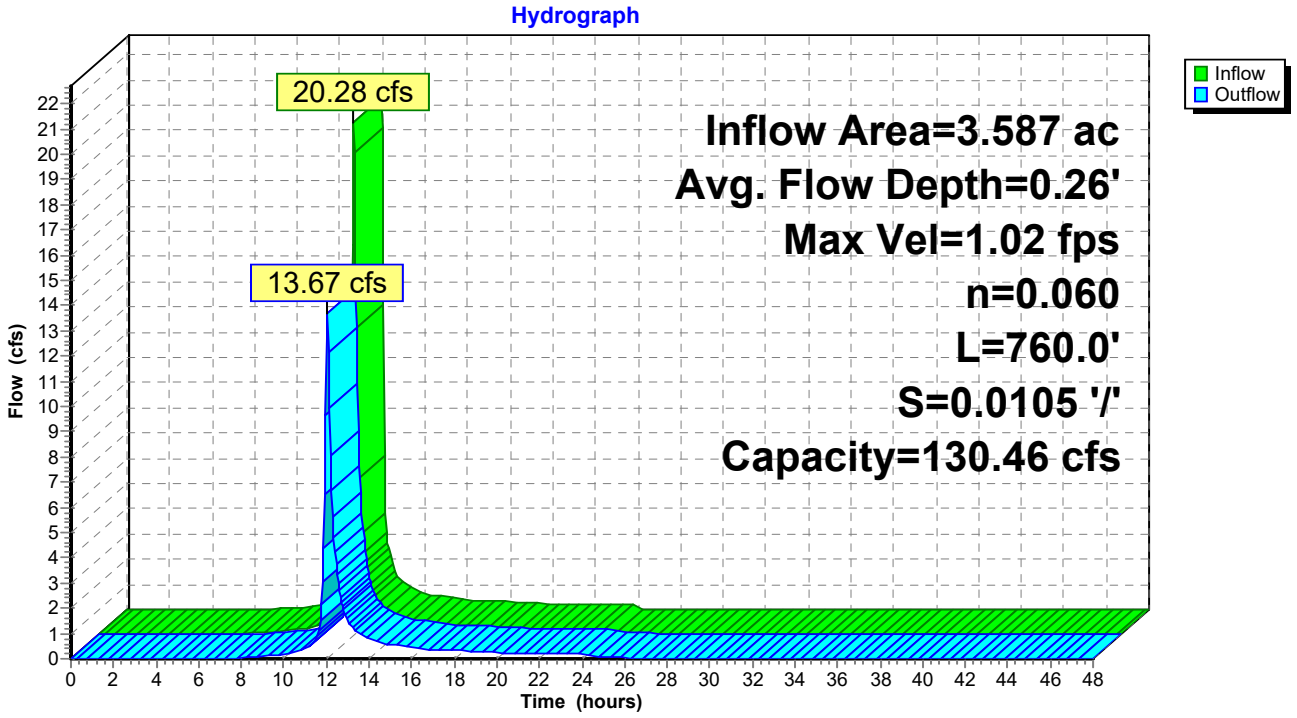
Peak Storage= 10,144 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 130.46 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 760.0' Slope= 0.0105 '/'
Inlet Invert= 16.00', Outlet Invert= 8.00'



‡

Reach 101R: Middle Channel 5



Summary for Reach 105R: East Channel 4

Inflow Area = 9.065 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 51.26 cfs @ 11.97 hrs, Volume= 2.547 af
Outflow = 44.35 cfs @ 12.01 hrs, Volume= 2.547 af, Atten= 13%, Lag= 2.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.57 fps, Min. Travel Time= 5.5 min
Avg. Velocity = 0.26 fps, Avg. Travel Time= 33.7 min

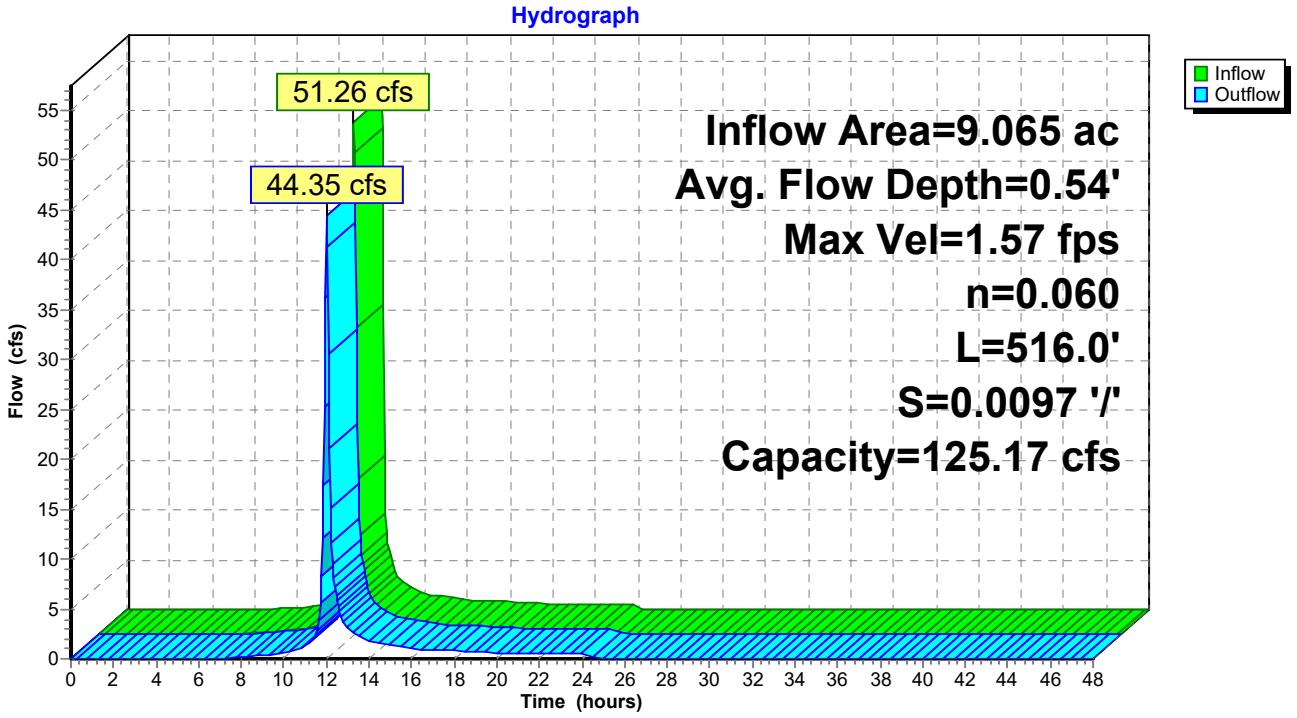
Peak Storage= 14,560 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 125.17 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 516.0' Slope= 0.0097 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡

Reach 105R: East Channel 4



Summary for Pond 28P: West Outlet/West Emergency Spillway

[62] Hint: Exceeded Reach 77R OUTLET depth by 2.30' @ 12.75 hrs
[62] Hint: Exceeded Reach 94R OUTLET depth by 2.39' @ 12.70 hrs
[62] Hint: Exceeded Reach 95R OUTLET depth by 2.34' @ 12.75 hrs
[62] Hint: Exceeded Reach 96R OUTLET depth by 2.39' @ 12.70 hrs
[62] Hint: Exceeded Reach 97R OUTLET depth by 2.39' @ 12.70 hrs

Inflow Area = 46.140 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 171.15 cfs @ 12.05 hrs, Volume= 12.962 af
Outflow = 34.15 cfs @ 12.62 hrs, Volume= 12.962 af, Atten= 80%, Lag= 34.7 min
Primary = 34.15 cfs @ 12.62 hrs, Volume= 12.962 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 9.53' @ 12.62 hrs Surf.Area= 136,996 sf Storage= 180,932 cf

Plug-Flow detention time= 42.9 min calculated for 12.949 af (100% of inflow)
Center-of-Mass det. time= 42.8 min (884.1 - 841.3)

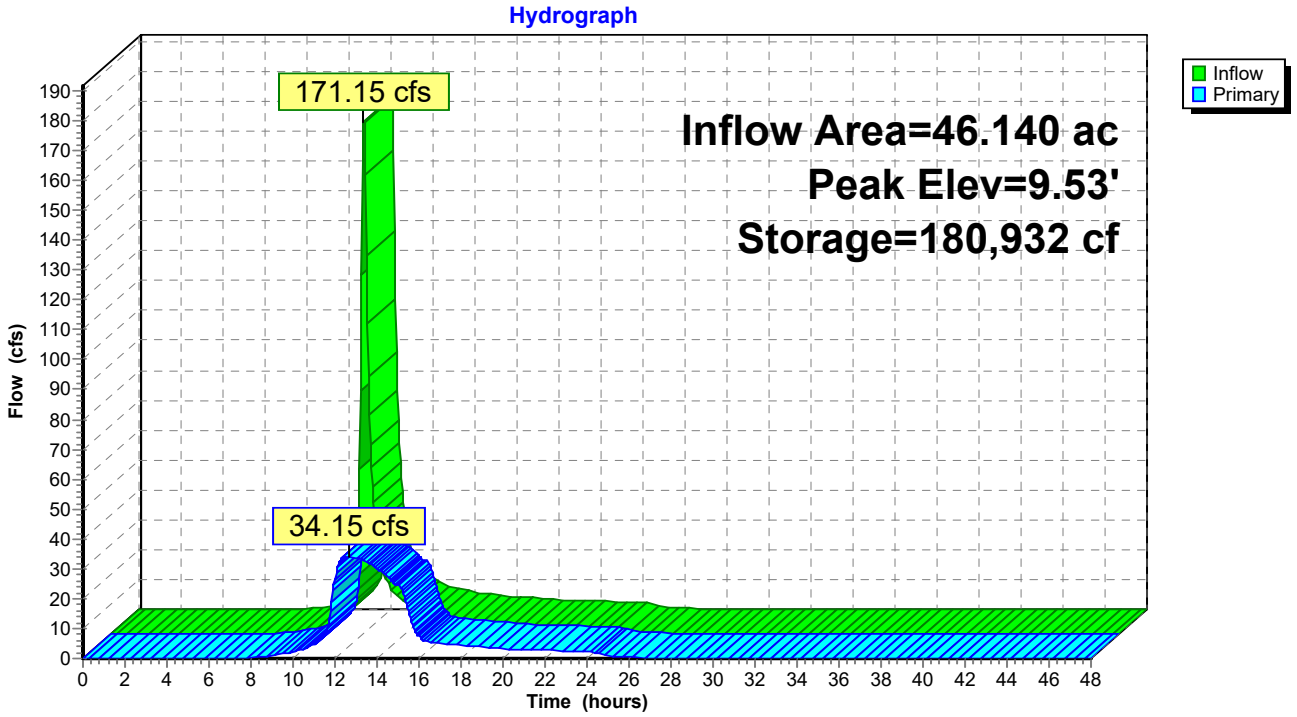
Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	786,184 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	25	25.0	0	0	25
7.00	17,893	714.0	6,196	6,196	40,545
8.00	54,145	1,528.0	34,388	40,584	185,777
9.00	103,329	2,053.0	77,424	118,008	335,396
10.00	171,483	2,546.0	135,975	253,983	515,837
11.00	261,382	2,995.0	214,859	468,842	713,838
12.00	376,810	3,340.0	317,342	786,184	887,789

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**18.0" Round Culvert X 3.00** L= 205.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0049 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	11.00'	**100.0' long x 155.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=34.15 cfs @ 12.62 hrs HW=9.52' (Free Discharge)
1=Culvert (Barrel Controls 34.15 cfs @ 6.44 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 28P: West Outlet/West Emergency Spillway



Summary for Pond 29P: Middle Outlet/Middle Emergency Spillway

[62] Hint: Exceeded Reach 82R OUTLET depth by 2.70' @ 12.70 hrs
[62] Hint: Exceeded Reach 84R OUTLET depth by 2.65' @ 12.75 hrs
[62] Hint: Exceeded Reach 86R OUTLET depth by 2.58' @ 12.80 hrs
[62] Hint: Exceeded Reach 99R OUTLET depth by 2.66' @ 12.75 hrs
[62] Hint: Exceeded Reach 101R OUTLET depth by 2.73' @ 12.70 hrs

Inflow Area = 51.444 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 194.05 cfs @ 12.05 hrs, Volume= 14.452 af
Outflow = 36.43 cfs @ 12.63 hrs, Volume= 14.452 af, Atten= 81%, Lag= 34.9 min
Primary = 36.43 cfs @ 12.63 hrs, Volume= 14.452 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.83' @ 12.63 hrs Surf.Area= 154,855 sf Storage= 207,094 cf

Plug-Flow detention time= 44.8 min calculated for 14.437 af (100% of inflow)
Center-of-Mass det. time= 44.8 min (883.2 - 838.5)

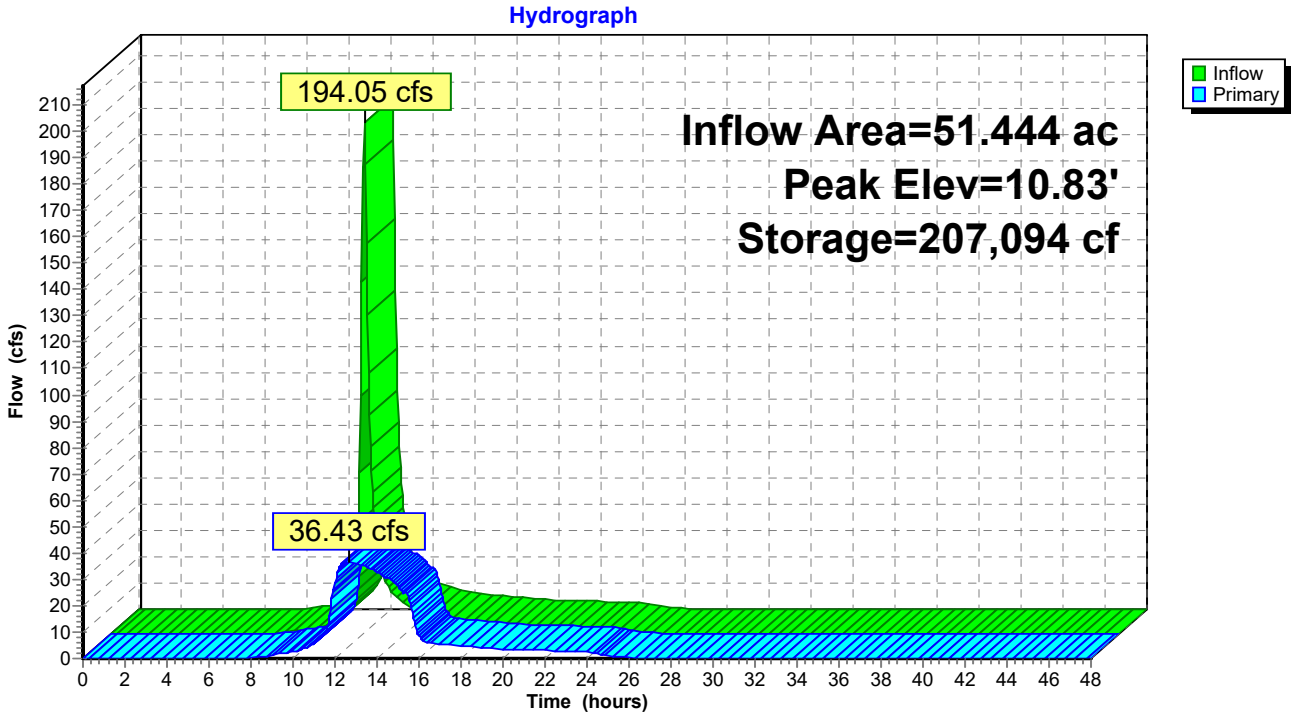
Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,236,409 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	25	25.0	0	0	25
8.00	10,947	460.0	3,832	3,832	16,816
9.00	49,342	1,391.0	27,843	31,675	153,953
10.00	97,395	1,948.0	72,020	103,695	301,963
11.00	168,546	2,477.0	131,355	235,050	488,253
12.00	261,632	2,967.0	213,390	448,440	700,548
13.00	390,402	3,366.0	323,877	772,317	901,654
14.00	541,914	3,757.0	464,092	1,236,409	1,123,314

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	**18.0" Round Culvert X 3.00** L= 195.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 7.00' / 6.00' S= 0.0051 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	12.50'	**100.0' long x 105.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=36.42 cfs @ 12.63 hrs HW=10.83' (Free Discharge)
1=Culvert (Barrel Controls 36.42 cfs @ 6.87 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 29P: Middle Outlet/Middle Emergency Spillway



Summary for Pond 30P: East Outlet/East Emergency Spillway

[62] Hint: Exceeded Reach 87R OUTLET depth by 1.50' @ 12.35 hrs
[62] Hint: Exceeded Reach 89R OUTLET depth by 1.45' @ 12.40 hrs
[62] Hint: Exceeded Reach 91R OUTLET depth by 1.34' @ 12.45 hrs
[62] Hint: Exceeded Reach 105R OUTLET depth by 1.40' @ 12.40 hrs

Inflow Area = 25.806 ac, 0.00% Impervious, Inflow Depth = 3.37" for 10-Year event
Inflow = 110.10 cfs @ 12.03 hrs, Volume= 7.250 af
Outflow = 30.77 cfs @ 12.34 hrs, Volume= 7.250 af, Atten= 72%, Lag= 18.7 min
Primary = 30.77 cfs @ 12.34 hrs, Volume= 7.250 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 12.59' @ 12.34 hrs Surf.Area= 81,118 sf Storage= 82,946 cf

Plug-Flow detention time= 20.0 min calculated for 7.242 af (100% of inflow)
Center-of-Mass det. time= 20.0 min (851.1 - 831.1)

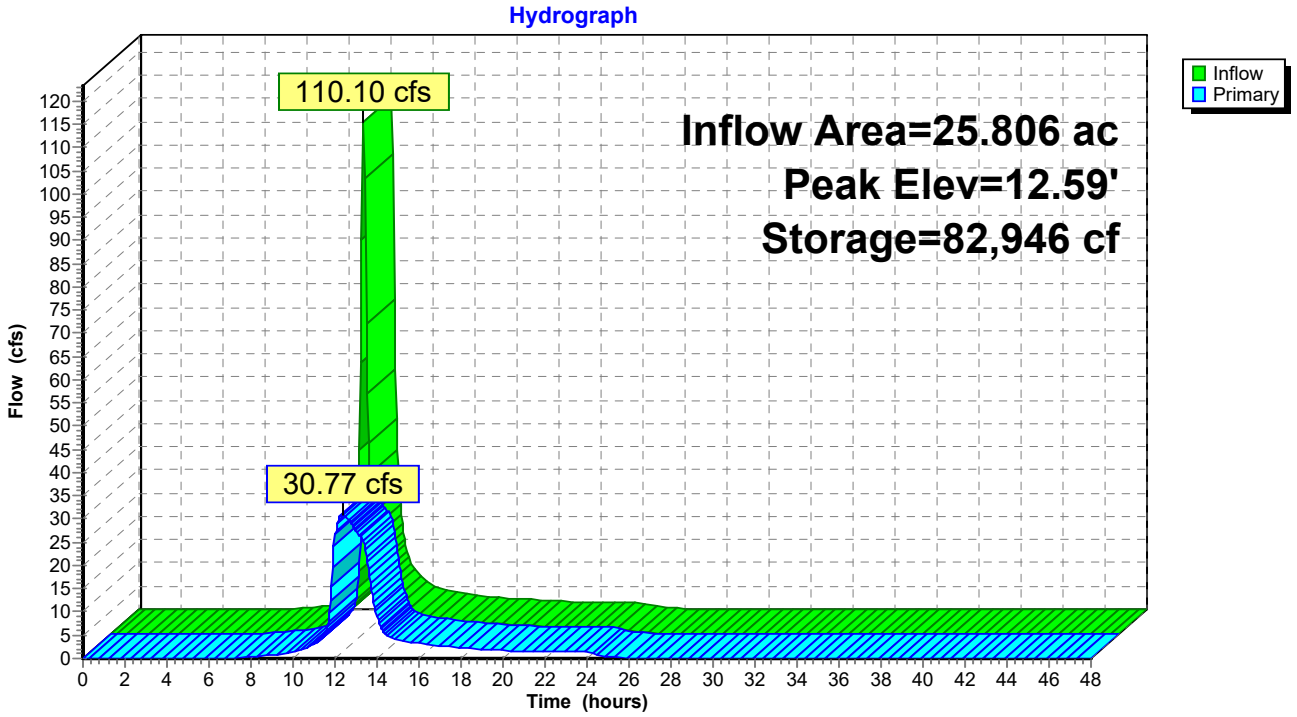
Volume	Invert	Avail.Storage	Storage Description
#1	10.00'	451,099 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
10.00	25	25.0	0	0	25
11.00	18,449	600.0	6,384	6,384	28,625
12.00	57,145	1,325.0	36,021	42,406	139,689
13.00	100,293	1,787.0	77,714	120,120	254,112
14.00	160,181	2,277.0	129,074	249,194	412,592
15.00	246,734	2,722.0	201,906	451,099	589,634

Device	Routing	Invert	Outlet Devices
#1	Primary	10.00'	**18.0" Round Culvert X 3.00** L= 160.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 10.00' / 9.00' S= 0.0063 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	14.00'	**100.0' long x 127.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=30.77 cfs @ 12.34 hrs HW=12.59' (Free Discharge)
1=Culvert (Barrel Controls 30.77 cfs @ 5.80 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 30P: East Outlet/East Emergency Spillway



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 72S: East Drainage Area 1 Runoff Area=2.239 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=16.61 cfs 0.837 af

Subcatchment 74S: Middle Drainage Area 1 Runoff Area=5.736 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=42.54 cfs 2.145 af

Subcatchment 76S: West Drainage Area 3 Runoff Area=14.150 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=104.95 cfs 5.291 af

Subcatchment 83S: Middle Drainage Area 2 Runoff Area=12.628 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=93.66 cfs 4.722 af

Subcatchment 85S: Middle Drainage Area 3 Runoff Area=19.614 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=145.47 cfs 7.335 af

Subcatchment 88S: East Drainage Area 2 Runoff Area=4.167 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=30.91 cfs 1.558 af

Subcatchment 90S: East Drainage Area 3 Runoff Area=10.335 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=76.65 cfs 3.865 af

Subcatchment 93S: West Drainage Area 2 Runoff Area=7.233 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=53.65 cfs 2.705 af

Subcatchment 94S: West Drainage Area 4 Runoff Area=11.630 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=86.26 cfs 4.349 af

Subcatchment 95S: West Drainage Area 1 Runoff Area=5.837 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=43.29 cfs 2.183 af

Subcatchment 96S: West Drainage Area 5 Runoff Area=7.290 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=54.07 cfs 2.726 af

Subcatchment 98S: Middle Drainage Area 4 Runoff Area=9.879 ac 0.00% Impervious Runoff Depth=4.49"
Tc=10.0 min CN=84 Runoff=65.09 cfs 3.694 af

Subcatchment 100S: Middle Drainage Area 5 Runoff Area=3.587 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=26.60 cfs 1.341 af

Subcatchment 104S: East Drainage Area 4 Runoff Area=9.065 ac 0.00% Impervious Runoff Depth=4.49"
Tc=6.0 min CN=84 Runoff=67.23 cfs 3.390 af

Reach 77R: West Channel 3 Avg. Flow Depth=0.68' Max Vel=1.85 fps Inflow=104.95 cfs 5.291 af
n=0.060 L=1,600.0' S=0.0100 '/' Capacity=149.49 cfs Outflow=66.50 cfs 5.291 af

Reach 82R: Middle Channel 1 Avg. Flow Depth=0.42' Max Vel=1.36 fps Inflow=42.54 cfs 2.145 af
n=0.060 L=975.0' S=0.0103 '/' Capacity=128.78 cfs Outflow=29.29 cfs 2.145 af

Reach 84R: Middle Channel 2 Avg. Flow Depth=0.71' Max Vel=1.89 fps Inflow=93.66 cfs 4.722 af
n=0.060 L=1,003.0' S=0.0100 '/' Capacity=149.26 cfs Outflow=71.50 cfs 4.722 af

Reach 86R: Middle Channel 3 Avg. Flow Depth=0.87' Max Vel=2.16 fps Inflow=145.47 cfs 7.335 af
n=0.060 L=1,500.0' S=0.0100 '/' Capacity=253.72 cfs Outflow=100.86 cfs 7.335 af

Reach 87R: East Channel 1 Avg. Flow Depth=0.25' Max Vel=1.06 fps Inflow=16.61 cfs 0.837 af
n=0.060 L=423.0' S=0.0118 '/' Capacity=138.25 cfs Outflow=13.83 cfs 0.837 af

Reach 89R: East Channel 2 Avg. Flow Depth=0.36' Max Vel=1.25 fps Inflow=30.91 cfs 1.558 af
n=0.060 L=673.0' S=0.0104 '/' Capacity=129.68 cfs Outflow=23.58 cfs 1.558 af

Reach 91R: East Channel 3 Avg. Flow Depth=0.61' Max Vel=1.72 fps Inflow=76.65 cfs 3.865 af
n=0.060 L=1,100.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=54.94 cfs 3.865 af

Reach 94R: West Channel 2 Avg. Flow Depth=0.50' Max Vel=1.51 fps Inflow=53.65 cfs 2.705 af
n=0.060 L=900.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=39.52 cfs 2.705 af

Reach 95R: West Channel 4 Avg. Flow Depth=0.66' Max Vel=1.81 fps Inflow=86.26 cfs 4.349 af
n=0.060 L=1,093.0' S=0.0101 '/' Capacity=127.57 cfs Outflow=63.14 cfs 4.349 af

Reach 96R: West Channel 1 Avg. Flow Depth=0.46' Max Vel=1.25 fps Inflow=43.29 cfs 2.183 af
n=0.060 L=910.0' S=0.0077 '/' Capacity=111.53 cfs Outflow=29.61 cfs 2.183 af

Reach 97R: West Channel 5 Avg. Flow Depth=0.48' Max Vel=1.57 fps Inflow=54.07 cfs 2.726 af
n=0.060 L=978.0' S=0.0112 '/' Capacity=134.86 cfs Outflow=39.15 cfs 2.726 af

Reach 99R: Middle Channel 4 Avg. Flow Depth=0.57' Max Vel=1.68 fps Inflow=65.09 cfs 3.694 af
n=0.060 L=960.0' S=0.0104 '/' Capacity=129.78 cfs Outflow=50.42 cfs 3.694 af

Reach 101R: Middle Channel 5 Avg. Flow Depth=0.32' Max Vel=1.16 fps Inflow=26.60 cfs 1.341 af
n=0.060 L=760.0' S=0.0105 '/' Capacity=130.46 cfs Outflow=18.96 cfs 1.341 af

Reach 105R: East Channel 4 Avg. Flow Depth=0.64' Max Vel=1.76 fps Inflow=67.23 cfs 3.390 af
n=0.060 L=516.0' S=0.0097 '/' Capacity=125.17 cfs Outflow=59.60 cfs 3.390 af

Pond 28P: West Outlet/West Emergency Peak Elev=10.09' Storage=269,369 cf Inflow=237.56 cfs 17.254 af
Outflow=37.19 cfs 17.254 af

Pond 29P: Middle Outlet/Middle Peak Elev=11.39' Storage=306,743 cf Inflow=267.95 cfs 19.238 af
Outflow=39.37 cfs 19.238 af

Pond 30P: East Outlet/East Emergency Peak Elev=13.05' Storage=125,081 cf Inflow=150.84 cfs 9.650 af
Outflow=33.99 cfs 9.650 af

Total Runoff Area = 123.390 ac Runoff Volume = 46.142 af Average Runoff Depth = 4.49"
100.00% Pervious = 123.390 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 72S: East Drainage Area 1

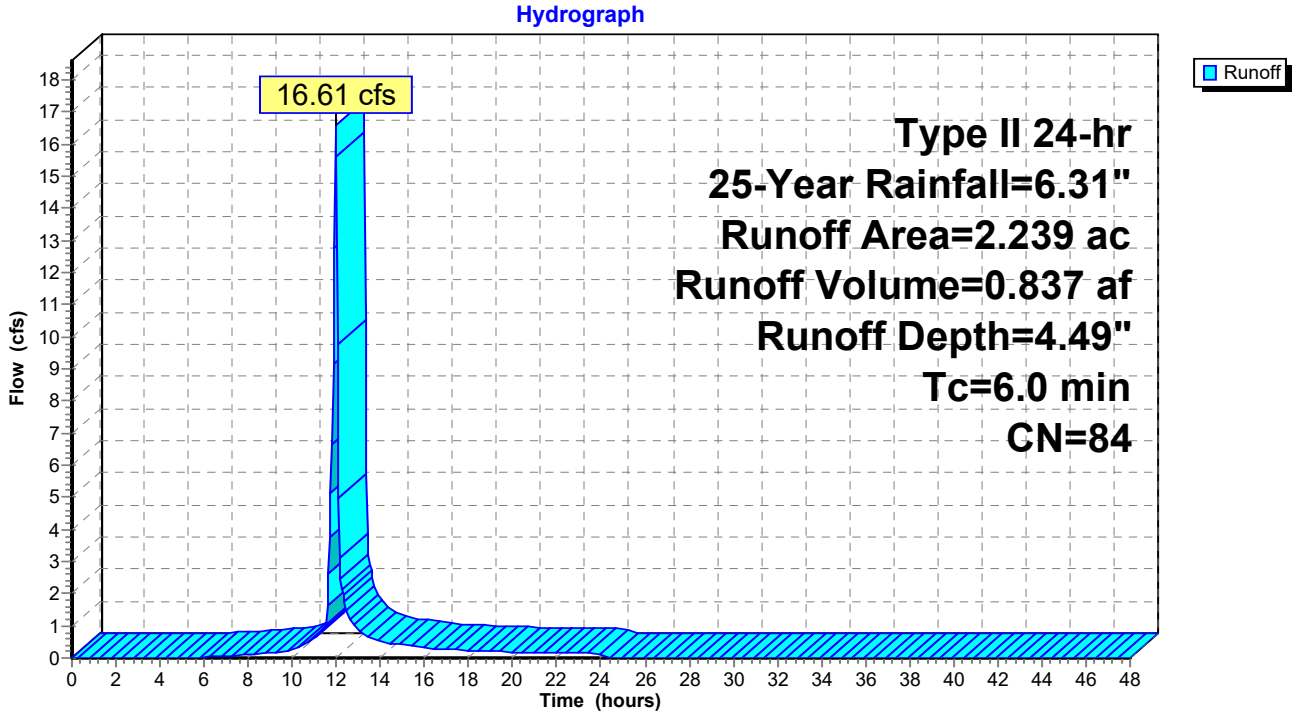
Runoff = 16.61 cfs @ 11.97 hrs, Volume= 0.837 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
2.239	84	50-75% Grass cover, Fair, HSG D
2.239		100.00% Pervious Area

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

Subcatchment 72S: East Drainage Area 1



Summary for Subcatchment 74S: Middle Drainage Area 1

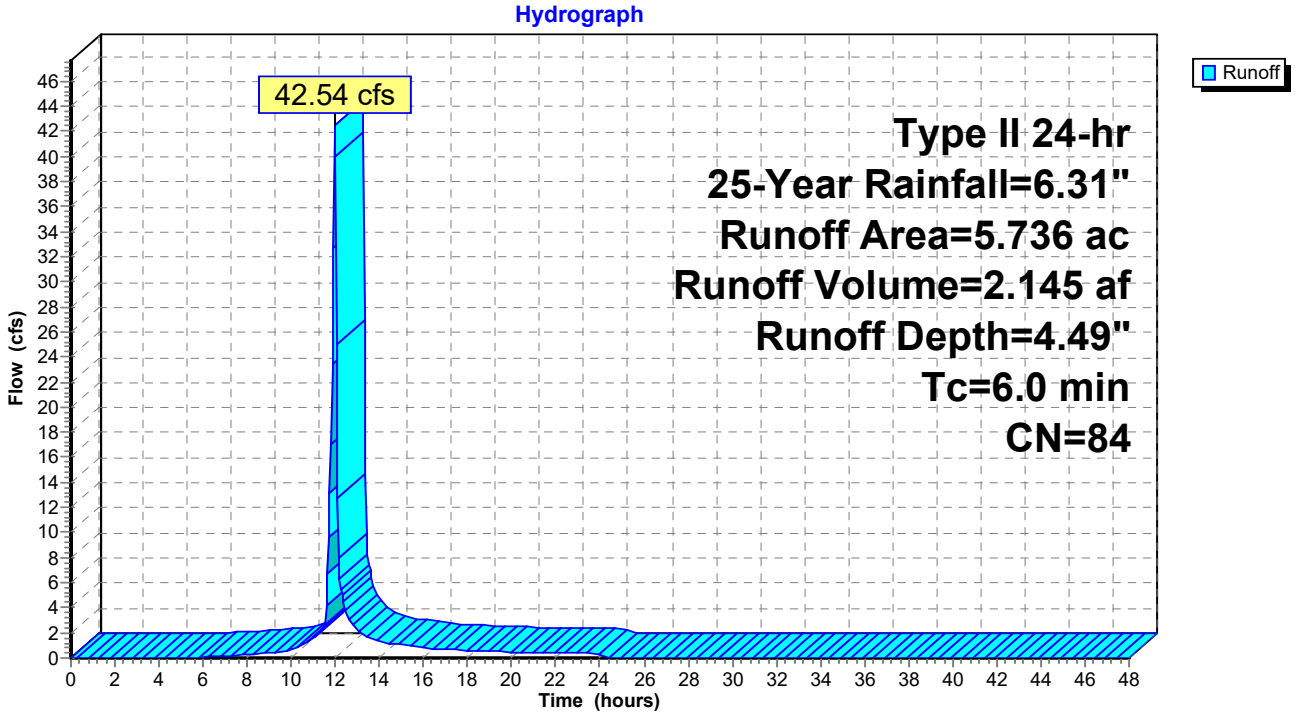
Runoff = 42.54 cfs @ 11.97 hrs, Volume= 2.145 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
5.736	84	50-75% Grass cover, Fair, HSG D
5.736		100.00% Pervious Area

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

Subcatchment 74S: Middle Drainage Area 1



Summary for Subcatchment 76S: West Drainage Area 3

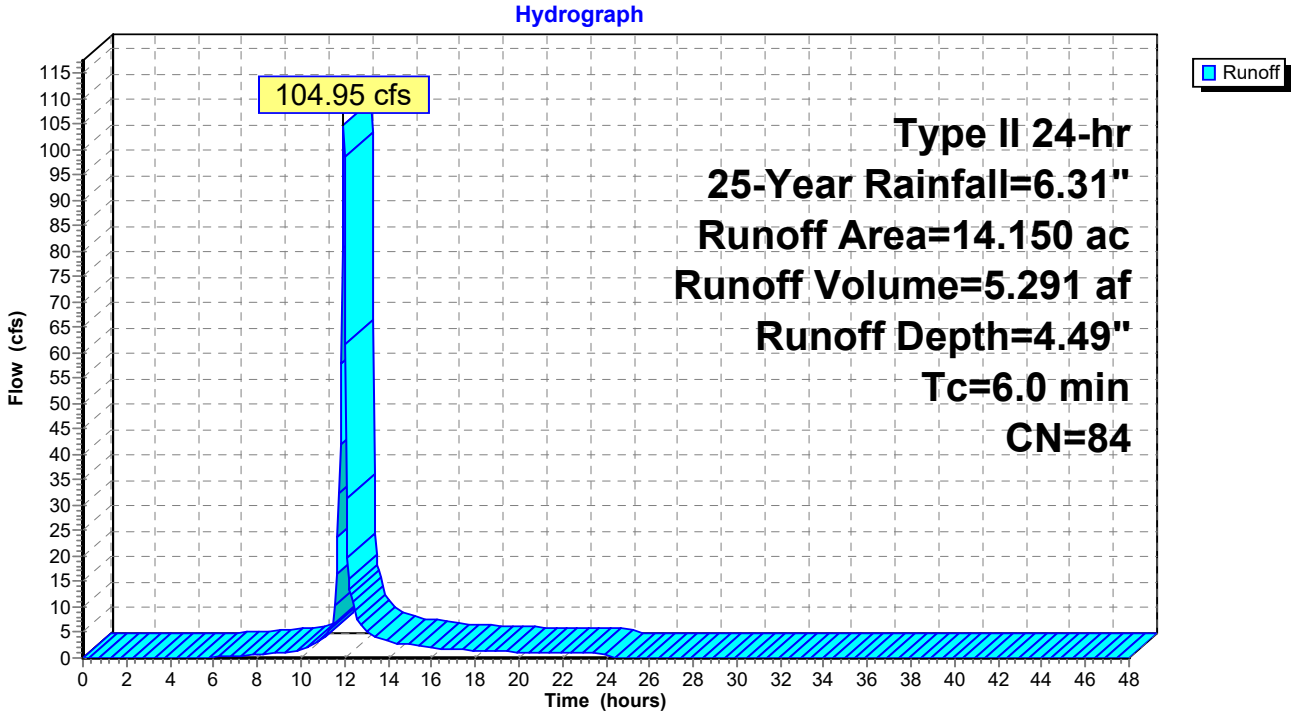
Runoff = 104.95 cfs @ 11.97 hrs, Volume= 5.291 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
14.150	84	50-75% Grass cover, Fair, HSG D
14.150		100.00% Pervious Area

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

Subcatchment 76S: West Drainage Area 3



Summary for Subcatchment 83S: Middle Drainage Area 2

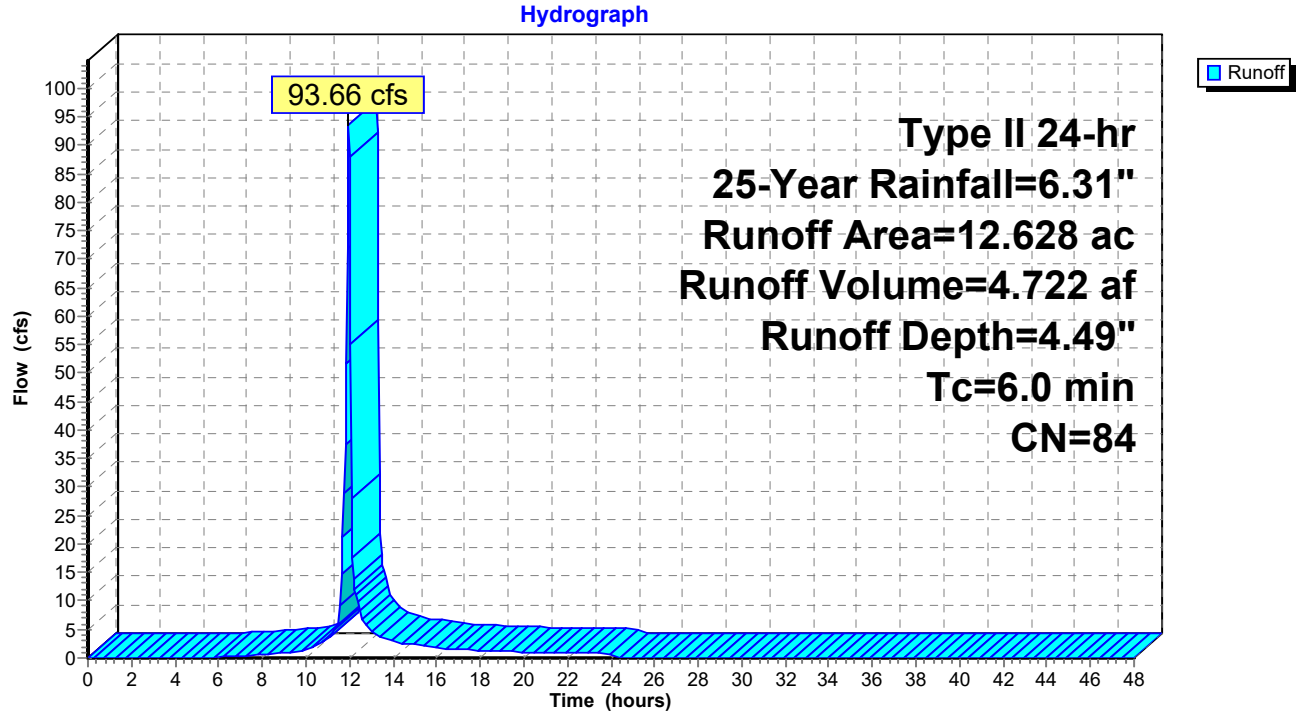
Runoff = 93.66 cfs @ 11.97 hrs, Volume= 4.722 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
12.628	84	50-75% Grass cover, Fair, HSG D
12.628		100.00% Pervious Area

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

Subcatchment 83S: Middle Drainage Area 2



Summary for Subcatchment 85S: Middle Drainage Area 3

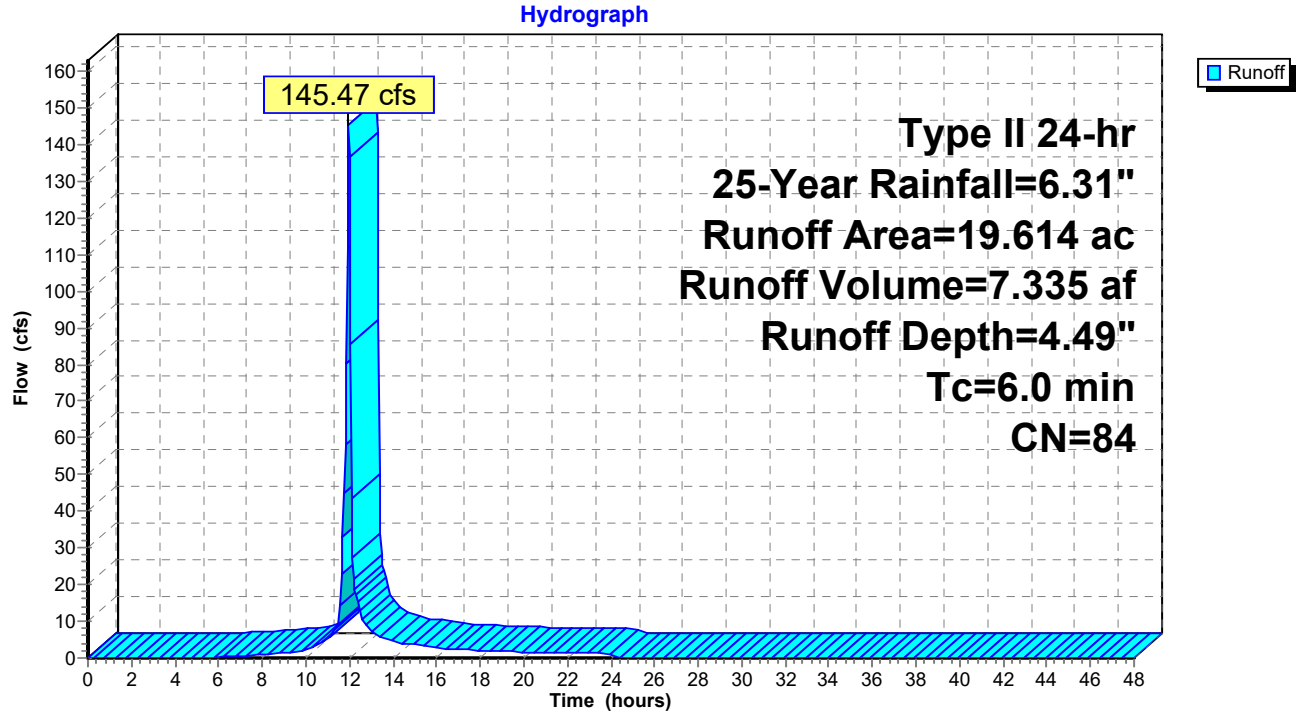
Runoff = 145.47 cfs @ 11.97 hrs, Volume= 7.335 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
19.614	84	50-75% Grass cover, Fair, HSG D
19.614		100.00% Pervious Area

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

Subcatchment 85S: Middle Drainage Area 3



Summary for Subcatchment 88S: East Drainage Area 2

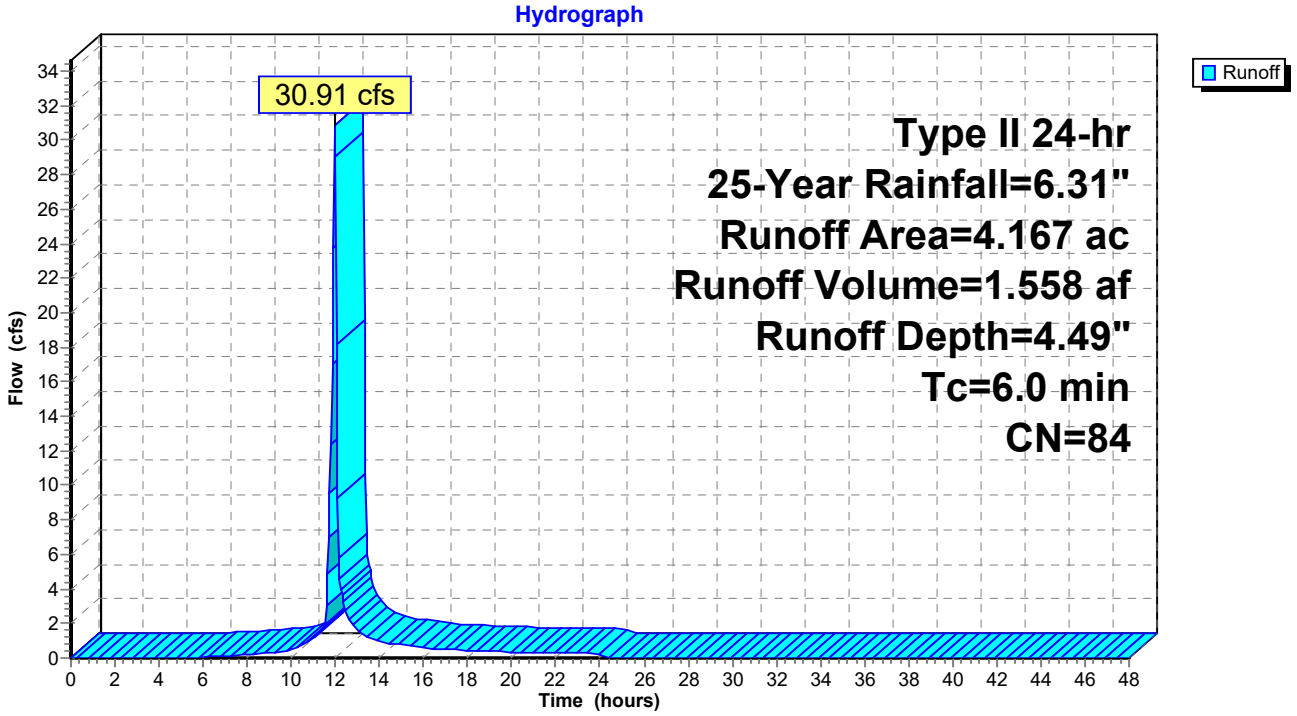
Runoff = 30.91 cfs @ 11.97 hrs, Volume= 1.558 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
4.167	84	50-75% Grass cover, Fair, HSG D
4.167		100.00% Pervious Area

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

Subcatchment 88S: East Drainage Area 2



Summary for Subcatchment 90S: East Drainage Area 3

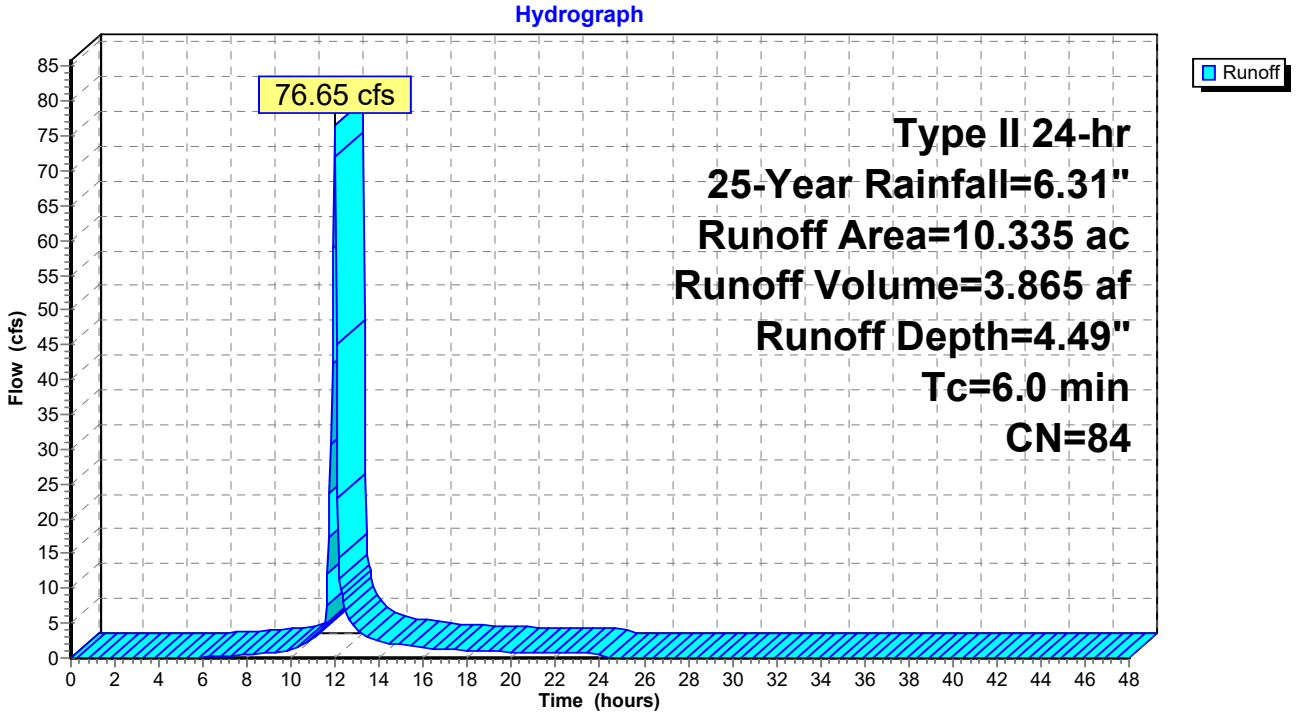
Runoff = 76.65 cfs @ 11.97 hrs, Volume= 3.865 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
10.335	84	50-75% Grass cover, Fair, HSG D
10.335		100.00% Pervious Area

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

Subcatchment 90S: East Drainage Area 3



Summary for Subcatchment 93S: West Drainage Area 2

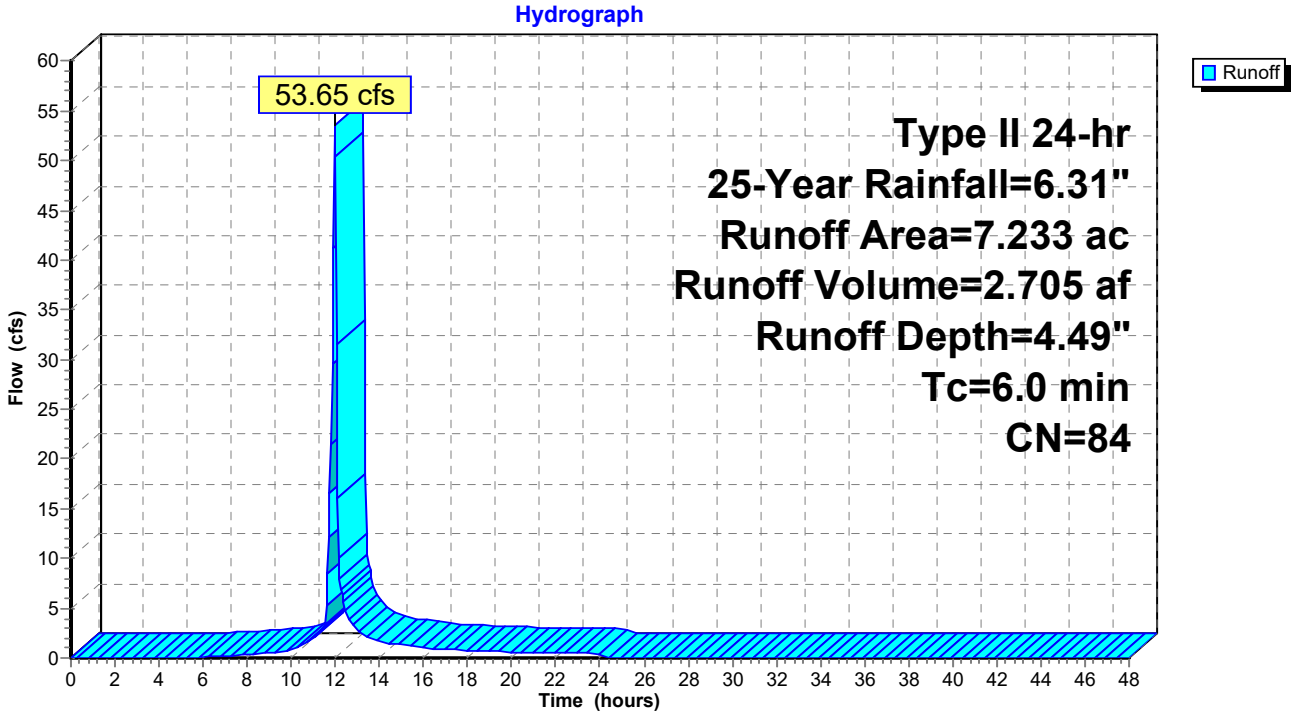
Runoff = 53.65 cfs @ 11.97 hrs, Volume= 2.705 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
7.233	84	50-75% Grass cover, Fair, HSG D
7.233		100.00% Pervious Area

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

Subcatchment 93S: West Drainage Area 2



Summary for Subcatchment 94S: West Drainage Area 4

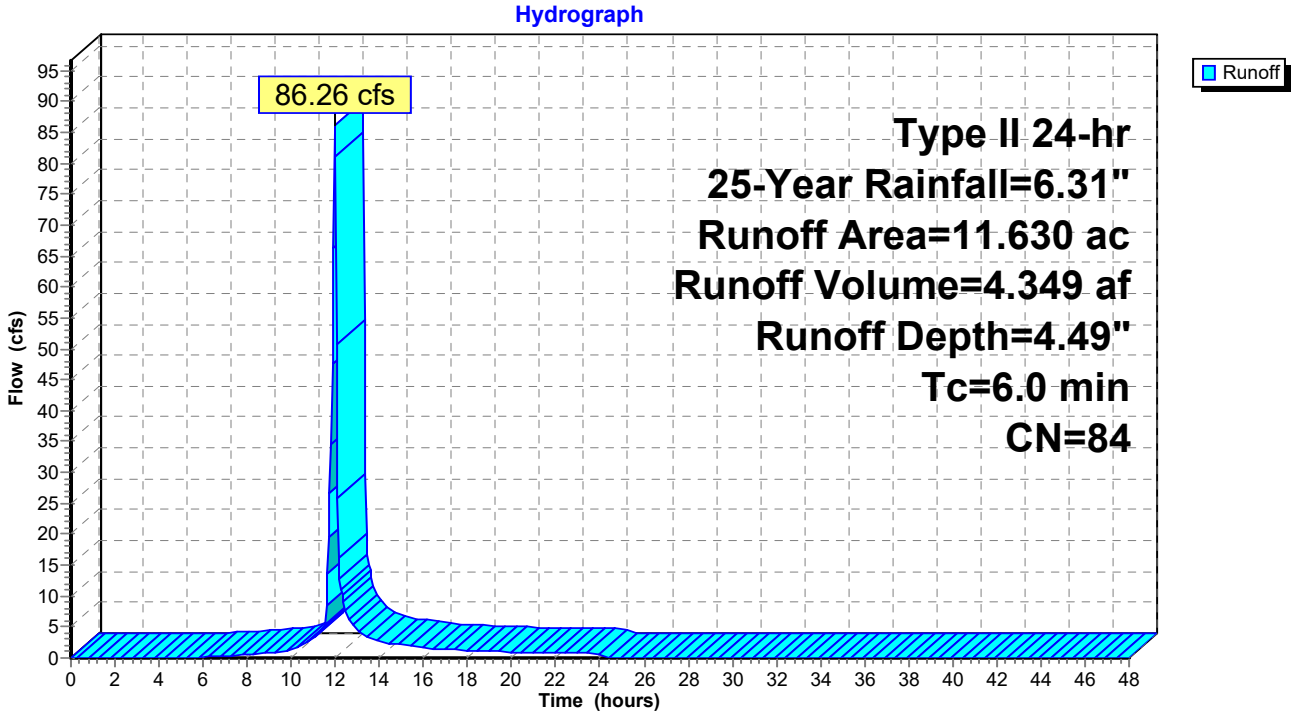
Runoff = 86.26 cfs @ 11.97 hrs, Volume= 4.349 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
11.630	84	50-75% Grass cover, Fair, HSG D
11.630		100.00% Pervious Area

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

Subcatchment 94S: West Drainage Area 4



Summary for Subcatchment 95S: West Drainage Area 1

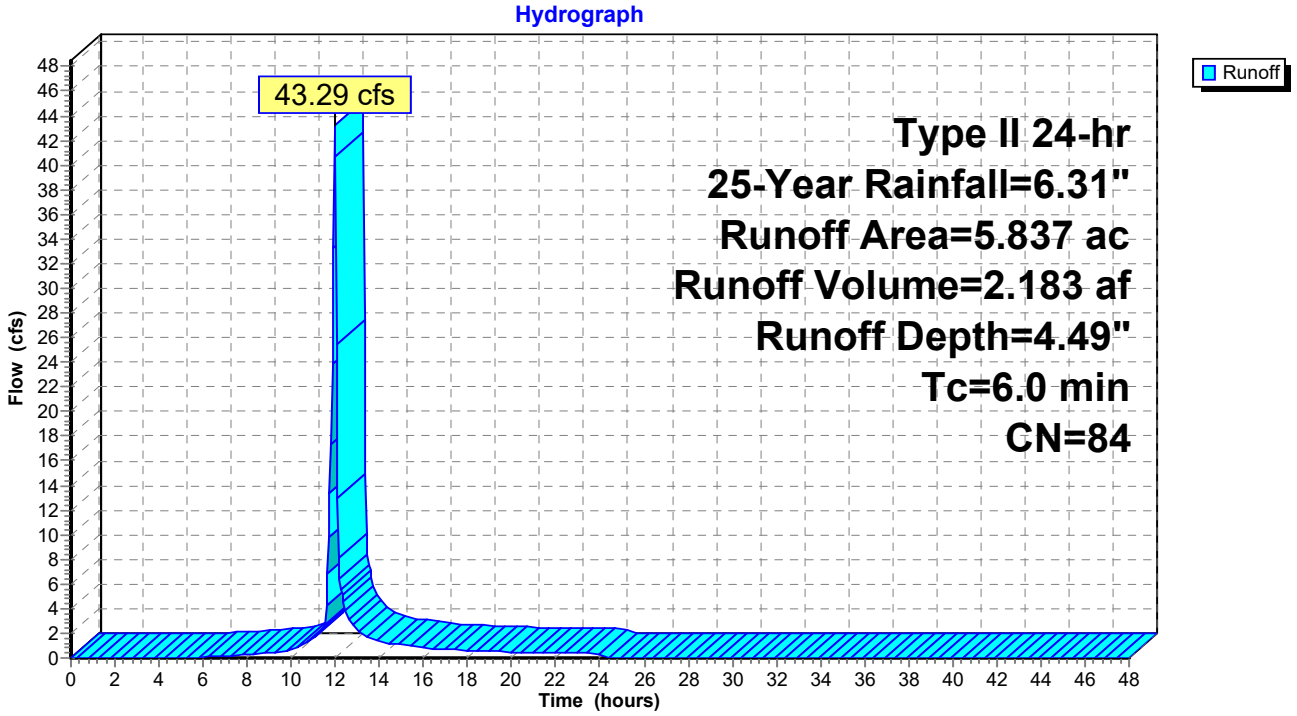
Runoff = 43.29 cfs @ 11.97 hrs, Volume= 2.183 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
5.837	84	50-75% Grass cover, Fair, HSG D
5.837		100.00% Pervious Area

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

Subcatchment 95S: West Drainage Area 1



Summary for Subcatchment 96S: West Drainage Area 5

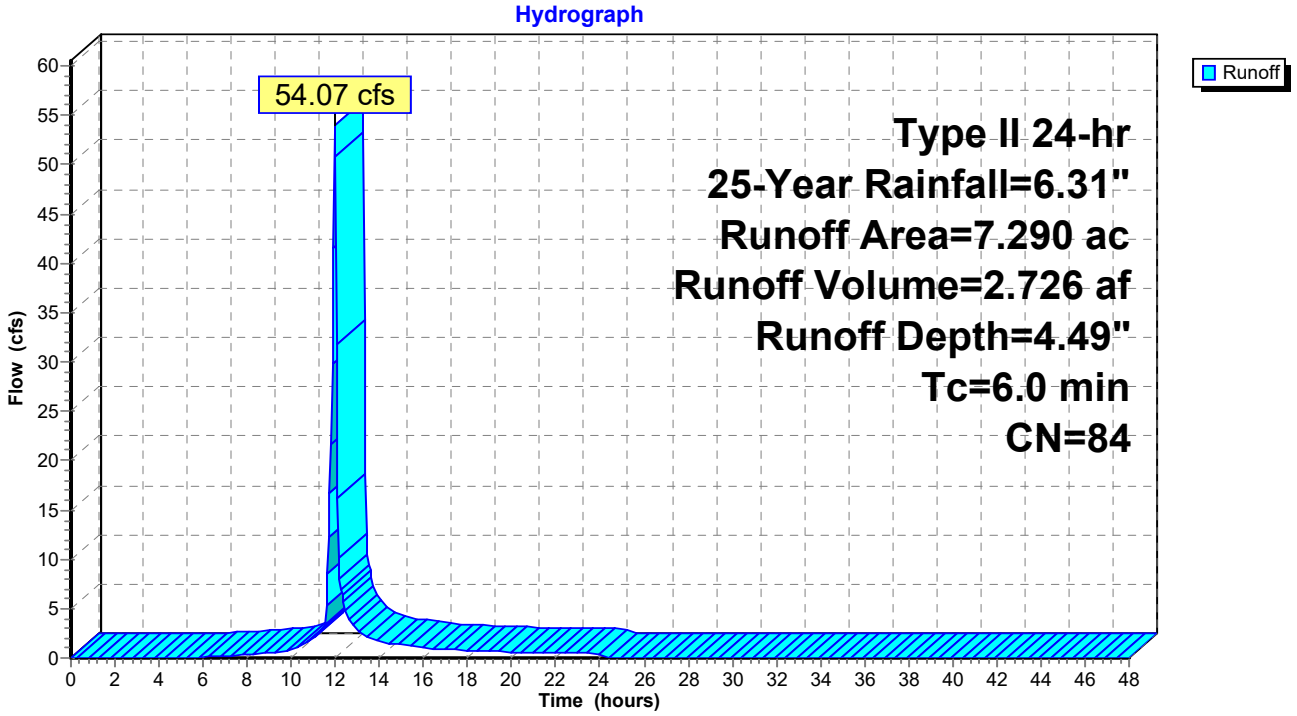
Runoff = 54.07 cfs @ 11.97 hrs, Volume= 2.726 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
7.290	84	50-75% Grass cover, Fair, HSG D
7.290		100.00% Pervious Area

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

Subcatchment 96S: West Drainage Area 5



Summary for Subcatchment 98S: Middle Drainage Area 4

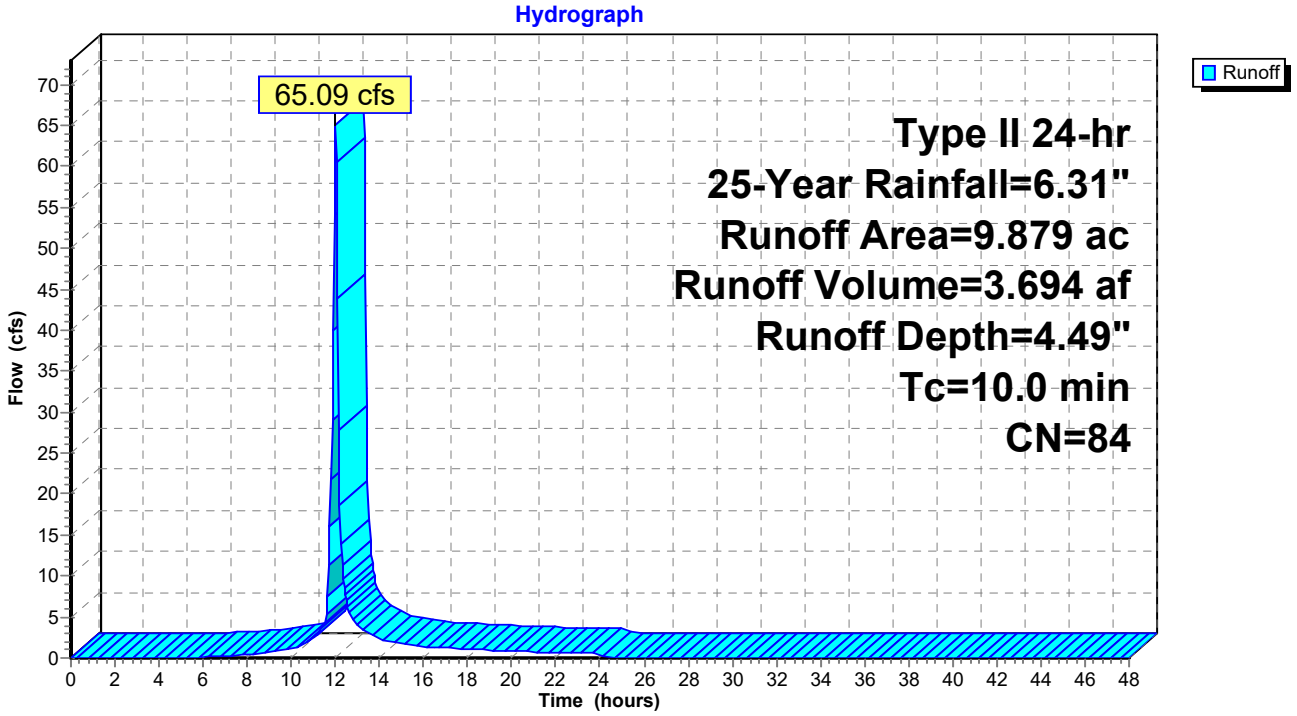
Runoff = 65.09 cfs @ 12.01 hrs, Volume= 3.694 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
9.879	84	50-75% Grass cover, Fair, HSG D
9.879		100.00% Pervious Area

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

Subcatchment 98S: Middle Drainage Area 4



Summary for Subcatchment 100S: Middle Drainage Area 5

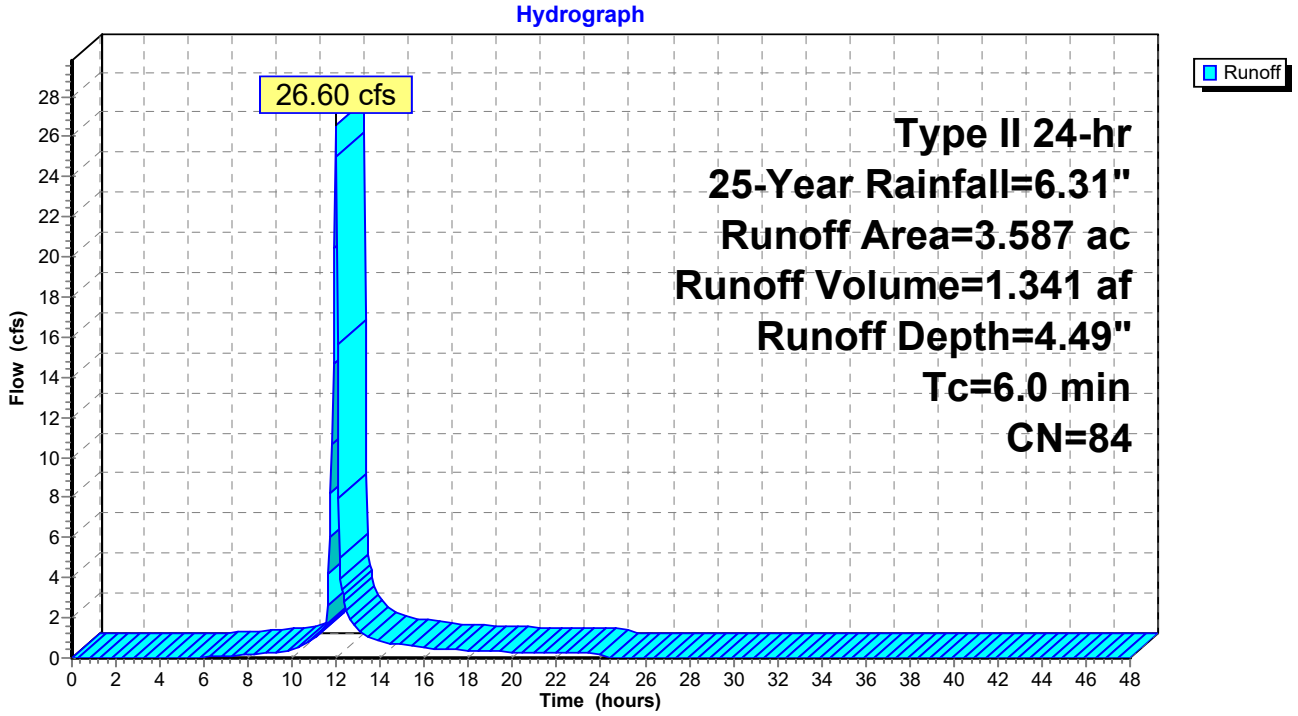
Runoff = 26.60 cfs @ 11.97 hrs, Volume= 1.341 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
3.587	84	50-75% Grass cover, Fair, HSG D
3.587		100.00% Pervious Area

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

Subcatchment 100S: Middle Drainage Area 5



Summary for Subcatchment 104S: East Drainage Area 4

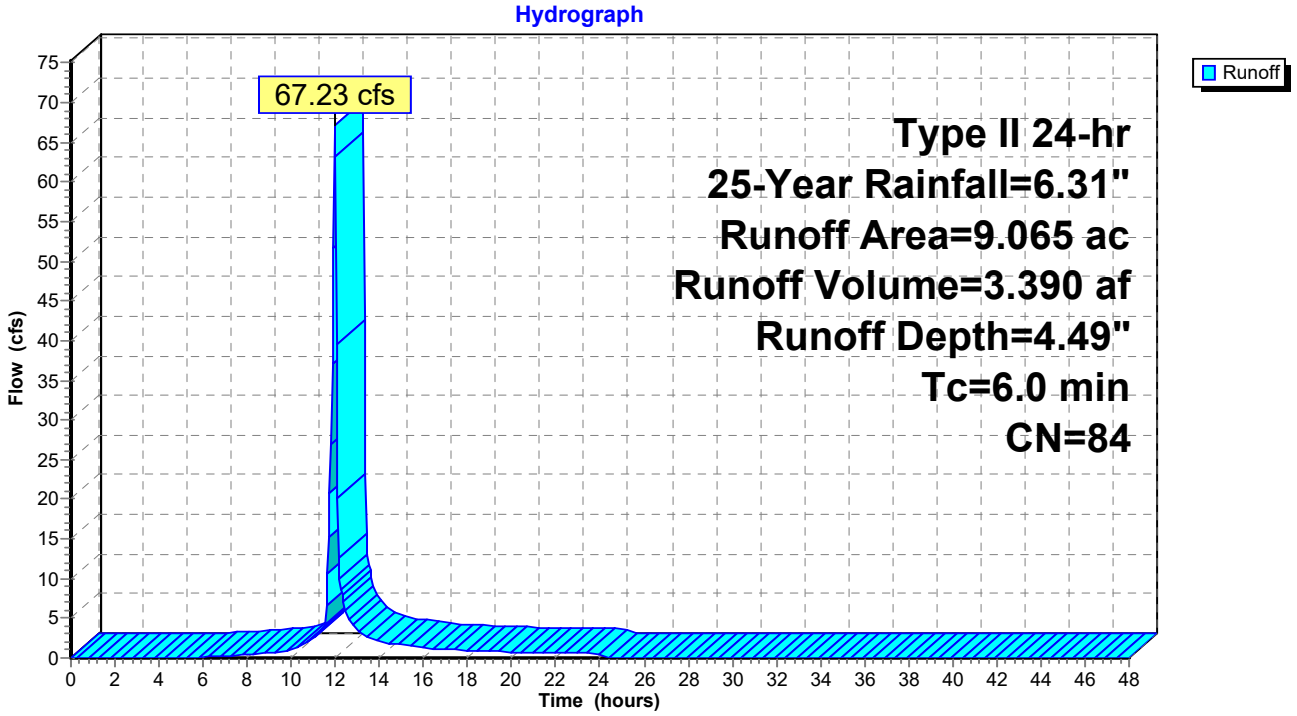
Runoff = 67.23 cfs @ 11.97 hrs, Volume= 3.390 af, Depth= 4.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=6.31"

Area (ac)	CN	Description
9.065	84	50-75% Grass cover, Fair, HSG D
9.065		100.00% Pervious Area

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

Subcatchment 104S: East Drainage Area 4



Summary for Reach 77R: West Channel 3

Inflow Area = 14.150 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 104.95 cfs @ 11.97 hrs, Volume= 5.291 af
Outflow = 66.50 cfs @ 12.05 hrs, Volume= 5.291 af, Atten= 37%, Lag= 5.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.85 fps, Min. Travel Time= 14.4 min
Avg. Velocity = 0.27 fps, Avg. Travel Time= 97.2 min

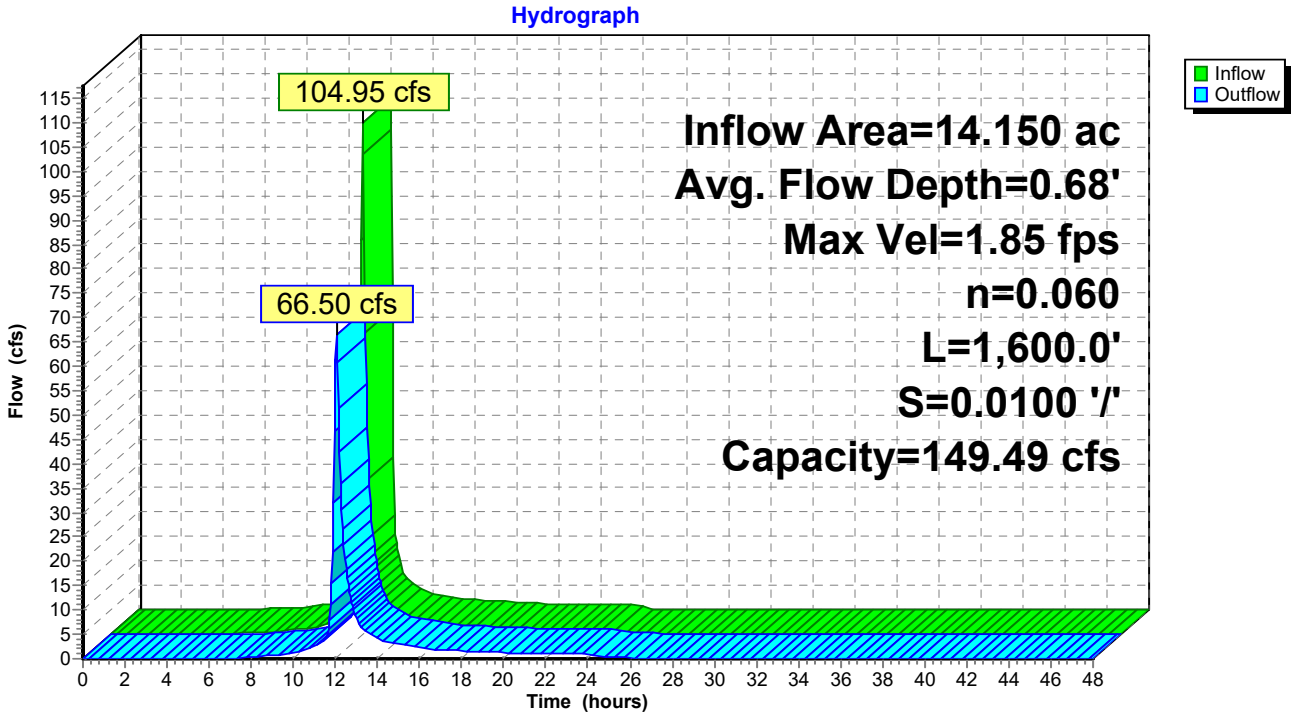
Peak Storage= 57,491 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.68'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.49 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,600.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 7.00'



‡

Reach 77R: West Channel 3



Summary for Reach 82R: Middle Channel 1

Inflow Area = 5.736 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 42.54 cfs @ 11.97 hrs, Volume= 2.145 af
Outflow = 29.29 cfs @ 12.04 hrs, Volume= 2.145 af, Atten= 31%, Lag= 4.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.36 fps, Min. Travel Time= 11.9 min
Avg. Velocity = 0.21 fps, Avg. Travel Time= 75.8 min

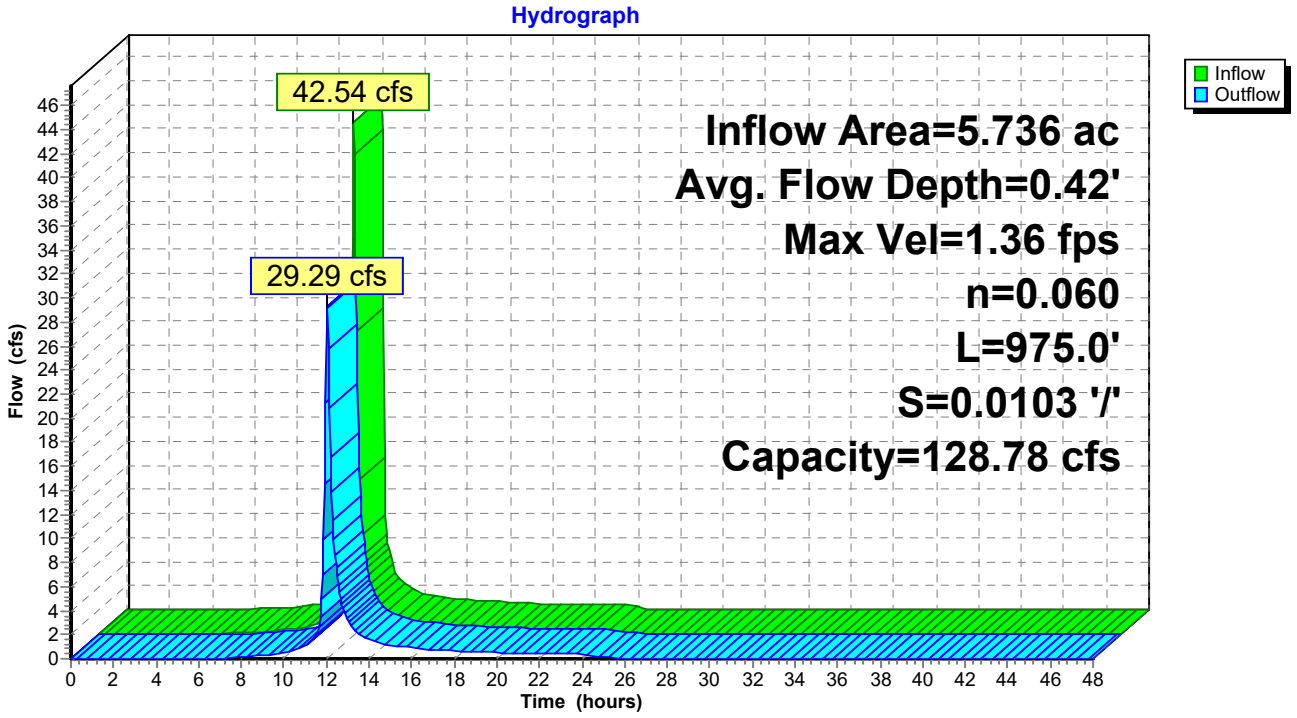
Peak Storage= 20,917 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 128.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 975.0' Slope= 0.0103 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 82R: Middle Channel 1



Summary for Reach 84R: Middle Channel 2

Inflow Area = 12.628 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 93.66 cfs @ 11.97 hrs, Volume= 4.722 af
Outflow = 71.50 cfs @ 12.03 hrs, Volume= 4.722 af, Atten= 24%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.89 fps, Min. Travel Time= 8.9 min
Avg. Velocity = 0.27 fps, Avg. Travel Time= 61.8 min

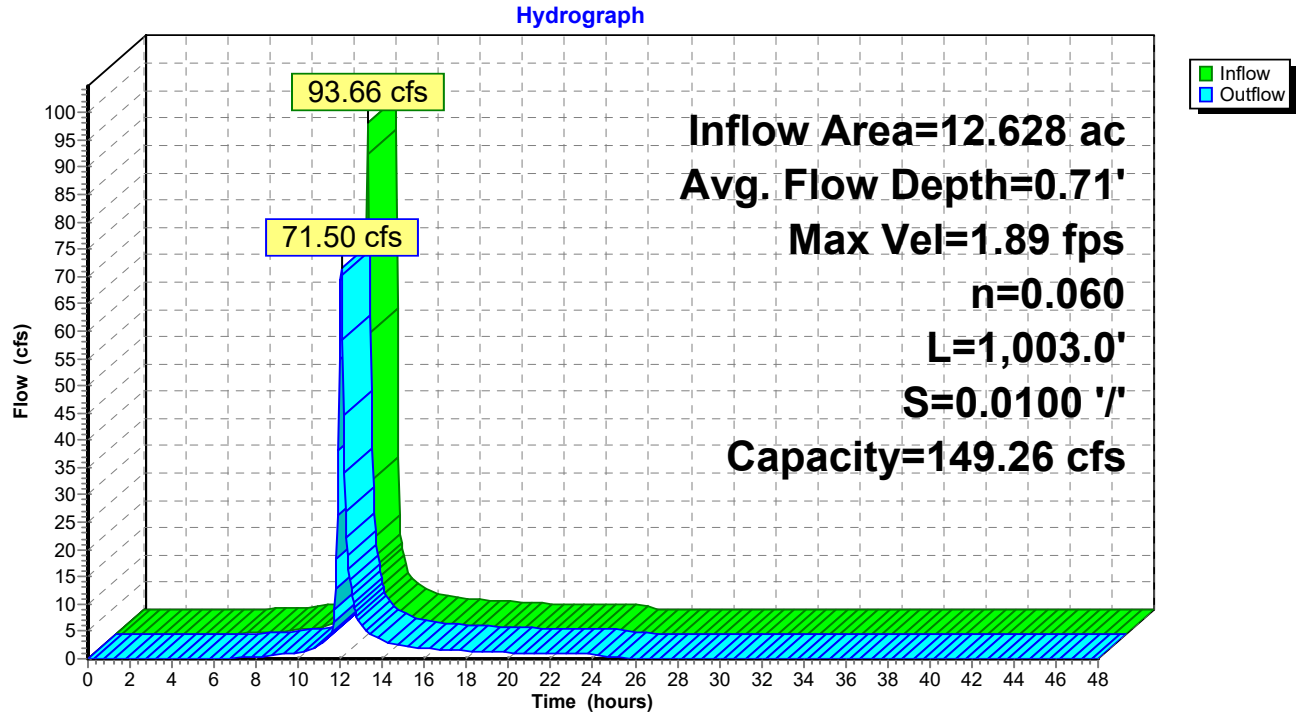
Peak Storage= 37,761 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.26 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,003.0' Slope= 0.0100 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 84R: Middle Channel 2



Summary for Reach 86R: Middle Channel 3

Changed depth to 0.6 feet to meet 100-year storm

Inflow Area = 19.614 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 145.47 cfs @ 11.97 hrs, Volume= 7.335 af
Outflow = 100.86 cfs @ 12.04 hrs, Volume= 7.335 af, Atten= 31%, Lag= 4.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.16 fps, Min. Travel Time= 11.6 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 78.9 min

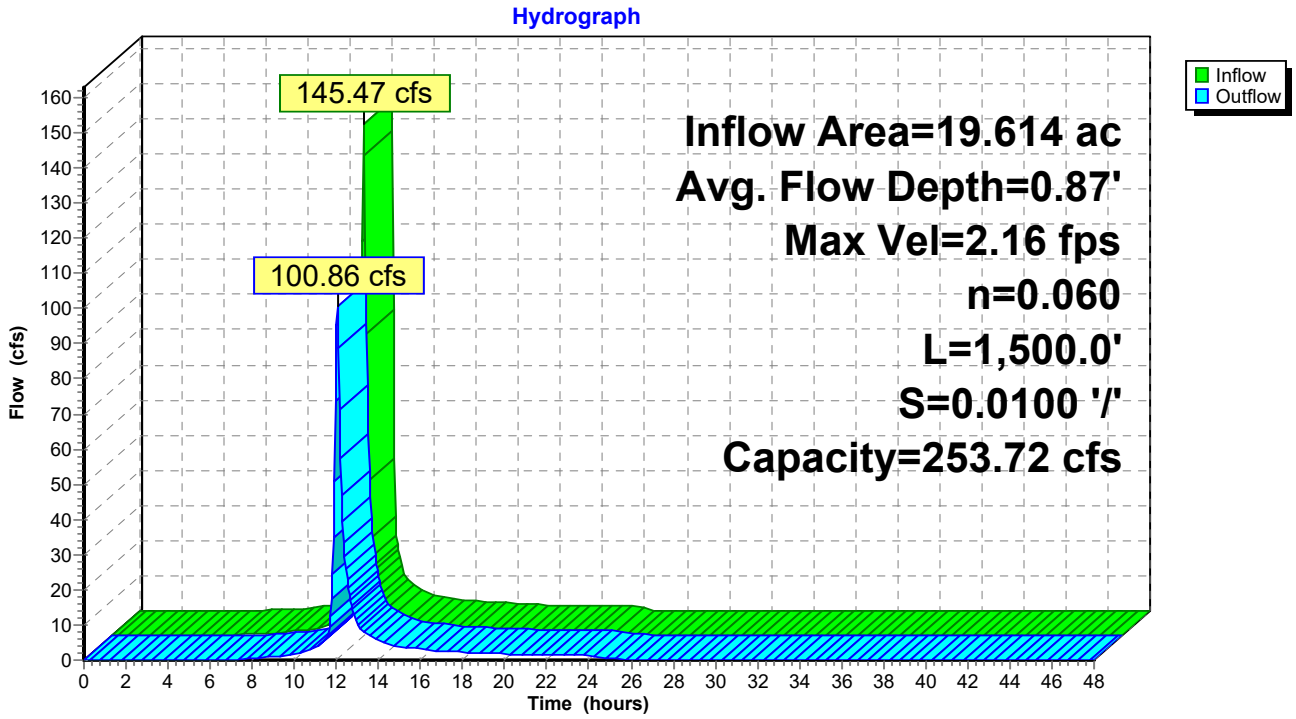
Peak Storage= 69,982 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.87'
Bank-Full Depth= 1.50' Flow Area= 84.0 sf, Capacity= 253.72 cfs

50.00' x 1.50' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 62.00'
Length= 1,500.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 8.00'



‡

Reach 86R: Middle Channel 3



Summary for Reach 87R: East Channel 1

Inflow Area = 2.239 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 16.61 cfs @ 11.97 hrs, Volume= 0.837 af
Outflow = 13.83 cfs @ 12.02 hrs, Volume= 0.837 af, Atten= 17%, Lag= 3.0 min

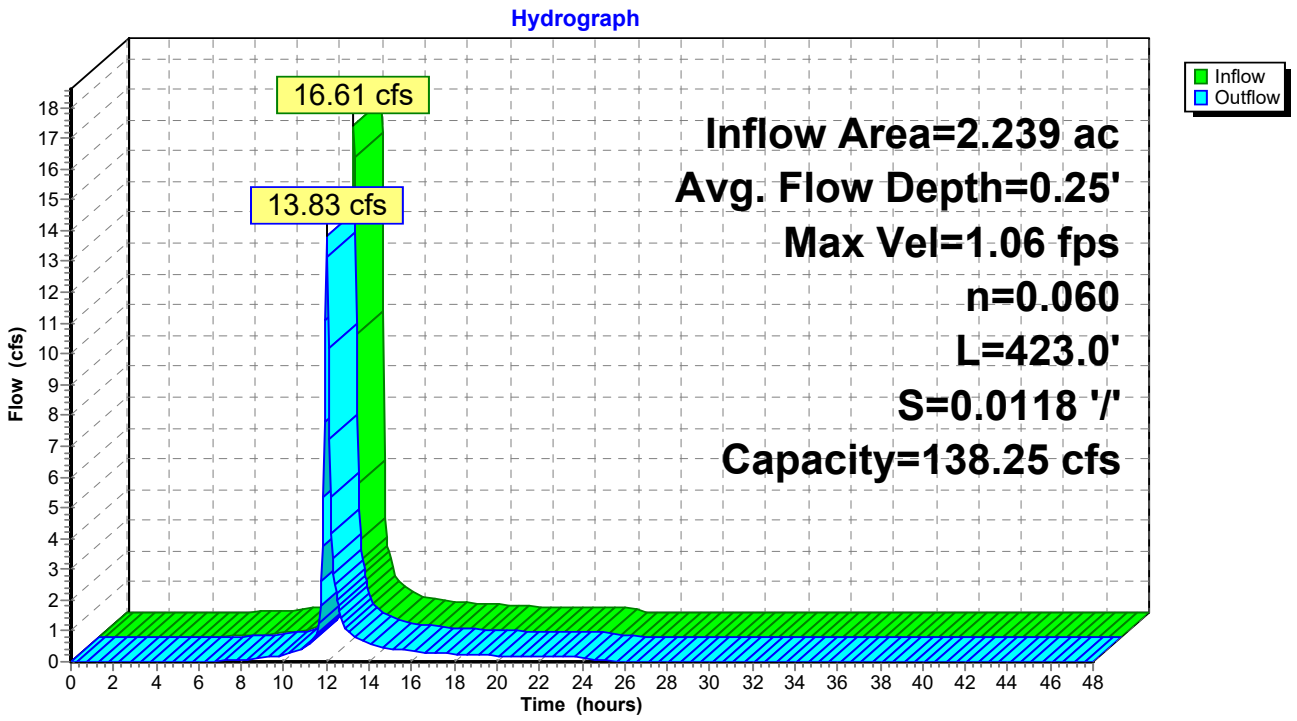
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.06 fps, Min. Travel Time= 6.6 min
Avg. Velocity = 0.20 fps, Avg. Travel Time= 34.8 min

Peak Storage= 5,490 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 138.25 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 423.0' Slope= 0.0118 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡



Summary for Reach 89R: East Channel 2

Inflow Area = 4.167 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 30.91 cfs @ 11.97 hrs, Volume= 1.558 af
Outflow = 23.58 cfs @ 12.03 hrs, Volume= 1.558 af, Atten= 24%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.25 fps, Min. Travel Time= 9.0 min
Avg. Velocity = 0.21 fps, Avg. Travel Time= 52.4 min

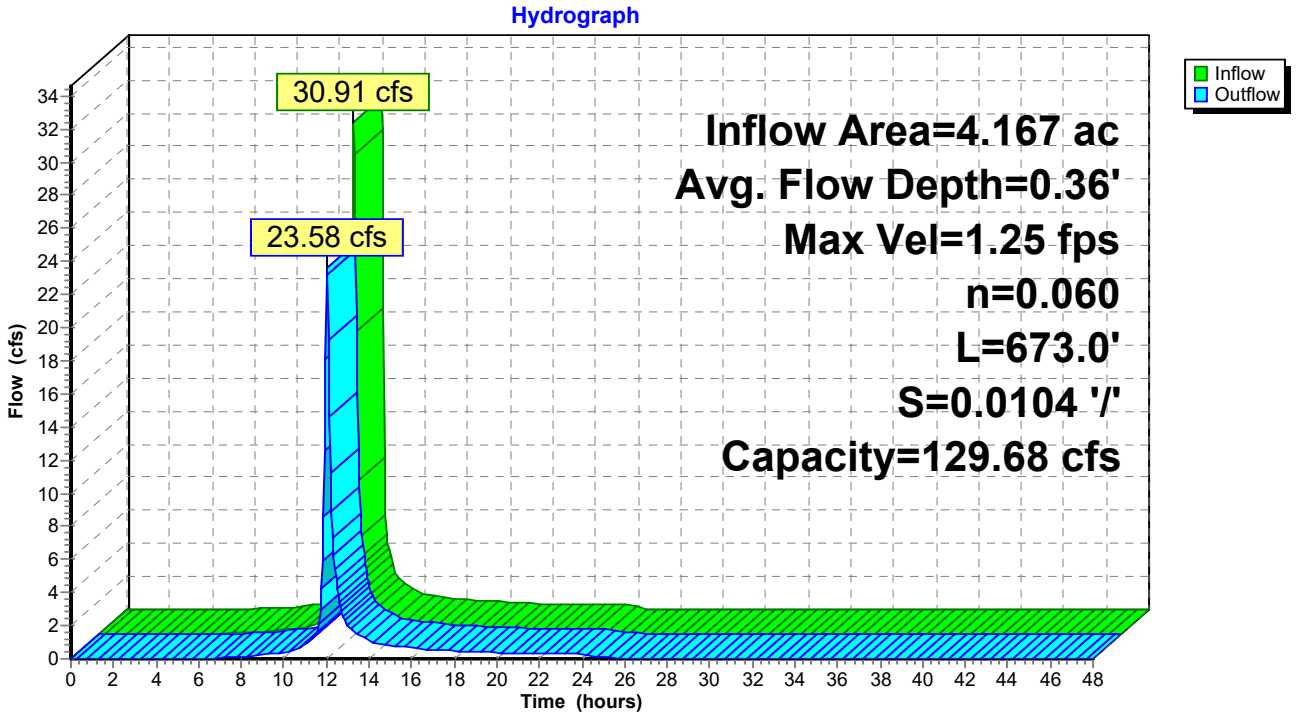
Peak Storage= 12,591 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.68 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 673.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 11.00'



‡

Reach 89R: East Channel 2



Summary for Reach 91R: East Channel 3

Inflow Area = 10.335 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 76.65 cfs @ 11.97 hrs, Volume= 3.865 af
Outflow = 54.94 cfs @ 12.04 hrs, Volume= 3.865 af, Atten= 28%, Lag= 4.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.72 fps, Min. Travel Time= 10.7 min
Avg. Velocity = 0.24 fps, Avg. Travel Time= 74.9 min

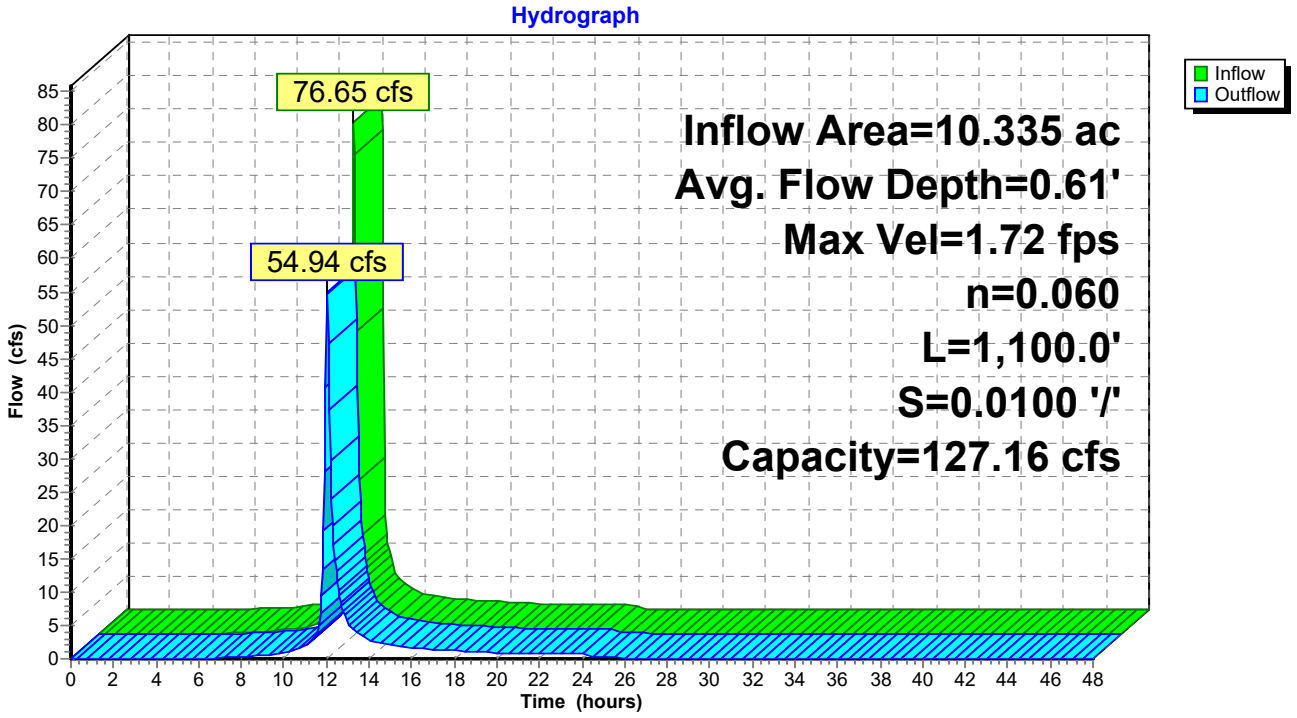
Peak Storage= 35,098 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,100.0' Slope= 0.0100 '/'
Inlet Invert= 22.00', Outlet Invert= 11.00'



‡

Reach 91R: East Channel 3



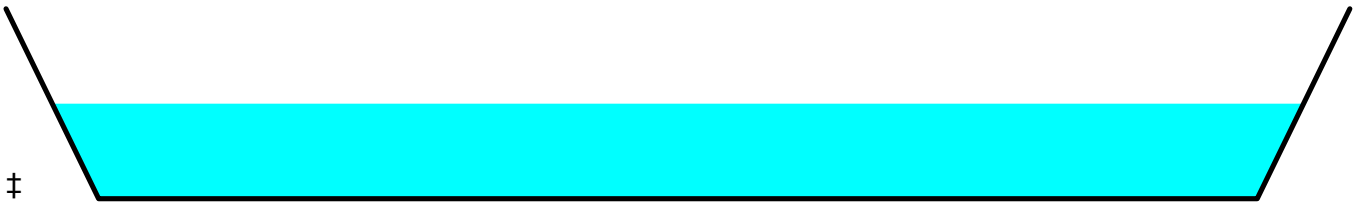
Summary for Reach 94R: West Channel 2

Inflow Area = 7.233 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 53.65 cfs @ 11.97 hrs, Volume= 2.705 af
Outflow = 39.52 cfs @ 12.03 hrs, Volume= 2.705 af, Atten= 26%, Lag= 4.0 min

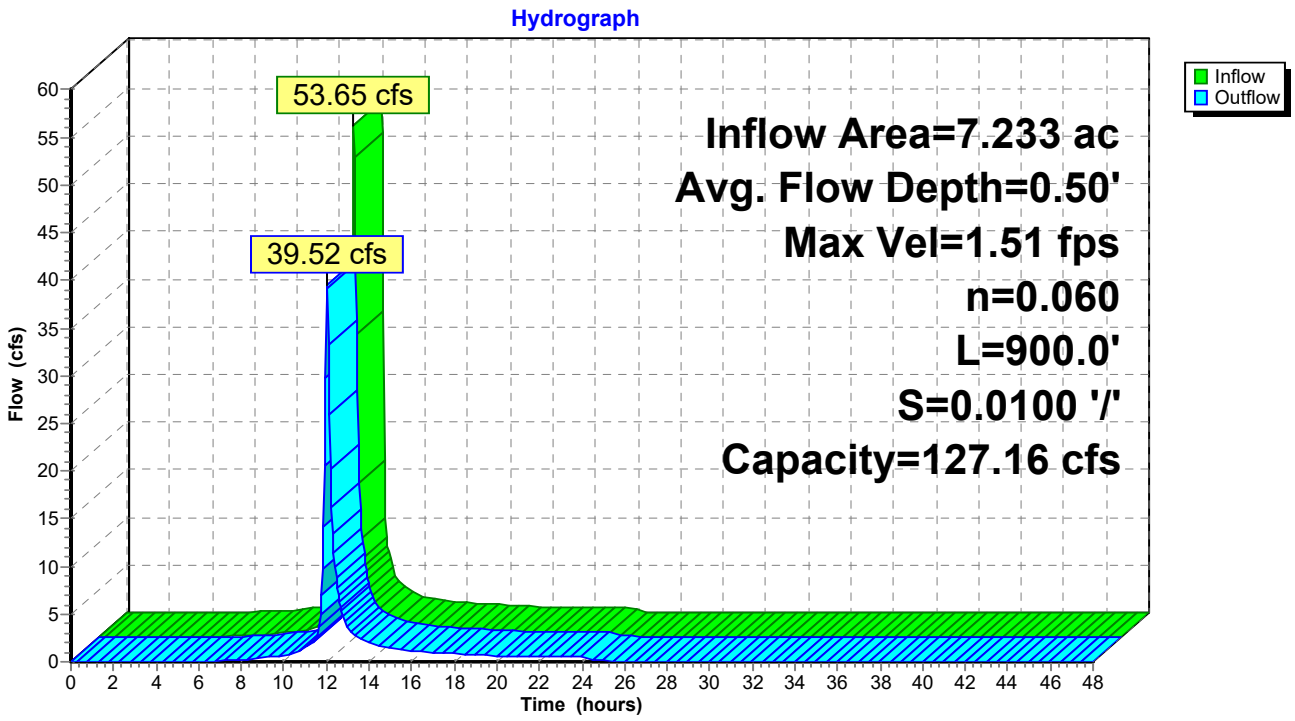
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.51 fps, Min. Travel Time= 9.9 min
Avg. Velocity = 0.23 fps, Avg. Travel Time= 65.1 min

Peak Storage= 23,415 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.50'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 900.0' Slope= 0.0100 '/'
Inlet Invert= 16.00', Outlet Invert= 7.00'



‡



Summary for Reach 95R: West Channel 4

Inflow Area = 11.630 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 86.26 cfs @ 11.97 hrs, Volume= 4.349 af
Outflow = 63.14 cfs @ 12.03 hrs, Volume= 4.349 af, Atten= 27%, Lag= 4.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.81 fps, Min. Travel Time= 10.1 min
Avg. Velocity = 0.25 fps, Avg. Travel Time= 71.8 min

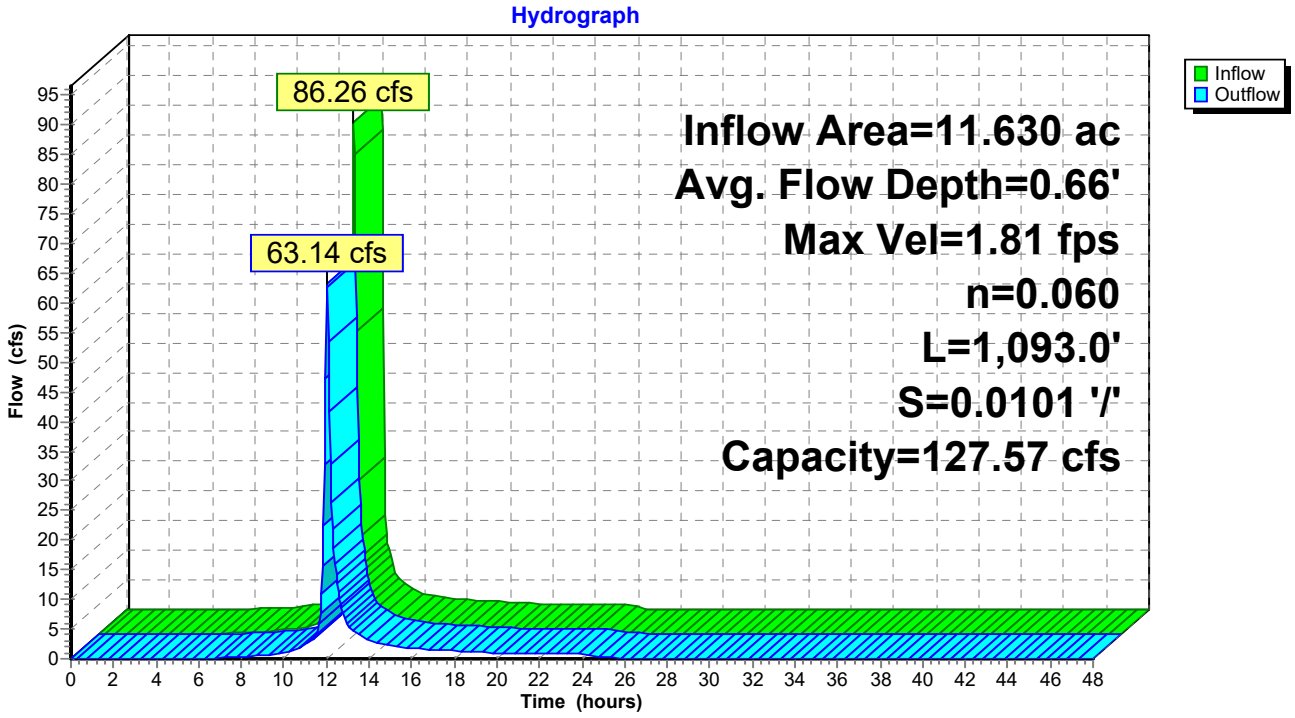
Peak Storage= 37,957 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.57 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,093.0' Slope= 0.0101 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 95R: West Channel 4



Summary for Reach 96R: West Channel 1

Inflow Area = 5.837 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 43.29 cfs @ 11.97 hrs, Volume= 2.183 af
Outflow = 29.61 cfs @ 12.04 hrs, Volume= 2.183 af, Atten= 32%, Lag= 4.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.25 fps, Min. Travel Time= 12.1 min
Avg. Velocity = 0.19 fps, Avg. Travel Time= 79.6 min

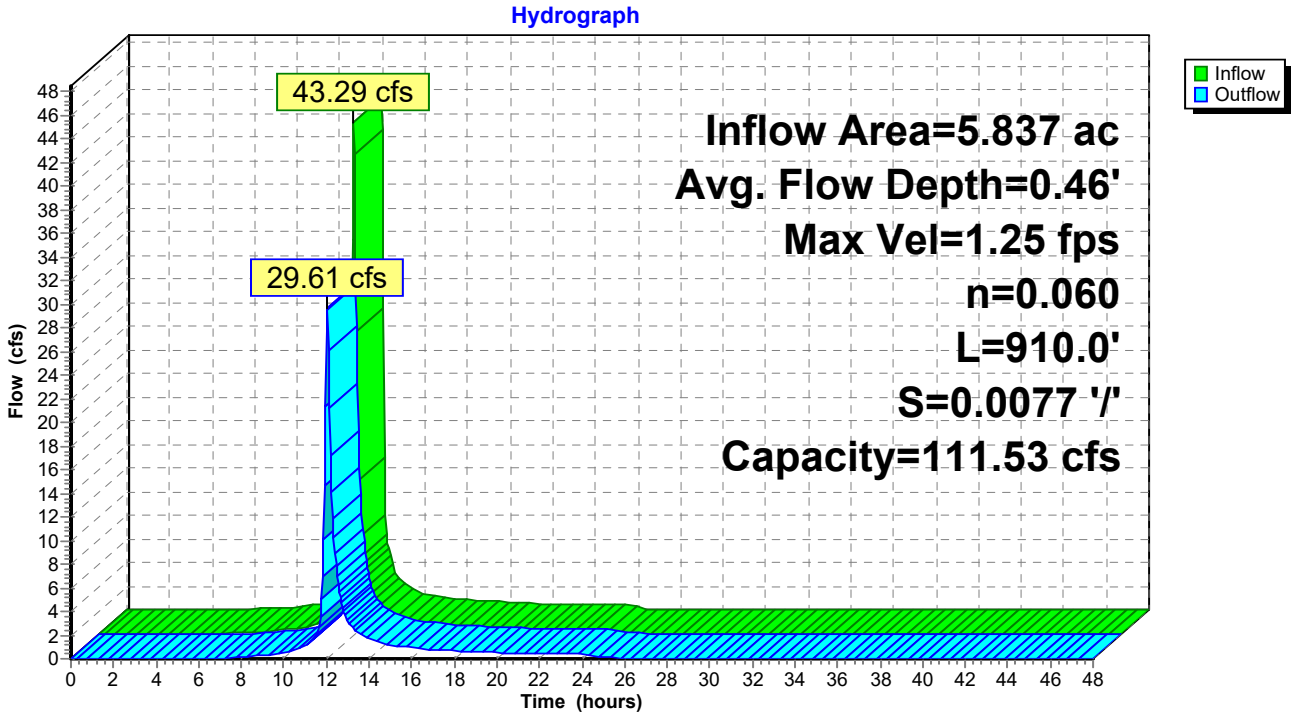
Peak Storage= 21,476 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 111.53 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 910.0' Slope= 0.0077 '/'
Inlet Invert= 14.00', Outlet Invert= 7.00'



‡

Reach 96R: West Channel 1



Summary for Reach 97R: West Channel 5

Inflow Area = 7.290 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 54.07 cfs @ 11.97 hrs, Volume= 2.726 af
Outflow = 39.15 cfs @ 12.04 hrs, Volume= 2.726 af, Atten= 28%, Lag= 4.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.57 fps, Min. Travel Time= 10.4 min
Avg. Velocity = 0.24 fps, Avg. Travel Time= 68.1 min

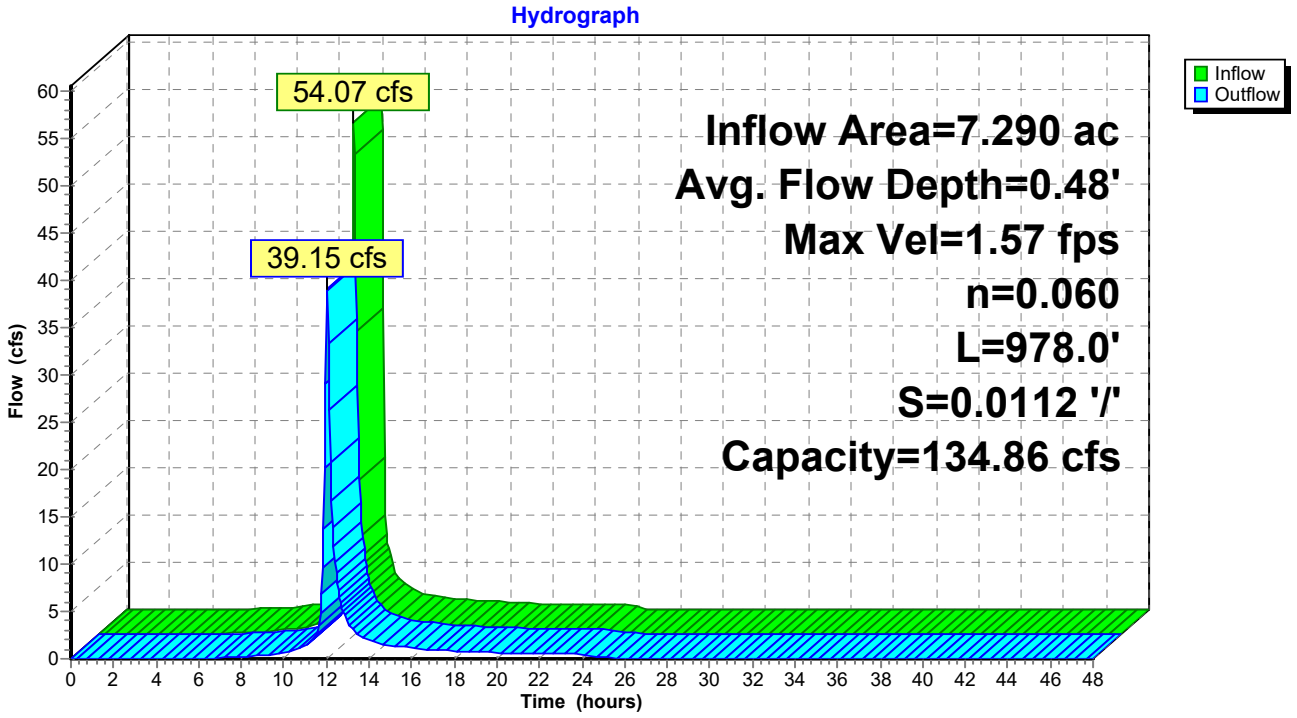
Peak Storage= 24,391 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 134.86 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 978.0' Slope= 0.0112 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 97R: West Channel 5



Summary for Reach 99R: Middle Channel 4

Inflow Area = 9.879 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 65.09 cfs @ 12.01 hrs, Volume= 3.694 af
Outflow = 50.42 cfs @ 12.08 hrs, Volume= 3.694 af, Atten= 23%, Lag= 4.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.68 fps, Min. Travel Time= 9.5 min
Avg. Velocity = 0.25 fps, Avg. Travel Time= 63.3 min

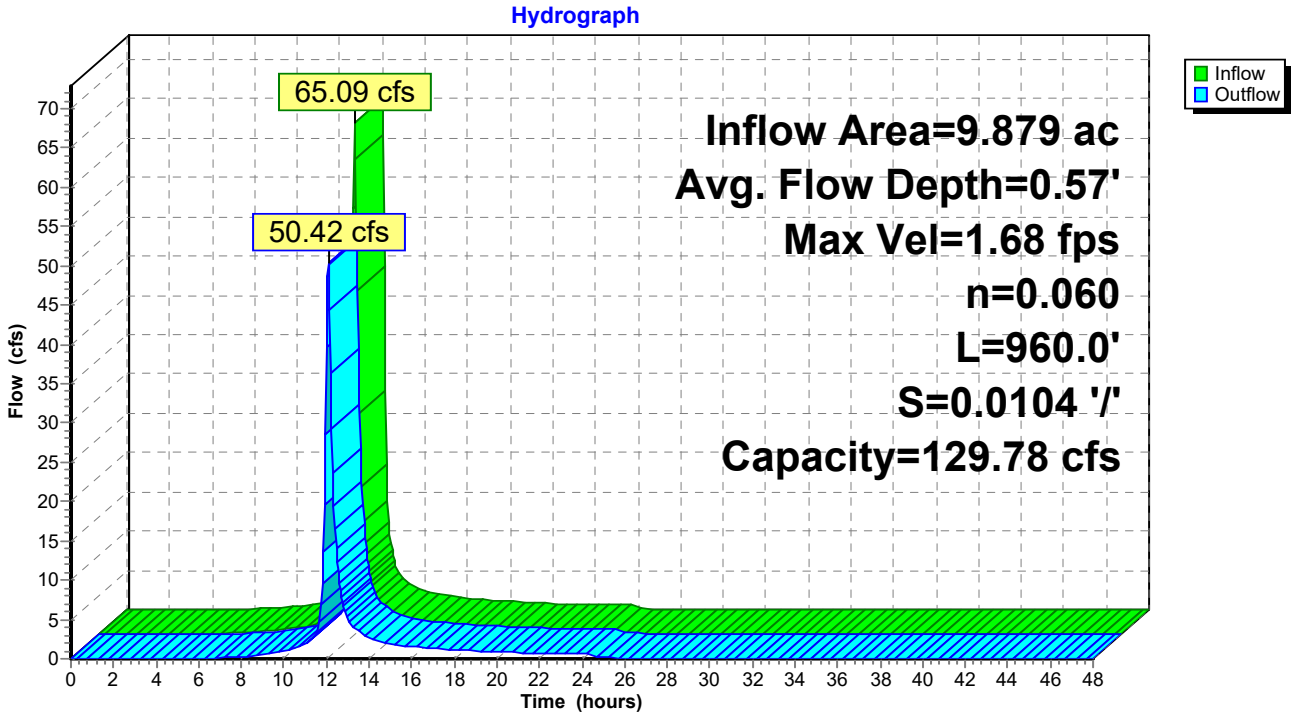
Peak Storage= 28,675 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.57'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 960.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 99R: Middle Channel 4



Summary for Reach 101R: Middle Channel 5

Inflow Area = 3.587 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 26.60 cfs @ 11.97 hrs, Volume= 1.341 af
Outflow = 18.96 cfs @ 12.04 hrs, Volume= 1.341 af, Atten= 29%, Lag= 4.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.16 fps, Min. Travel Time= 10.9 min
Avg. Velocity = 0.20 fps, Avg. Travel Time= 62.8 min

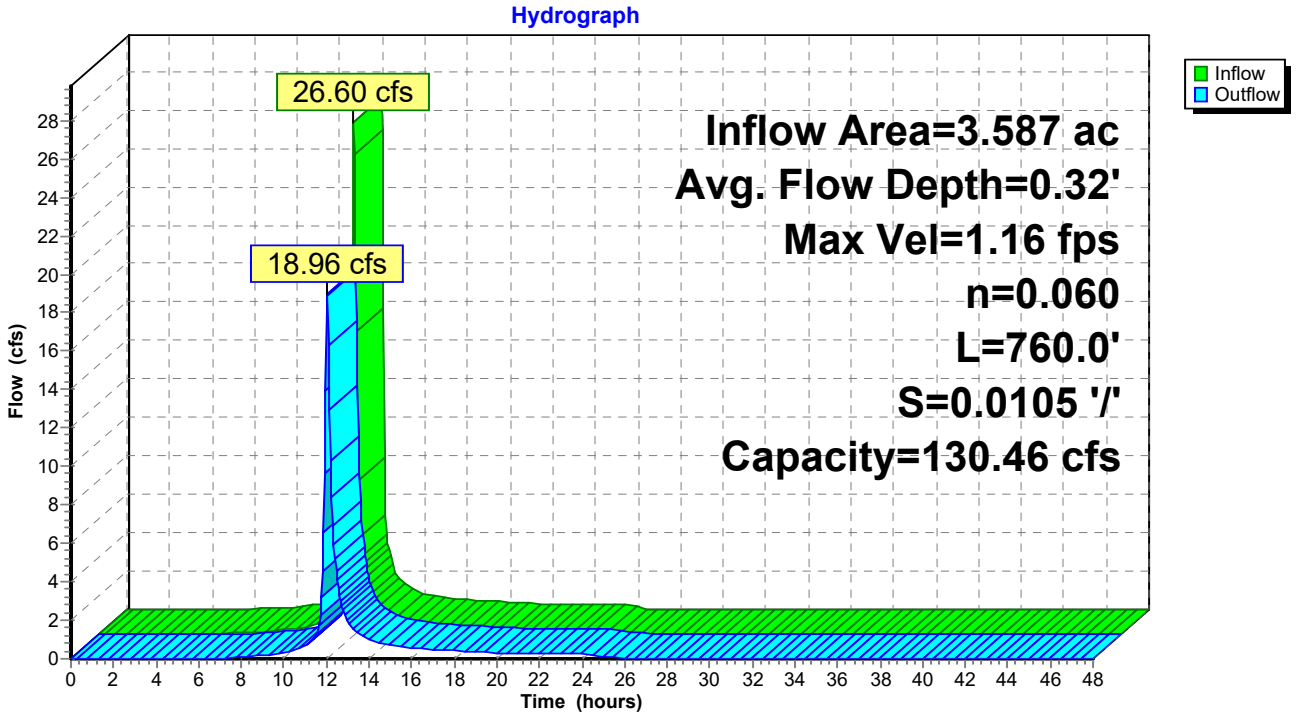
Peak Storage= 12,390 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 130.46 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 760.0' Slope= 0.0105 '/'
Inlet Invert= 16.00', Outlet Invert= 8.00'



‡

Reach 101R: Middle Channel 5



Summary for Reach 105R: East Channel 4

Inflow Area = 9.065 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 67.23 cfs @ 11.97 hrs, Volume= 3.390 af
Outflow = 59.60 cfs @ 12.01 hrs, Volume= 3.390 af, Atten= 11%, Lag= 2.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.76 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 0.28 fps, Avg. Travel Time= 31.0 min

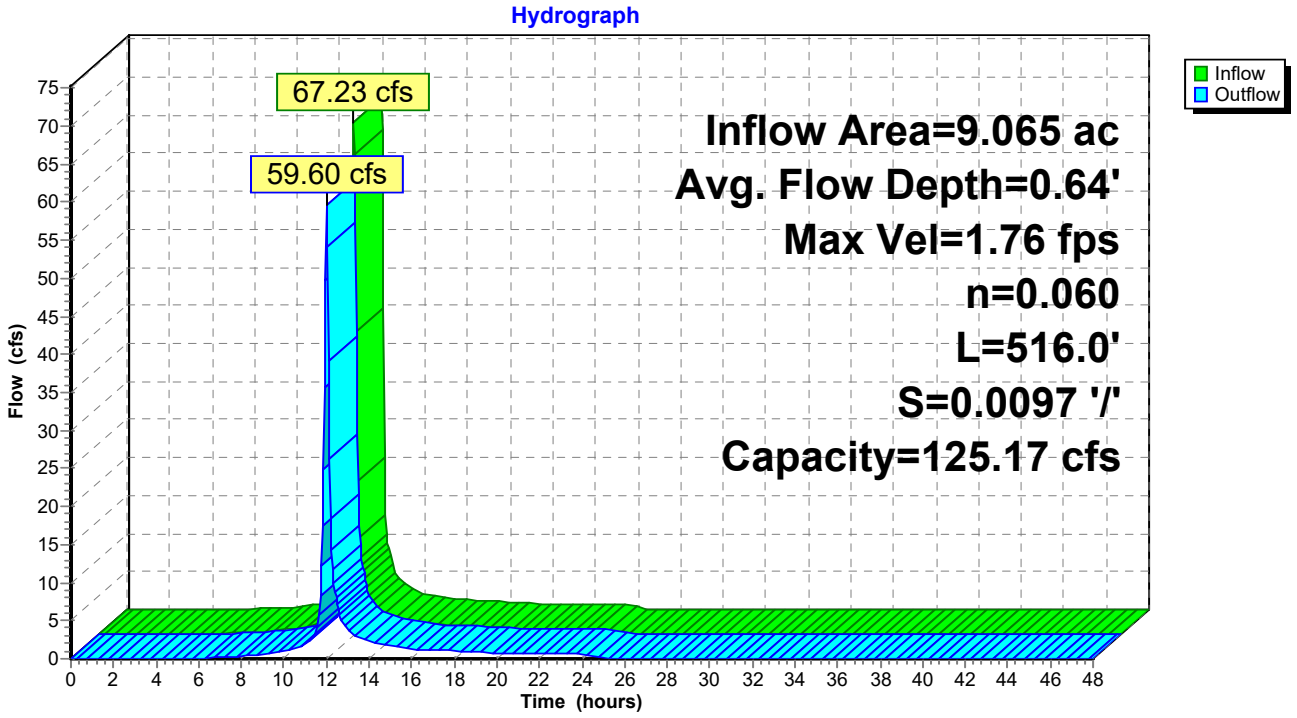
Peak Storage= 17,489 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.64'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 125.17 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 516.0' Slope= 0.0097 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡

Reach 105R: East Channel 4



Summary for Pond 28P: West Outlet/West Emergency Spillway

[62] Hint: Exceeded Reach 77R OUTLET depth by 2.85' @ 12.85 hrs
[62] Hint: Exceeded Reach 94R OUTLET depth by 2.94' @ 12.80 hrs
[62] Hint: Exceeded Reach 95R OUTLET depth by 2.90' @ 12.80 hrs
[62] Hint: Exceeded Reach 96R OUTLET depth by 2.94' @ 12.80 hrs
[62] Hint: Exceeded Reach 97R OUTLET depth by 2.95' @ 12.80 hrs

Inflow Area = 46.140 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 237.56 cfs @ 12.04 hrs, Volume= 17.254 af
Outflow = 37.19 cfs @ 12.69 hrs, Volume= 17.254 af, Atten= 84%, Lag= 38.9 min
Primary = 37.19 cfs @ 12.69 hrs, Volume= 17.254 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.09' @ 12.69 hrs Surf.Area= 178,628 sf Storage= 269,369 cf

Plug-Flow detention time= 59.8 min calculated for 17.236 af (100% of inflow)
Center-of-Mass det. time= 59.8 min (889.6 - 829.8)

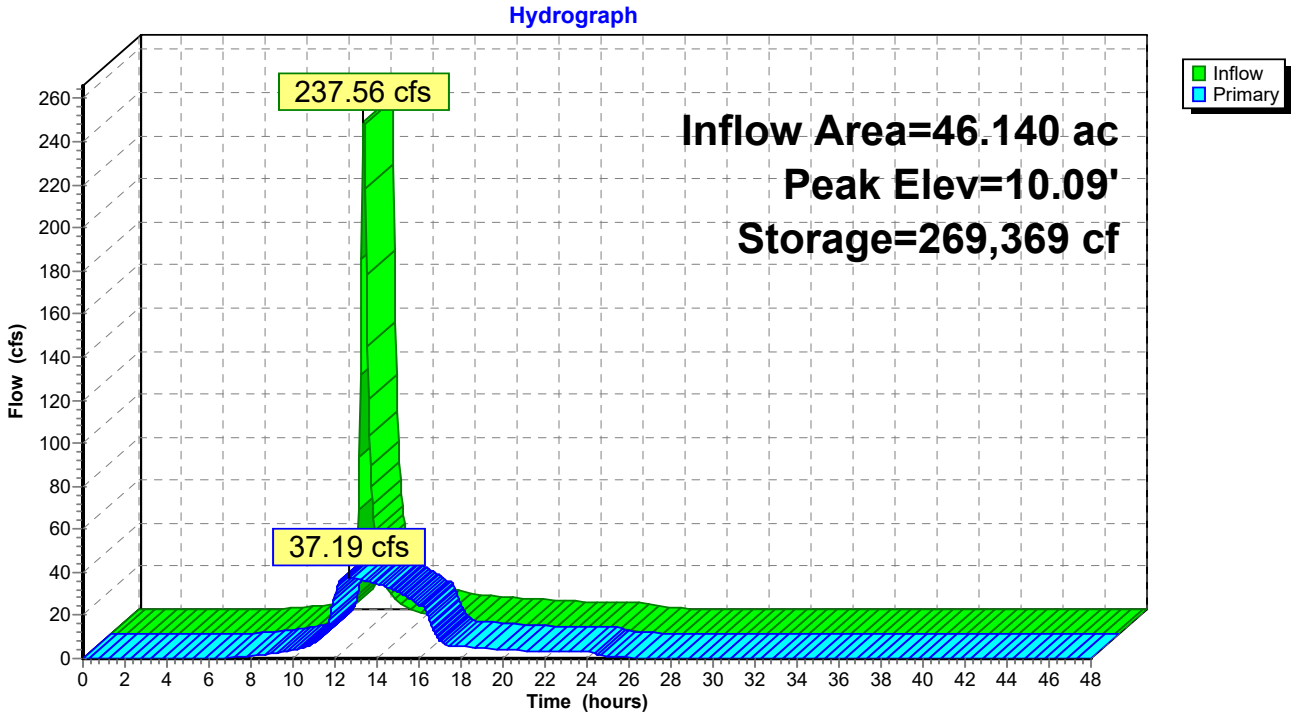
Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	786,184 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	25	25.0	0	0	25
7.00	17,893	714.0	6,196	6,196	40,545
8.00	54,145	1,528.0	34,388	40,584	185,777
9.00	103,329	2,053.0	77,424	118,008	335,396
10.00	171,483	2,546.0	135,975	253,983	515,837
11.00	261,382	2,995.0	214,859	468,842	713,838
12.00	376,810	3,340.0	317,342	786,184	887,789

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**18.0" Round Culvert X 3.00** L= 205.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0049 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	11.00'	**100.0' long x 155.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=37.19 cfs @ 12.69 hrs HW=10.09' (Free Discharge)
1=Culvert (Barrel Controls 37.19 cfs @ 7.02 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 28P: West Outlet/West Emergency Spillway



Summary for Pond 29P: Middle Outlet/Middle Emergency Spillway

[62] Hint: Exceeded Reach 82R OUTLET depth by 3.26' @ 12.80 hrs
[62] Hint: Exceeded Reach 84R OUTLET depth by 3.20' @ 12.85 hrs
[62] Hint: Exceeded Reach 86R OUTLET depth by 3.13' @ 12.90 hrs
[62] Hint: Exceeded Reach 99R OUTLET depth by 3.21' @ 12.85 hrs
[62] Hint: Exceeded Reach 101R OUTLET depth by 3.29' @ 12.75 hrs

Inflow Area = 51.444 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 267.95 cfs @ 12.04 hrs, Volume= 19.238 af
Outflow = 39.37 cfs @ 12.70 hrs, Volume= 19.238 af, Atten= 85%, Lag= 39.3 min
Primary = 39.37 cfs @ 12.70 hrs, Volume= 19.238 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 11.39' @ 12.70 hrs Surf.Area= 202,180 sf Storage= 306,743 cf

Plug-Flow detention time= 63.2 min calculated for 19.218 af (100% of inflow)
Center-of-Mass det. time= 63.2 min (890.5 - 827.3)

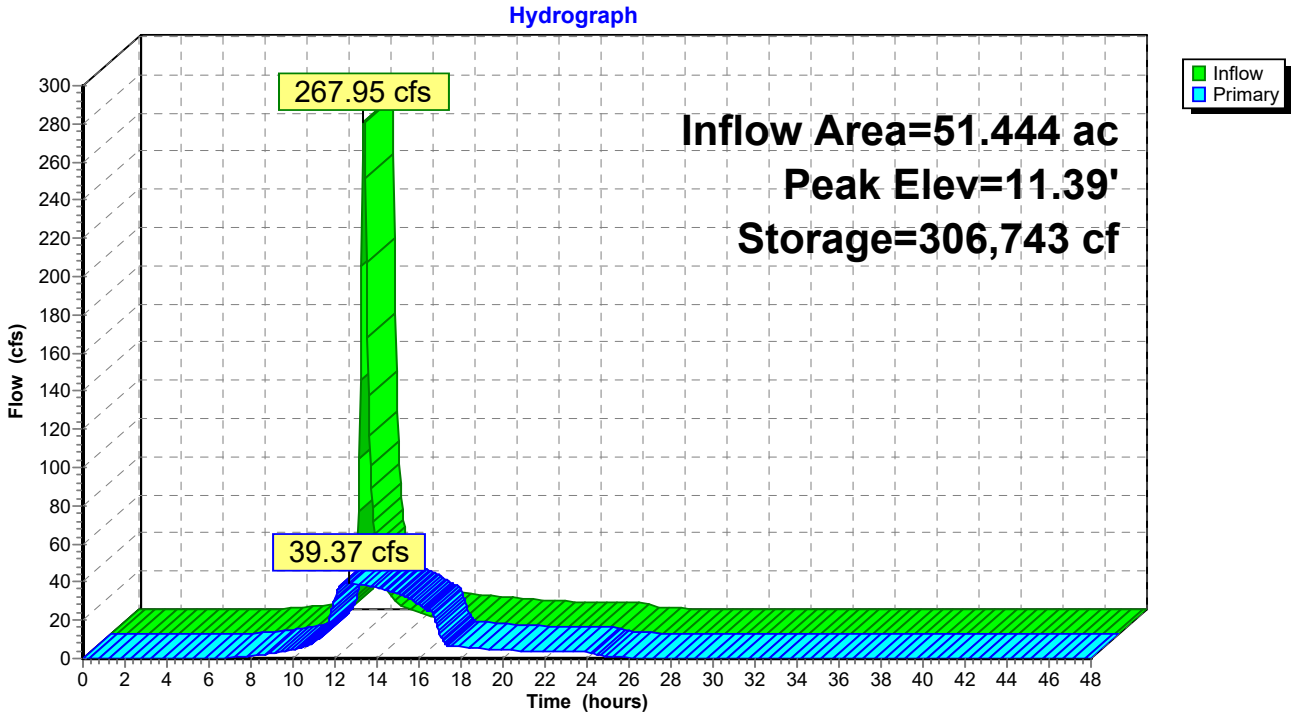
Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,236,409 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	25	25.0	0	0	25
8.00	10,947	460.0	3,832	3,832	16,816
9.00	49,342	1,391.0	27,843	31,675	153,953
10.00	97,395	1,948.0	72,020	103,695	301,963
11.00	168,546	2,477.0	131,355	235,050	488,253
12.00	261,632	2,967.0	213,390	448,440	700,548
13.00	390,402	3,366.0	323,877	772,317	901,654
14.00	541,914	3,757.0	464,092	1,236,409	1,123,314

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	**18.0" Round Culvert X 3.00** L= 195.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 7.00' / 6.00' S= 0.0051 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	12.50'	**100.0' long x 105.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=39.37 cfs @ 12.70 hrs HW=11.39' (Free Discharge)
1=Culvert (Barrel Controls 39.37 cfs @ 7.43 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 29P: Middle Outlet/Middle Emergency Spillway



Summary for Pond 30P: East Outlet/East Emergency Spillway

[62] Hint: Exceeded Reach 87R OUTLET depth by 1.96' @ 12.40 hrs
[62] Hint: Exceeded Reach 89R OUTLET depth by 1.90' @ 12.45 hrs
[62] Hint: Exceeded Reach 91R OUTLET depth by 1.79' @ 12.50 hrs
[62] Hint: Exceeded Reach 105R OUTLET depth by 1.85' @ 12.45 hrs

Inflow Area = 25.806 ac, 0.00% Impervious, Inflow Depth = 4.49" for 25-Year event
Inflow = 150.84 cfs @ 12.02 hrs, Volume= 9.650 af
Outflow = 33.99 cfs @ 12.37 hrs, Volume= 9.650 af, Atten= 77%, Lag= 21.2 min
Primary = 33.99 cfs @ 12.37 hrs, Volume= 9.650 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 13.05' @ 12.37 hrs Surf.Area= 102,894 sf Storage= 125,081 cf

Plug-Flow detention time= 27.6 min calculated for 9.650 af (100% of inflow)
Center-of-Mass det. time= 27.5 min (848.1 - 820.6)

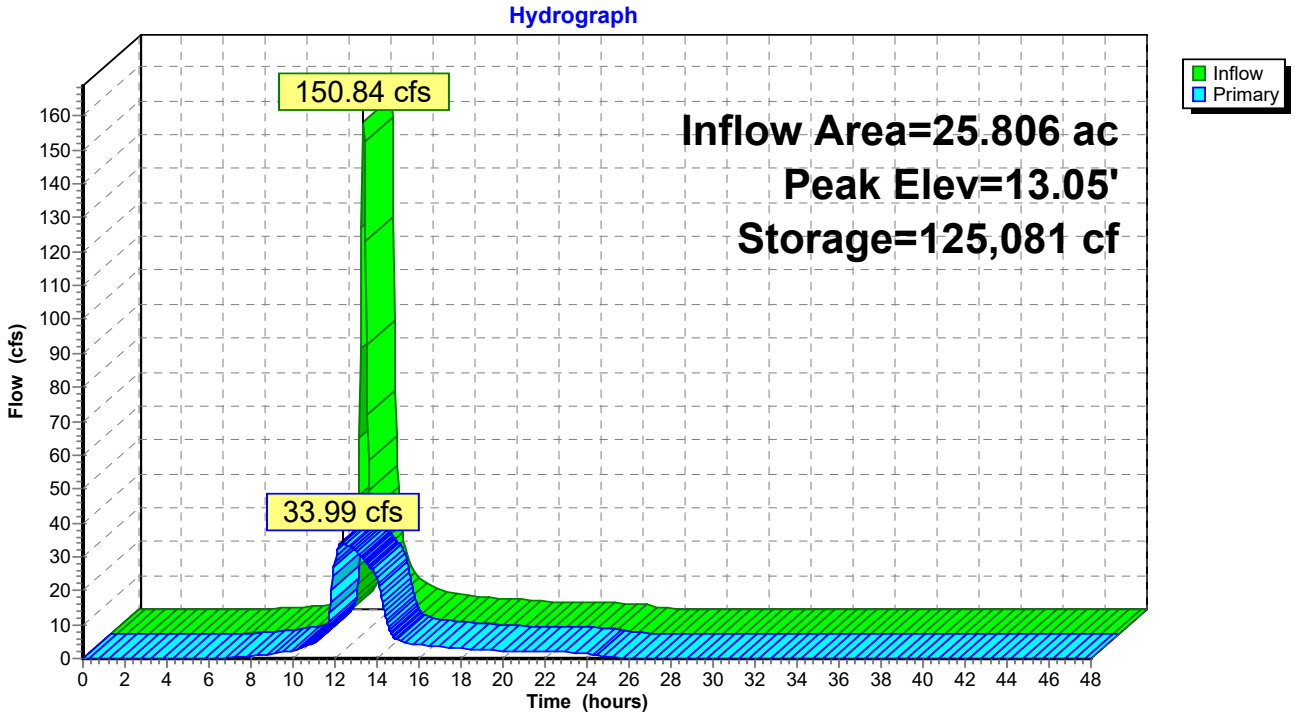
Volume	Invert	Avail.Storage	Storage Description
#1	10.00'	451,099 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
10.00	25	25.0	0	0	25
11.00	18,449	600.0	6,384	6,384	28,625
12.00	57,145	1,325.0	36,021	42,406	139,689
13.00	100,293	1,787.0	77,714	120,120	254,112
14.00	160,181	2,277.0	129,074	249,194	412,592
15.00	246,734	2,722.0	201,906	451,099	589,634

Device	Routing	Invert	Outlet Devices
#1	Primary	10.00'	**18.0" Round Culvert X 3.00** L= 160.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 10.00' / 9.00' S= 0.0063 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	14.00'	**100.0' long x 127.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=33.98 cfs @ 12.37 hrs HW=13.05' (Free Discharge)
1=Culvert (Barrel Controls 33.98 cfs @ 6.41 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 30P: East Outlet/East Emergency Spillway



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 72S: East Drainage Area 1 Runoff Area=2.239 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=23.63 cfs 1.218 af

Subcatchment 74S: Middle Drainage Area 1 Runoff Area=5.736 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=60.53 cfs 3.120 af

Subcatchment 76S: West Drainage Area 3 Runoff Area=14.150 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=149.31 cfs 7.698 af

Subcatchment 83S: Middle Drainage Area 2 Runoff Area=12.628 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=133.25 cfs 6.870 af

Subcatchment 85S: Middle Drainage Area 3 Runoff Area=19.614 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=206.97 cfs 10.670 af

Subcatchment 88S: East Drainage Area 2 Runoff Area=4.167 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=43.97 cfs 2.267 af

Subcatchment 90S: East Drainage Area 3 Runoff Area=10.335 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=109.06 cfs 5.622 af

Subcatchment 93S: West Drainage Area 2 Runoff Area=7.233 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=76.32 cfs 3.935 af

Subcatchment 94S: West Drainage Area 4 Runoff Area=11.630 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=122.72 cfs 6.327 af

Subcatchment 95S: West Drainage Area 1 Runoff Area=5.837 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=61.59 cfs 3.175 af

Subcatchment 96S: West Drainage Area 5 Runoff Area=7.290 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=76.93 cfs 3.966 af

Subcatchment 98S: Middle Drainage Area 4 Runoff Area=9.879 ac 0.00% Impervious Runoff Depth=6.53"
Tc=10.0 min CN=84 Runoff=92.81 cfs 5.374 af

Subcatchment 100S: Middle Drainage Area 5 Runoff Area=3.587 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=37.85 cfs 1.951 af

Subcatchment 104S: East Drainage Area 4 Runoff Area=9.065 ac 0.00% Impervious Runoff Depth=6.53"
Tc=6.0 min CN=84 Runoff=95.66 cfs 4.931 af

Reach 77R: West Channel 3 Avg. Flow Depth=0.88' Max Vel=2.17 fps Inflow=149.31 cfs 7.698 af
n=0.060 L=1,600.0' S=0.0100 '/' Capacity=149.49 cfs Outflow=101.87 cfs 7.698 af

Reach 82R: Middle Channel 1 Avg. Flow Depth=0.53' Max Vel=1.60 fps Inflow=60.53 cfs 3.120 af
n=0.060 L=975.0' S=0.0103 '/' Capacity=128.78 cfs Outflow=44.44 cfs 3.120 af

Reach 84R: Middle Channel 2 Avg. Flow Depth=0.90' Max Vel=2.19 fps Inflow=133.25 cfs 6.870 af
n=0.060 L=1,003.0' S=0.0100 '/' Capacity=149.26 cfs Outflow=106.98 cfs 6.870 af

Reach 86R: Middle Channel 3 Avg. Flow Depth=1.11' Max Vel=2.51 fps Inflow=206.97 cfs 10.670 af
n=0.060 L=1,500.0' S=0.0100 '/' Capacity=253.72 cfs Outflow=152.31 cfs 10.670 af

Reach 87R: East Channel 1 Avg. Flow Depth=0.32' Max Vel=1.24 fps Inflow=23.63 cfs 1.218 af
n=0.060 L=423.0' S=0.0118 '/' Capacity=138.25 cfs Outflow=20.44 cfs 1.218 af

Reach 89R: East Channel 2 Avg. Flow Depth=0.46' Max Vel=1.46 fps Inflow=43.97 cfs 2.267 af
n=0.060 L=673.0' S=0.0104 '/' Capacity=129.68 cfs Outflow=35.38 cfs 2.267 af

Reach 91R: East Channel 3 Avg. Flow Depth=0.78' Max Vel=2.00 fps Inflow=109.06 cfs 5.622 af
n=0.060 L=1,100.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=82.73 cfs 5.622 af

Reach 94R: West Channel 2 Avg. Flow Depth=0.64' Max Vel=1.76 fps Inflow=76.32 cfs 3.935 af
n=0.060 L=900.0' S=0.0100 '/' Capacity=127.16 cfs Outflow=59.45 cfs 3.935 af

Reach 95R: West Channel 4 Avg. Flow Depth=0.84' Max Vel=2.10 fps Inflow=122.72 cfs 6.327 af
n=0.060 L=1,093.0' S=0.0101 '/' Capacity=127.57 cfs Outflow=94.75 cfs 6.327 af

Reach 96R: West Channel 1 Avg. Flow Depth=0.58' Max Vel=1.47 fps Inflow=61.59 cfs 3.175 af
n=0.060 L=910.0' S=0.0077 '/' Capacity=111.53 cfs Outflow=44.96 cfs 3.175 af

Reach 97R: West Channel 5 Avg. Flow Depth=0.61' Max Vel=1.82 fps Inflow=76.93 cfs 3.966 af
n=0.060 L=978.0' S=0.0112 '/' Capacity=134.86 cfs Outflow=58.92 cfs 3.966 af

Reach 99R: Middle Channel 4 Avg. Flow Depth=0.73' Max Vel=1.95 fps Inflow=92.81 cfs 5.374 af
n=0.060 L=960.0' S=0.0104 '/' Capacity=129.78 cfs Outflow=75.47 cfs 5.374 af

Reach 101R: Middle Channel 5 Avg. Flow Depth=0.41' Max Vel=1.36 fps Inflow=37.85 cfs 1.951 af
n=0.060 L=760.0' S=0.0105 '/' Capacity=130.46 cfs Outflow=28.65 cfs 1.951 af

Reach 105R: East Channel 4 Avg. Flow Depth=0.81' Max Vel=2.03 fps Inflow=95.66 cfs 4.931 af
n=0.060 L=516.0' S=0.0097 '/' Capacity=125.17 cfs Outflow=86.94 cfs 4.931 af

Pond 28P: West Outlet/West Emergency Peak Elev=10.88' Storage=438,594 cf Inflow=359.23 cfs 25.100 af
Outflow=41.10 cfs 25.100 af

Pond 29P: Middle Outlet/Middle Peak Elev=12.18' Storage=497,423 cf Inflow=402.72 cfs 27.986 af
Outflow=43.20 cfs 27.986 af

Pond 30P: East Outlet/East Emergency Peak Elev=13.72' Storage=206,662 cf Inflow=224.30 cfs 14.039 af
Outflow=38.19 cfs 14.039 af

Total Runoff Area = 123.390 ac Runoff Volume = 67.125 af Average Runoff Depth = 6.53"
100.00% Pervious = 123.390 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 72S: East Drainage Area 1

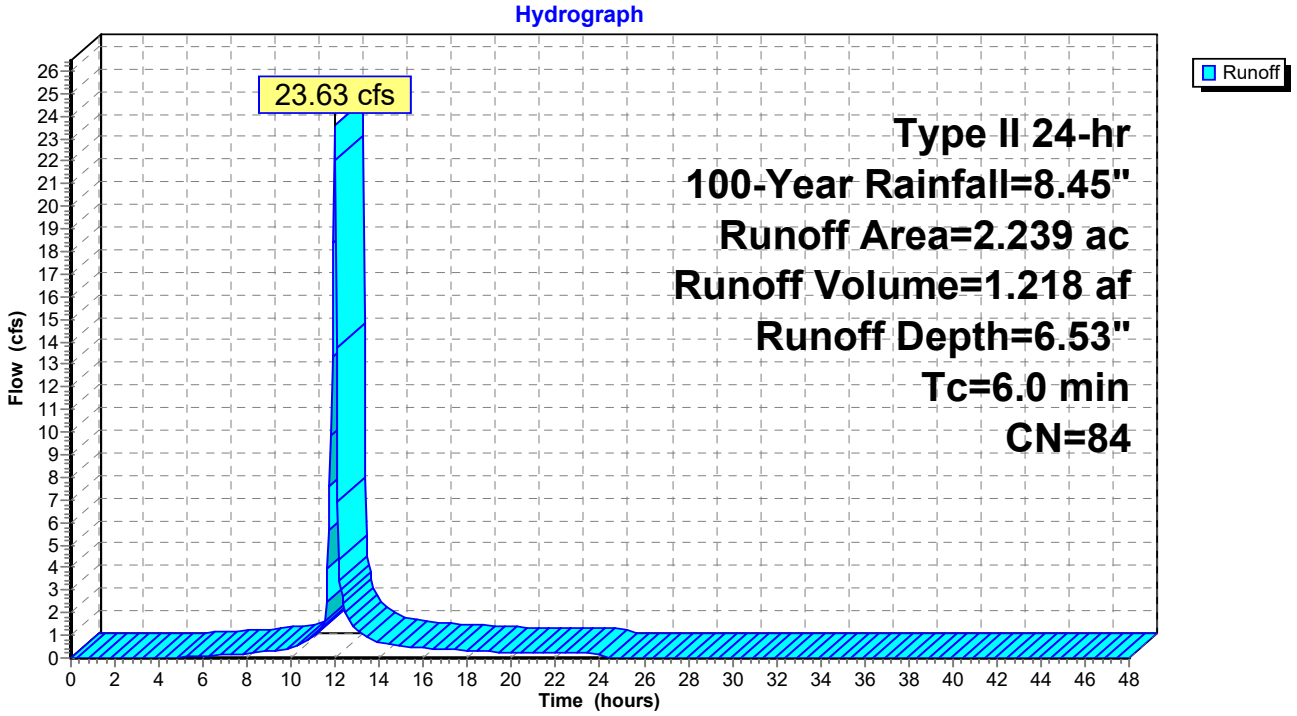
Runoff = 23.63 cfs @ 11.96 hrs, Volume= 1.218 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
2.239	84	50-75% Grass cover, Fair, HSG D
2.239		100.00% Pervious Area

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

Subcatchment 72S: East Drainage Area 1



Summary for Subcatchment 74S: Middle Drainage Area 1

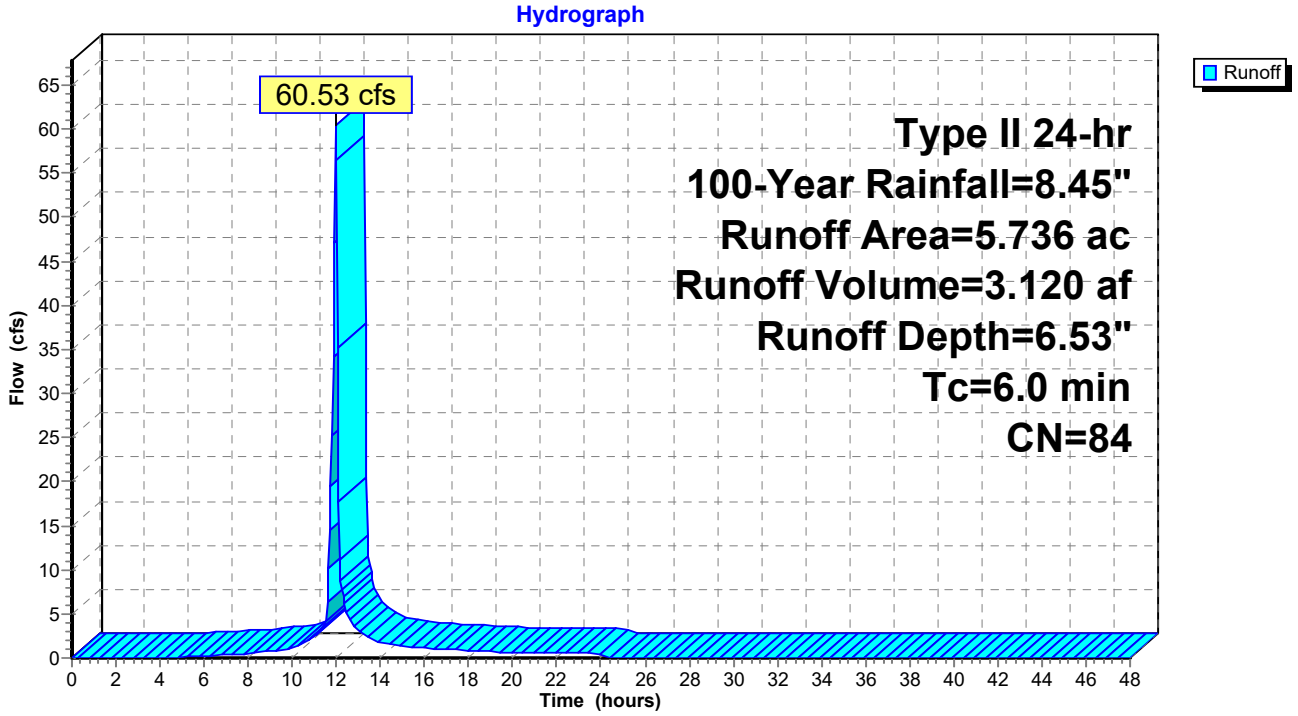
Runoff = 60.53 cfs @ 11.96 hrs, Volume= 3.120 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
5.736	84	50-75% Grass cover, Fair, HSG D
5.736		100.00% Pervious Area

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

Subcatchment 74S: Middle Drainage Area 1



Summary for Subcatchment 76S: West Drainage Area 3

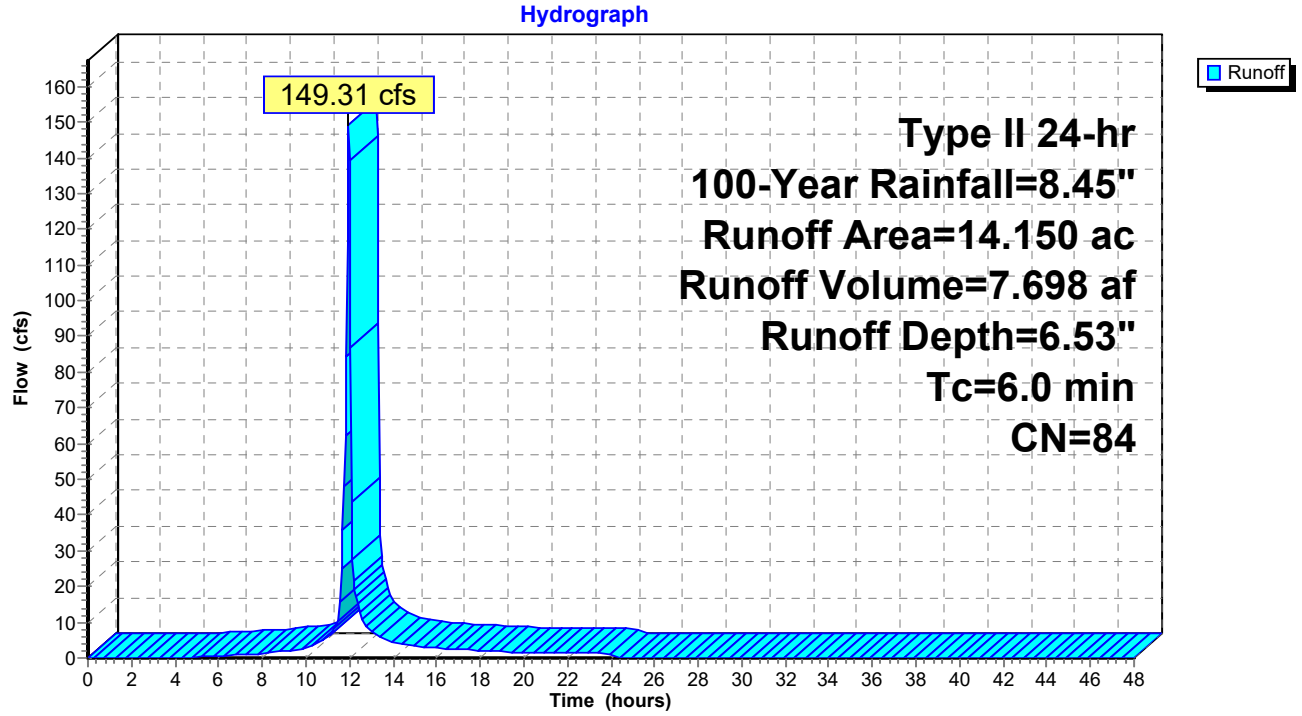
Runoff = 149.31 cfs @ 11.96 hrs, Volume= 7.698 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
14.150	84	50-75% Grass cover, Fair, HSG D
14.150		100.00% Pervious Area

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

Subcatchment 76S: West Drainage Area 3



Summary for Subcatchment 83S: Middle Drainage Area 2

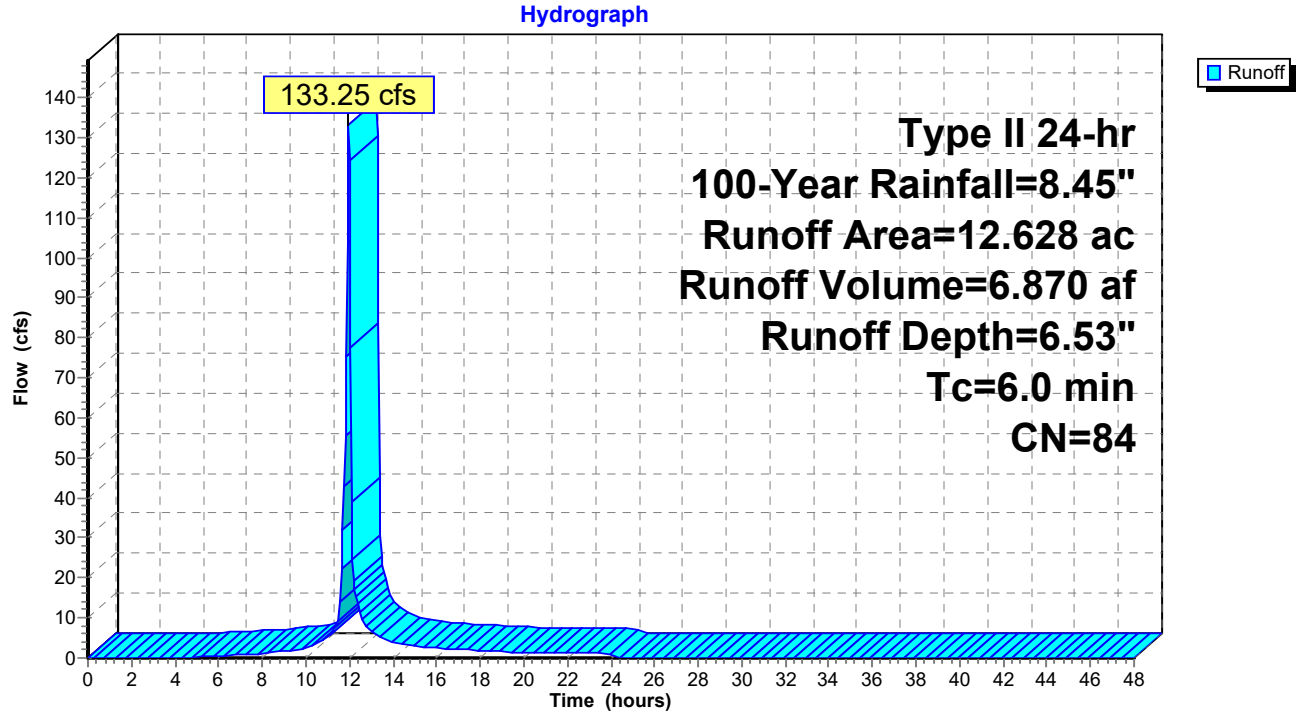
Runoff = 133.25 cfs @ 11.96 hrs, Volume= 6.870 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
12.628	84	50-75% Grass cover, Fair, HSG D
12.628		100.00% Pervious Area

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

Subcatchment 83S: Middle Drainage Area 2



Summary for Subcatchment 85S: Middle Drainage Area 3

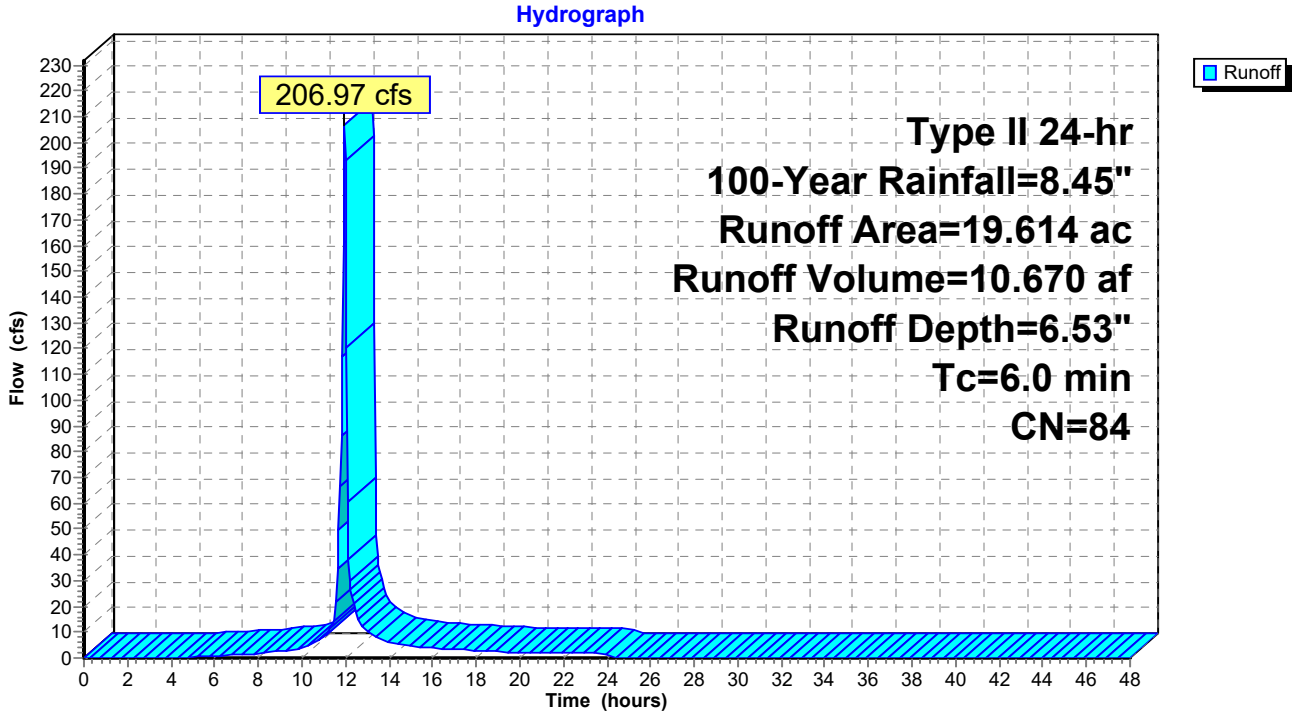
Runoff = 206.97 cfs @ 11.96 hrs, Volume= 10.670 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
19.614	84	50-75% Grass cover, Fair, HSG D
19.614		100.00% Pervious Area

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

Subcatchment 85S: Middle Drainage Area 3



Summary for Subcatchment 88S: East Drainage Area 2

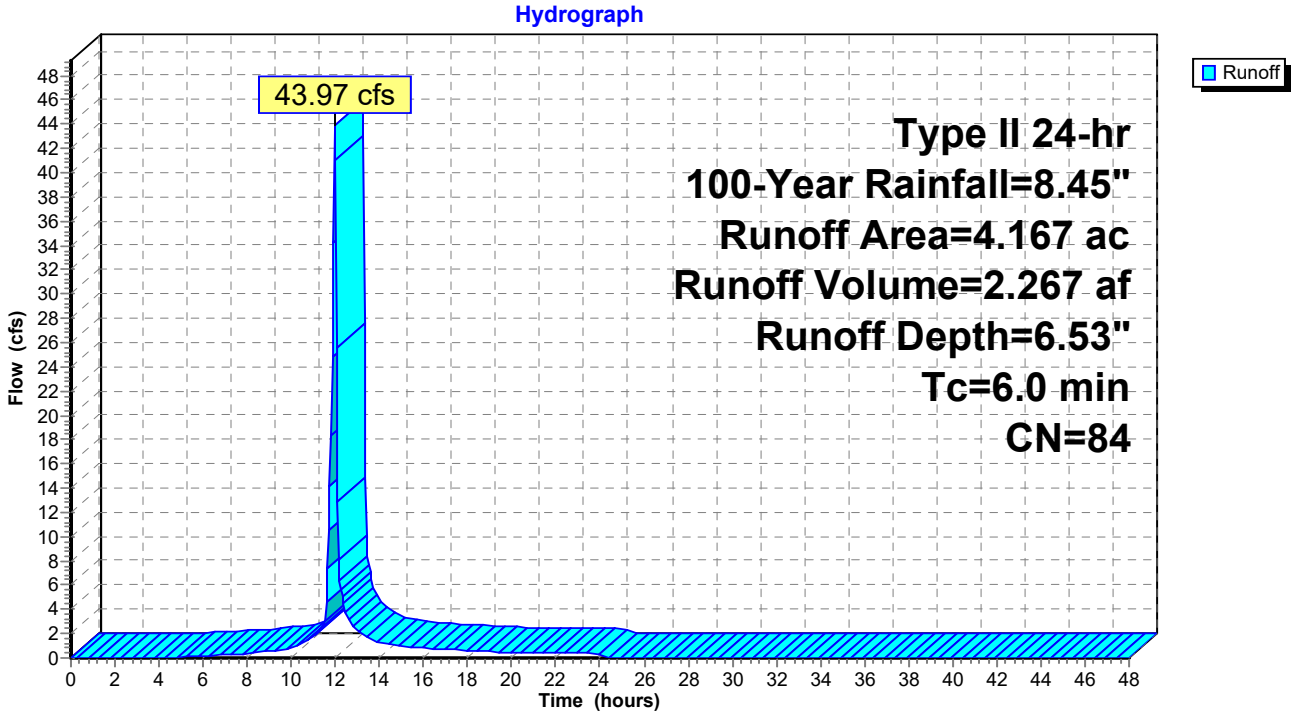
Runoff = 43.97 cfs @ 11.96 hrs, Volume= 2.267 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
4.167	84	50-75% Grass cover, Fair, HSG D
4.167		100.00% Pervious Area

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

Subcatchment 88S: East Drainage Area 2



Summary for Subcatchment 90S: East Drainage Area 3

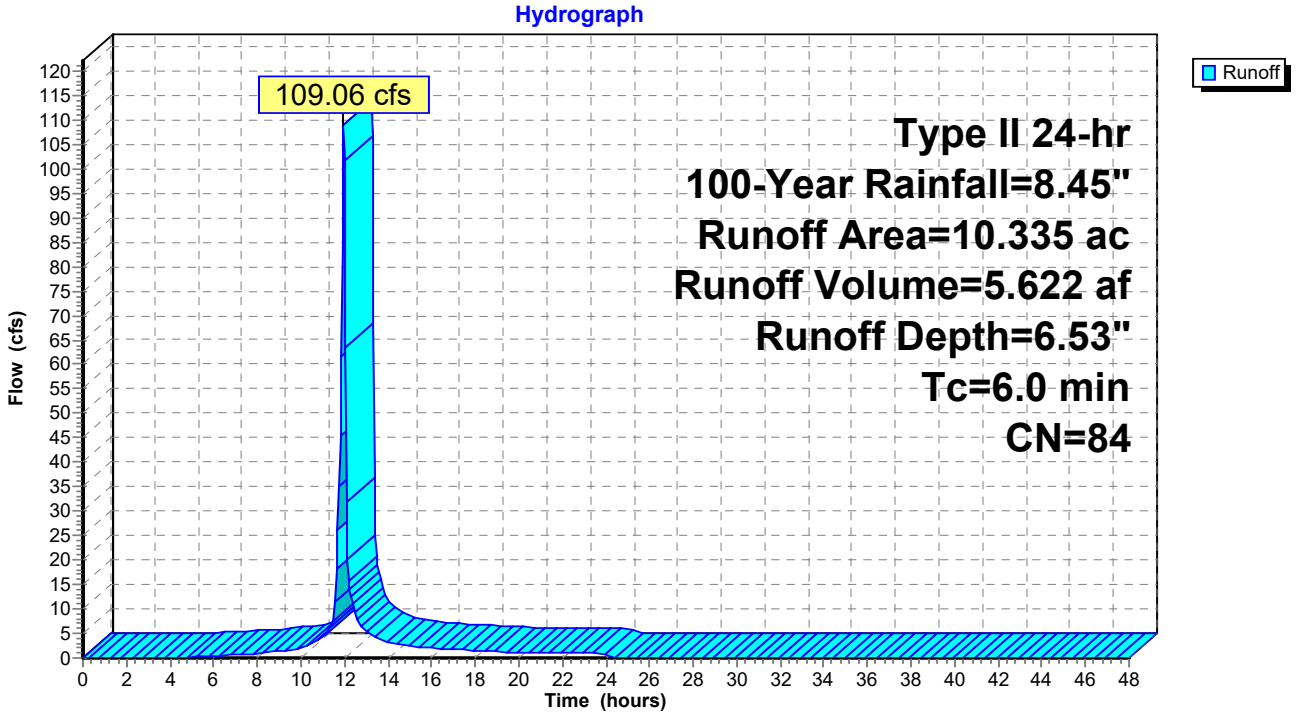
Runoff = 109.06 cfs @ 11.96 hrs, Volume= 5.622 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
10.335	84	50-75% Grass cover, Fair, HSG D
10.335		100.00% Pervious Area

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

Subcatchment 90S: East Drainage Area 3



Summary for Subcatchment 93S: West Drainage Area 2

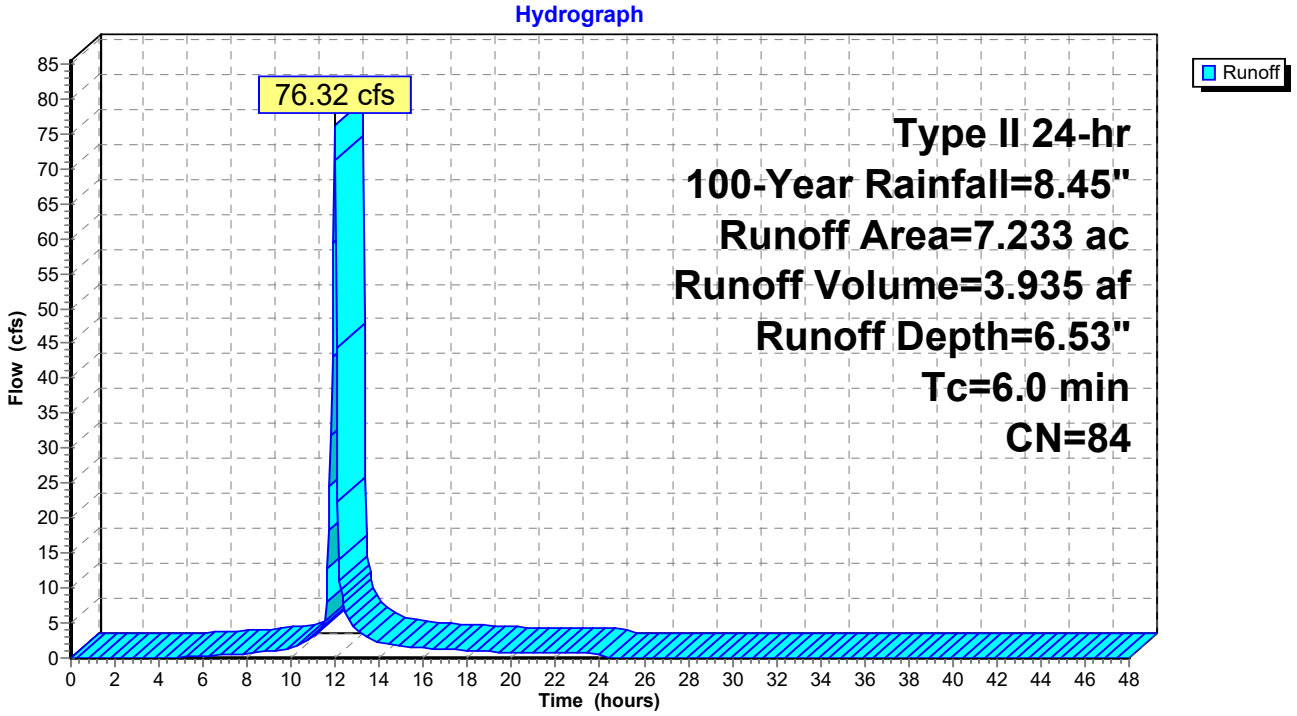
Runoff = 76.32 cfs @ 11.96 hrs, Volume= 3.935 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
7.233	84	50-75% Grass cover, Fair, HSG D
7.233		100.00% Pervious Area

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

Subcatchment 93S: West Drainage Area 2



Summary for Subcatchment 94S: West Drainage Area 4

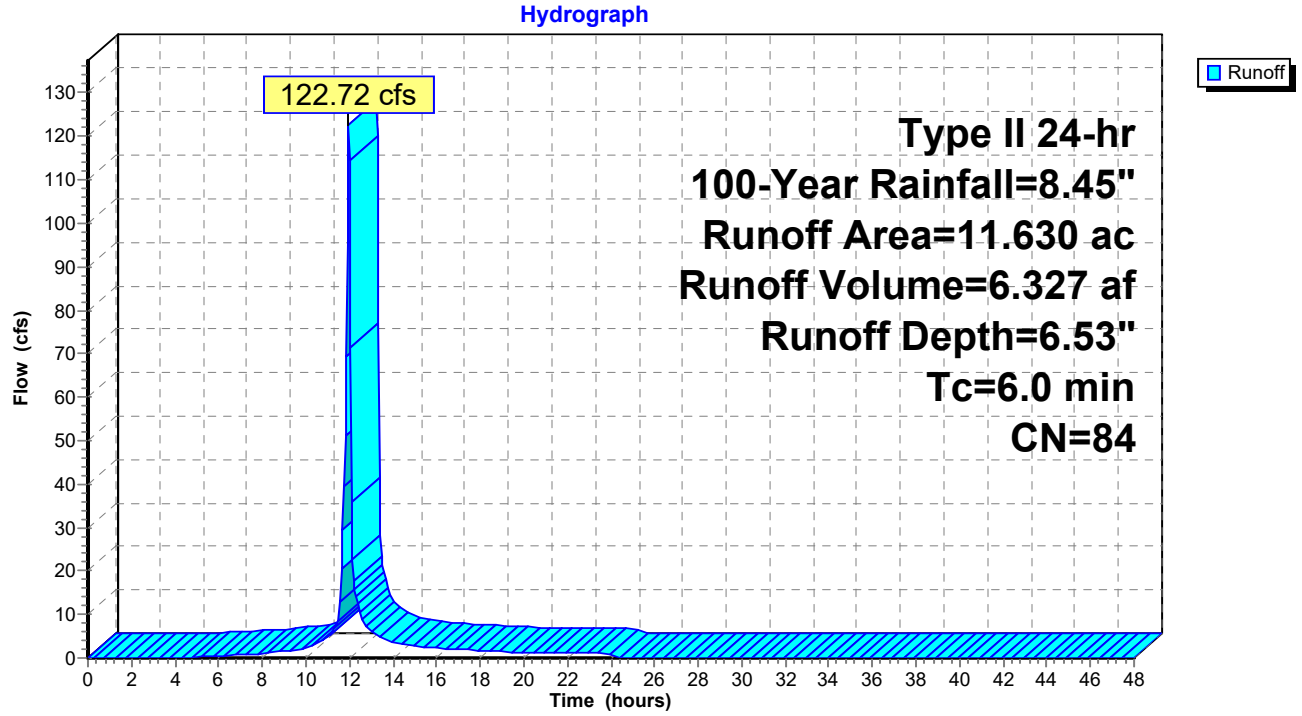
Runoff = 122.72 cfs @ 11.96 hrs, Volume= 6.327 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
11.630	84	50-75% Grass cover, Fair, HSG D
11.630		100.00% Pervious Area

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

Subcatchment 94S: West Drainage Area 4



Summary for Subcatchment 95S: West Drainage Area 1

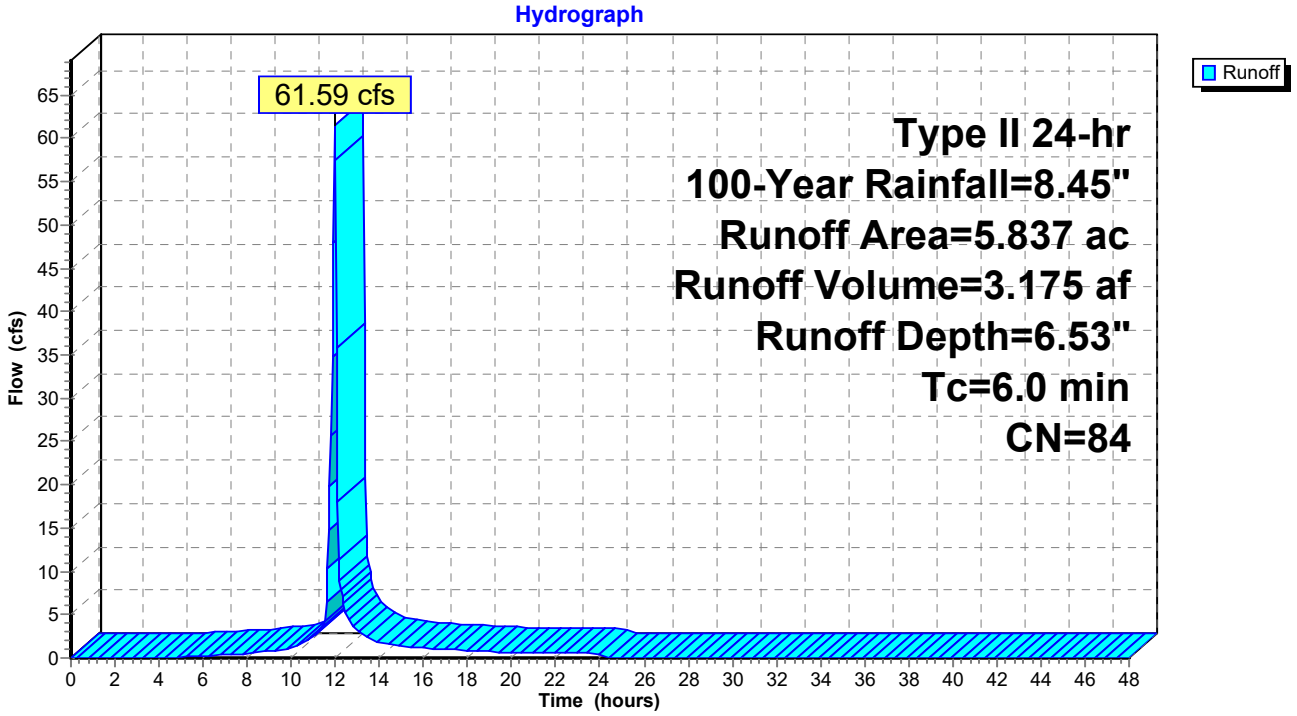
Runoff = 61.59 cfs @ 11.96 hrs, Volume= 3.175 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
5.837	84	50-75% Grass cover, Fair, HSG D
5.837		100.00% Pervious Area

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

Subcatchment 95S: West Drainage Area 1



Summary for Subcatchment 96S: West Drainage Area 5

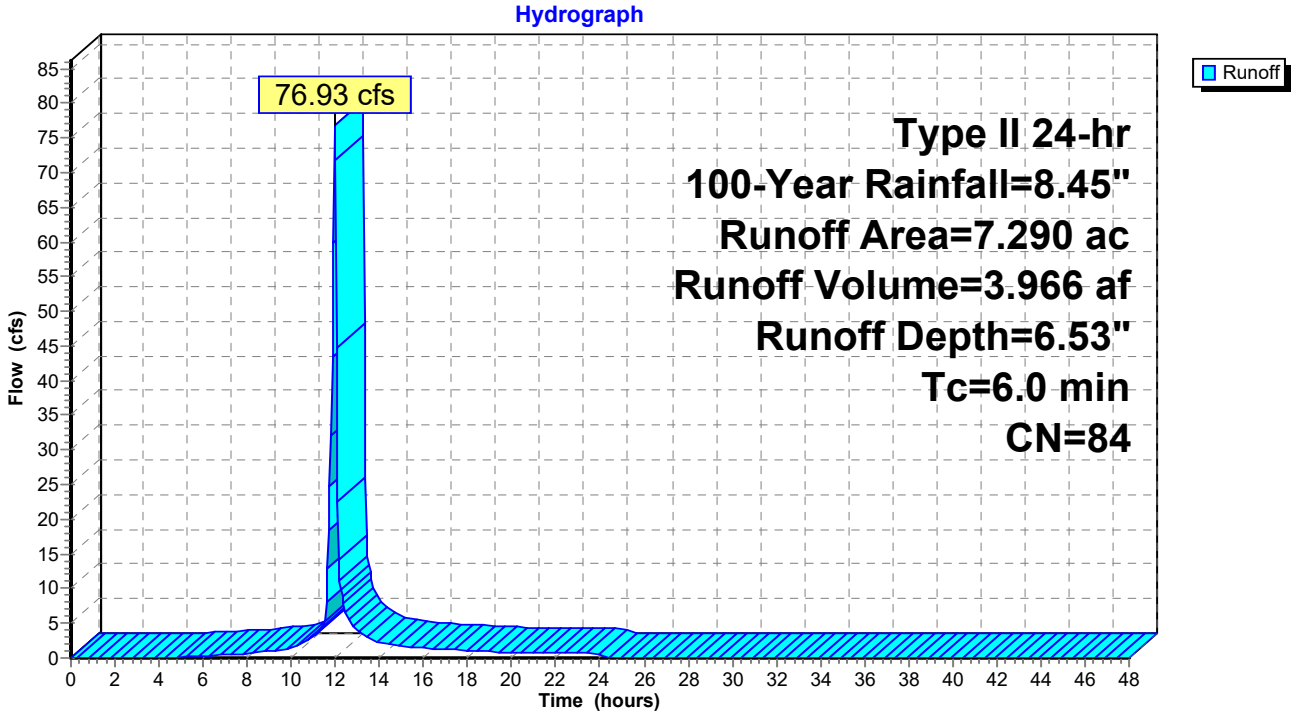
Runoff = 76.93 cfs @ 11.96 hrs, Volume= 3.966 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
7.290	84	50-75% Grass cover, Fair, HSG D
7.290		100.00% Pervious Area

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

Subcatchment 96S: West Drainage Area 5



Summary for Subcatchment 98S: Middle Drainage Area 4

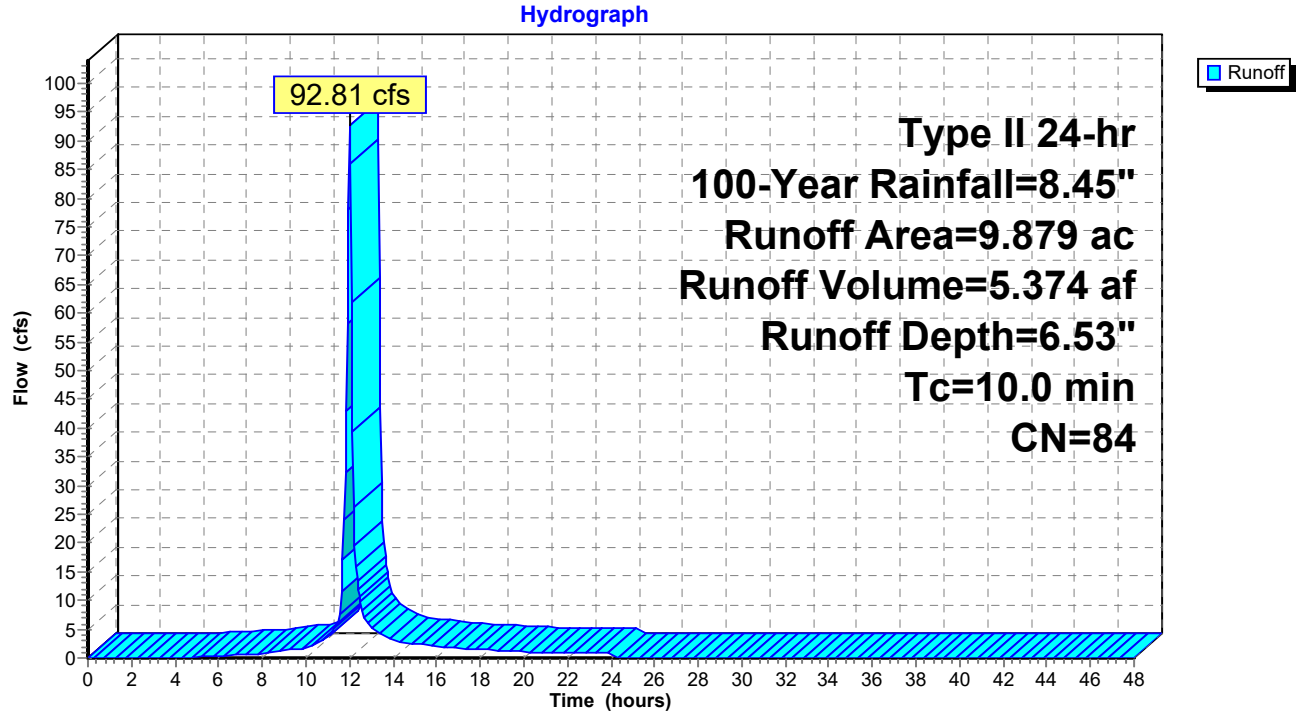
Runoff = 92.81 cfs @ 12.01 hrs, Volume= 5.374 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
9.879	84	50-75% Grass cover, Fair, HSG D
9.879		100.00% Pervious Area

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

Subcatchment 98S: Middle Drainage Area 4



Summary for Subcatchment 100S: Middle Drainage Area 5

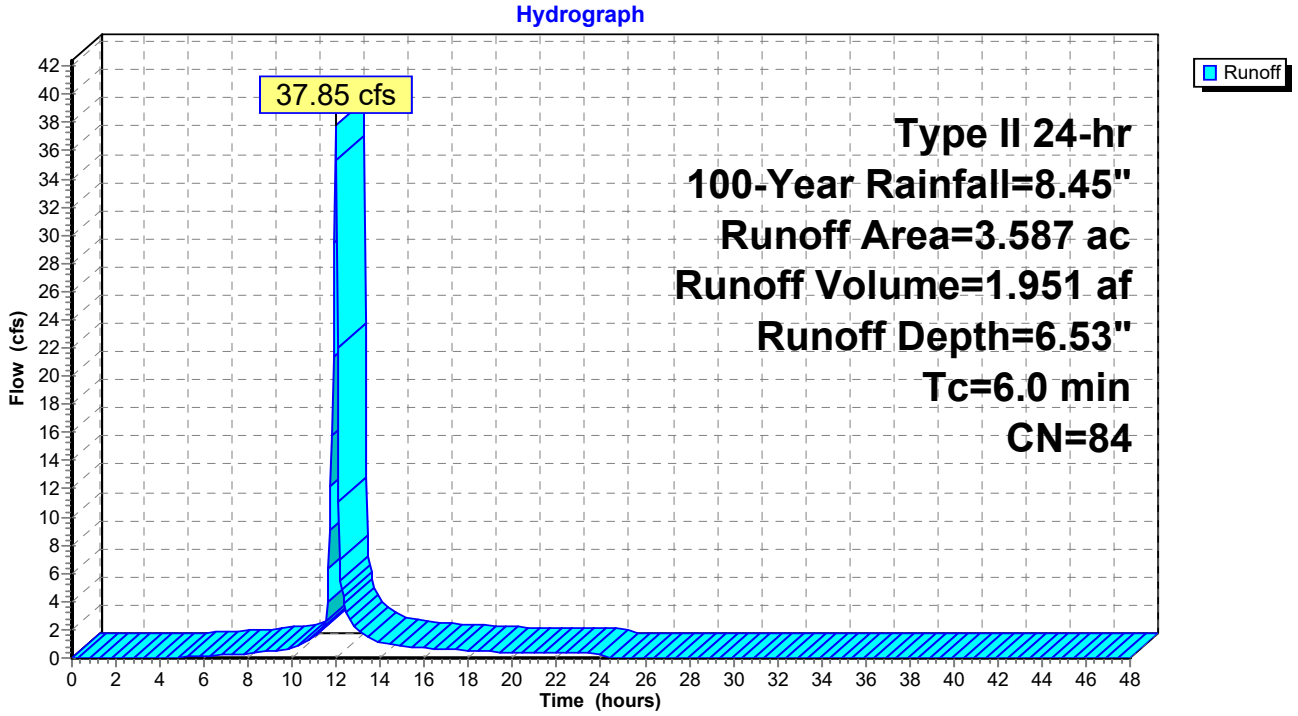
Runoff = 37.85 cfs @ 11.96 hrs, Volume= 1.951 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
3.587	84	50-75% Grass cover, Fair, HSG D
3.587		100.00% Pervious Area

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

Subcatchment 100S: Middle Drainage Area 5



Summary for Subcatchment 104S: East Drainage Area 4

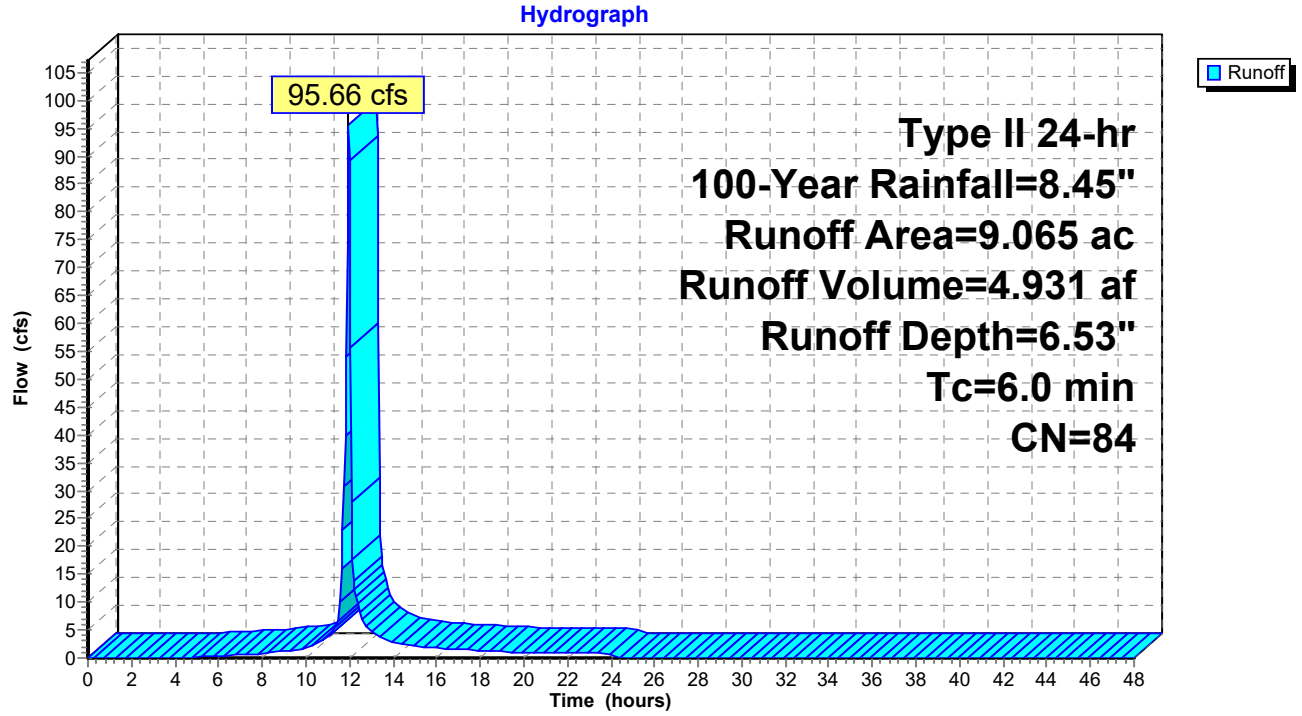
Runoff = 95.66 cfs @ 11.96 hrs, Volume= 4.931 af, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=8.45"

Area (ac)	CN	Description
9.065	84	50-75% Grass cover, Fair, HSG D
9.065		100.00% Pervious Area

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

Subcatchment 104S: East Drainage Area 4



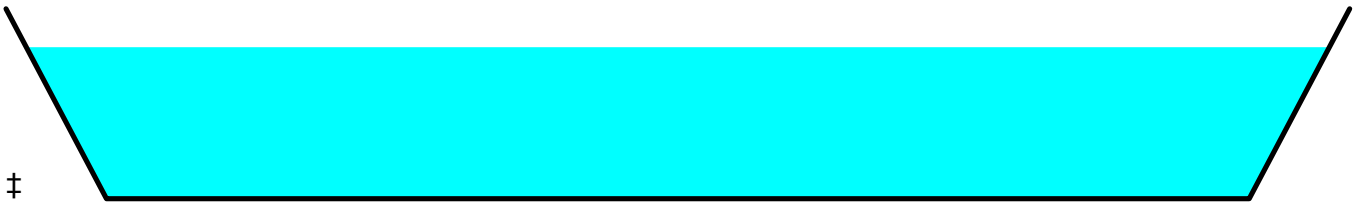
Summary for Reach 77R: West Channel 3

Inflow Area = 14.150 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 149.31 cfs @ 11.96 hrs, Volume= 7.698 af
Outflow = 101.87 cfs @ 12.04 hrs, Volume= 7.698 af, Atten= 32%, Lag= 4.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.17 fps, Min. Travel Time= 12.3 min
Avg. Velocity = 0.31 fps, Avg. Travel Time= 86.9 min

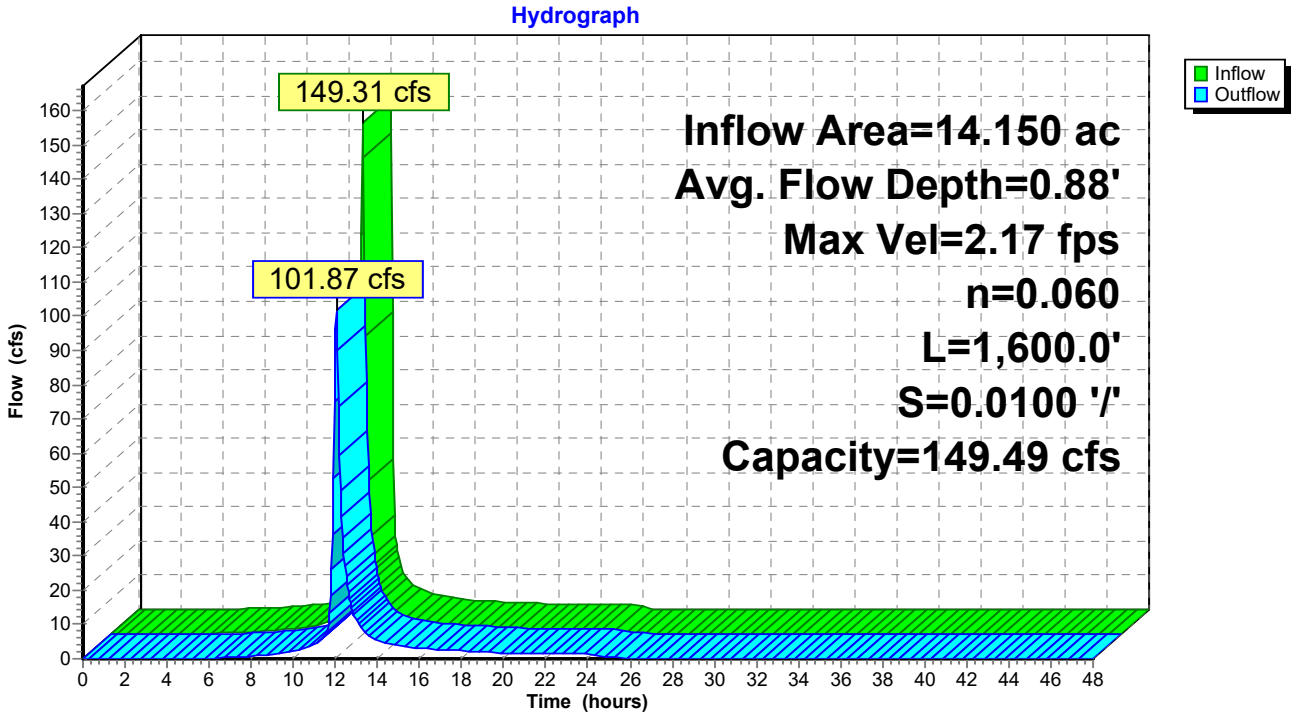
Peak Storage= 75,113 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.88'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.49 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,600.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 7.00'



‡

Reach 77R: West Channel 3



Summary for Reach 82R: Middle Channel 1

Inflow Area = 5.736 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 60.53 cfs @ 11.96 hrs, Volume= 3.120 af
Outflow = 44.44 cfs @ 12.03 hrs, Volume= 3.120 af, Atten= 27%, Lag= 4.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.60 fps, Min. Travel Time= 10.2 min
Avg. Velocity = 0.24 fps, Avg. Travel Time= 68.5 min

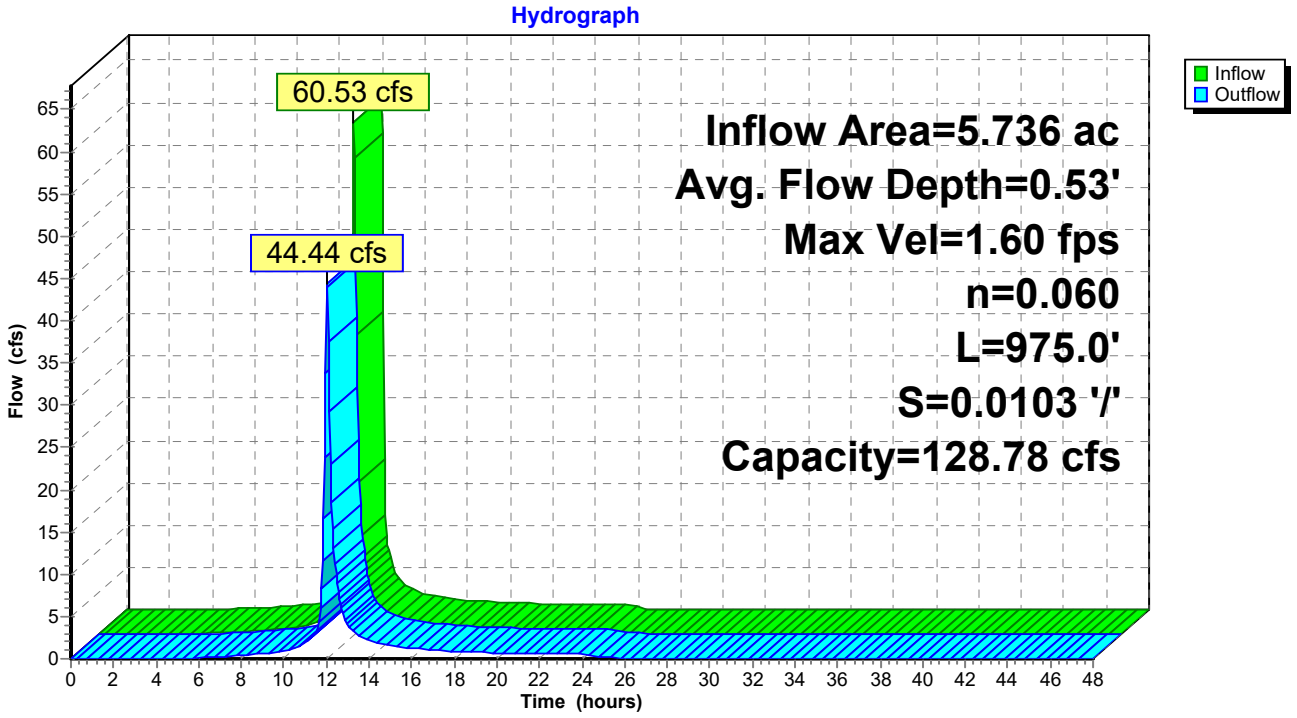
Peak Storage= 27,064 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.53'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 128.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 975.0' Slope= 0.0103 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 82R: Middle Channel 1



Summary for Reach 84R: Middle Channel 2

Inflow Area = 12.628 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 133.25 cfs @ 11.96 hrs, Volume= 6.870 af
Outflow = 106.98 cfs @ 12.02 hrs, Volume= 6.870 af, Atten= 20%, Lag= 3.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.19 fps, Min. Travel Time= 7.6 min
Avg. Velocity = 0.30 fps, Avg. Travel Time= 55.3 min

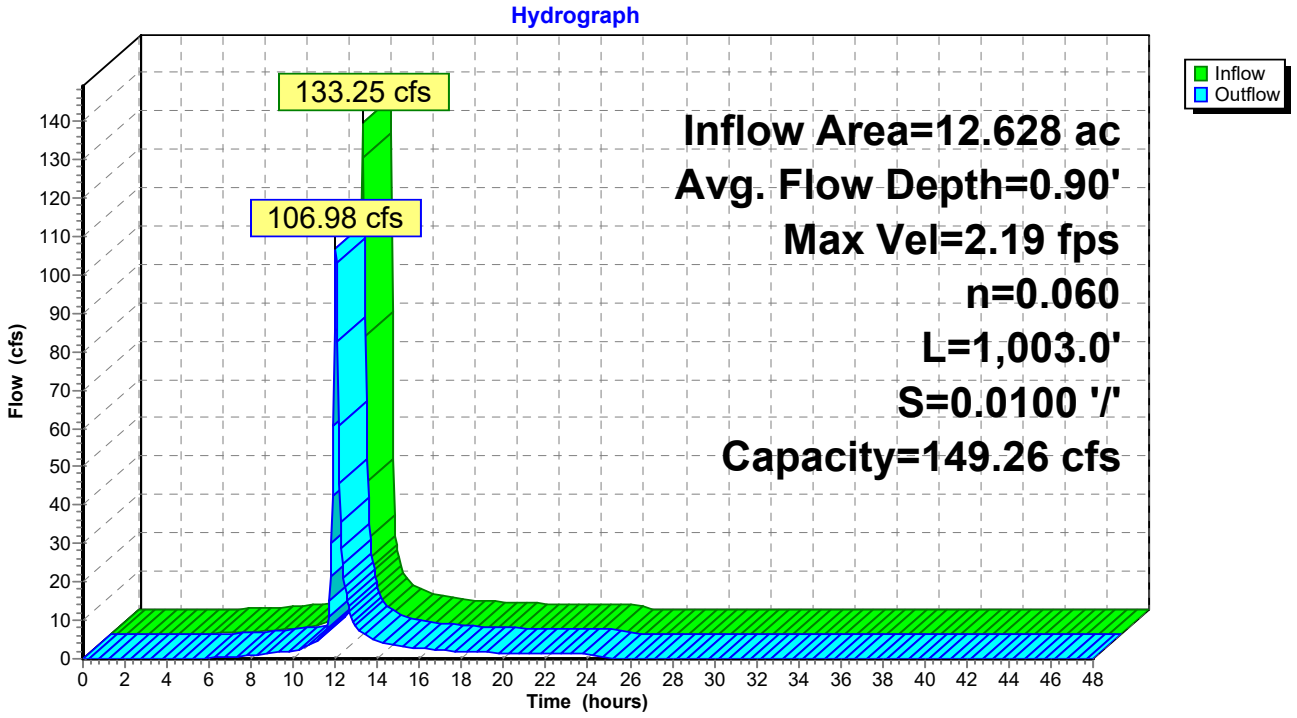
Peak Storage= 48,628 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.90'
Bank-Full Depth= 1.10' Flow Area= 59.8 sf, Capacity= 149.26 cfs

50.00' x 1.10' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.80'
Length= 1,003.0' Slope= 0.0100 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 84R: Middle Channel 2



Summary for Reach 86R: Middle Channel 3

Changed depth to 0.6 feet to meet 100-year storm

Inflow Area = 19.614 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 206.97 cfs @ 11.96 hrs, Volume= 10.670 af
Outflow = 152.31 cfs @ 12.03 hrs, Volume= 10.670 af, Atten= 26%, Lag= 4.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.51 fps, Min. Travel Time= 10.0 min
Avg. Velocity = 0.35 fps, Avg. Travel Time= 70.7 min

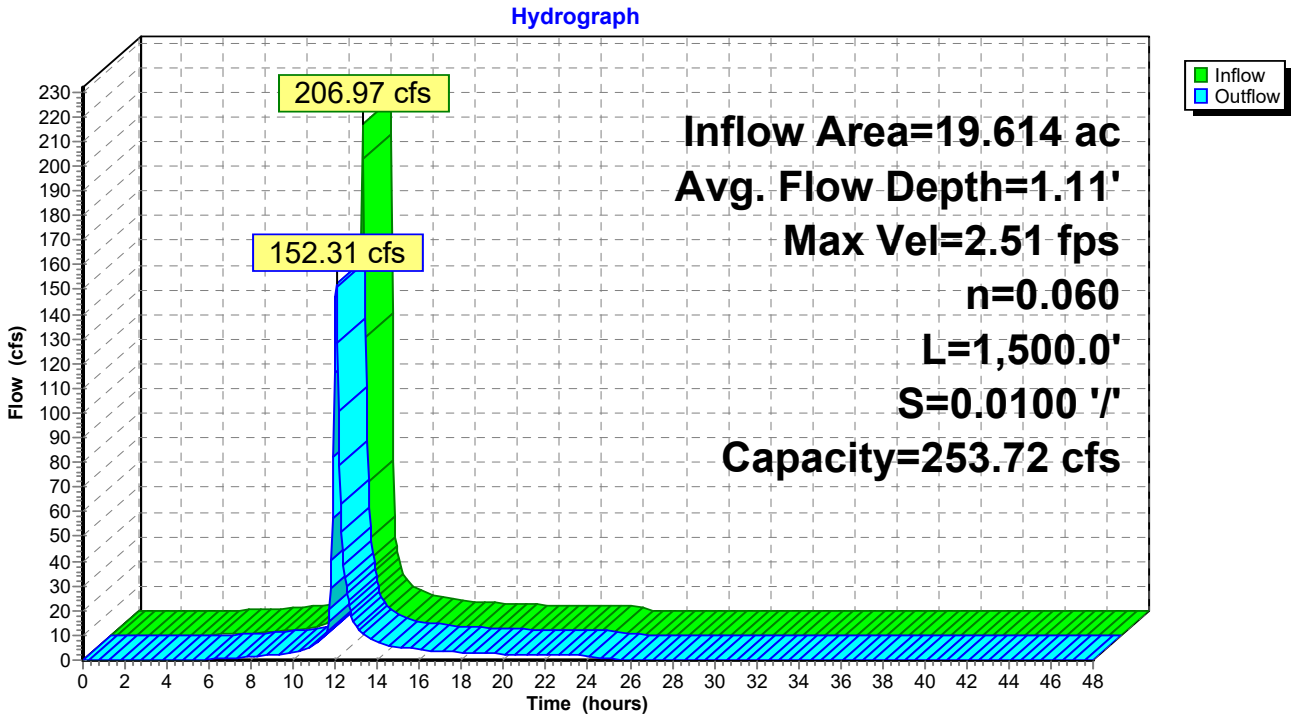
Peak Storage= 90,861 cf @ 12.03 hrs
Average Depth at Peak Storage= 1.11'
Bank-Full Depth= 1.50' Flow Area= 84.0 sf, Capacity= 253.72 cfs

50.00' x 1.50' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 62.00'
Length= 1,500.0' Slope= 0.0100 '/'
Inlet Invert= 23.00', Outlet Invert= 8.00'



‡

Reach 86R: Middle Channel 3



Summary for Reach 87R: East Channel 1

Inflow Area = 2.239 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 23.63 cfs @ 11.96 hrs, Volume= 1.218 af
Outflow = 20.44 cfs @ 12.01 hrs, Volume= 1.218 af, Atten= 13%, Lag= 2.7 min

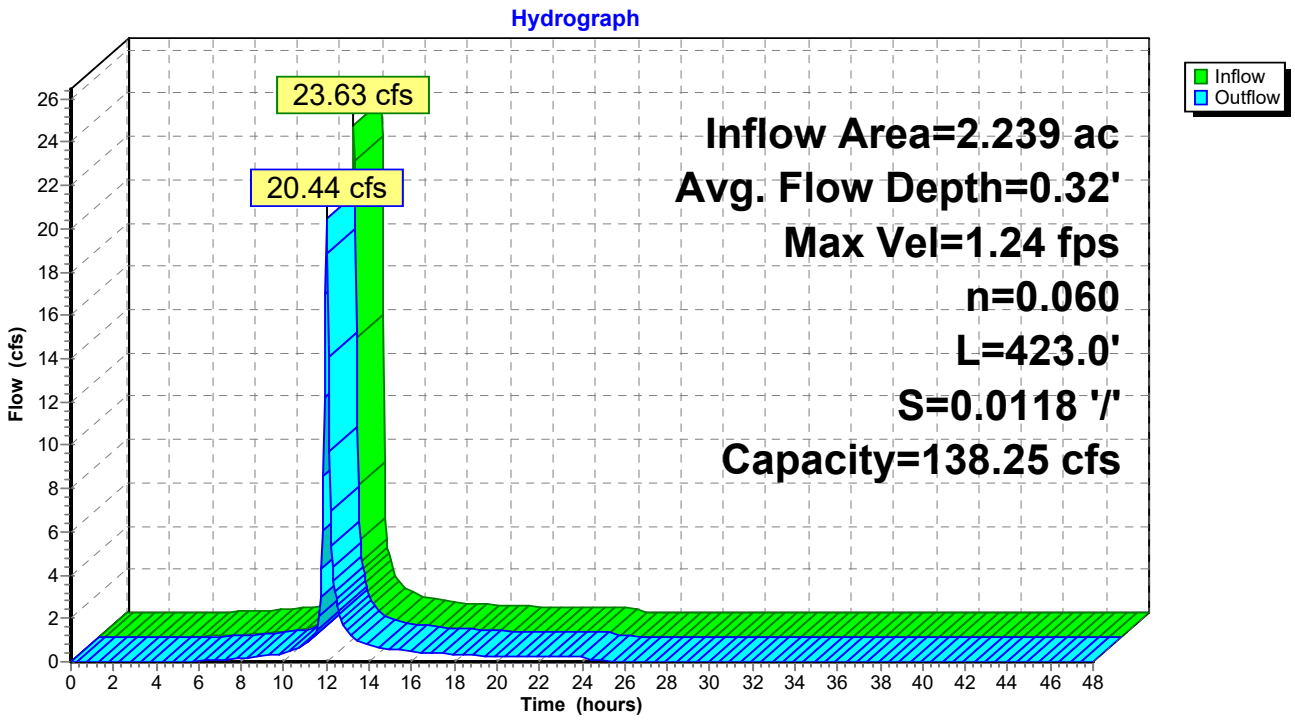
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.24 fps, Min. Travel Time= 5.7 min
Avg. Velocity = 0.22 fps, Avg. Travel Time= 31.4 min

Peak Storage= 6,969 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 138.25 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 423.0' Slope= 0.0118 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡



Summary for Reach 89R: East Channel 2

Inflow Area = 4.167 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 43.97 cfs @ 11.96 hrs, Volume= 2.267 af
Outflow = 35.38 cfs @ 12.02 hrs, Volume= 2.267 af, Atten= 20%, Lag= 3.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.46 fps, Min. Travel Time= 7.7 min
Avg. Velocity = 0.24 fps, Avg. Travel Time= 47.3 min

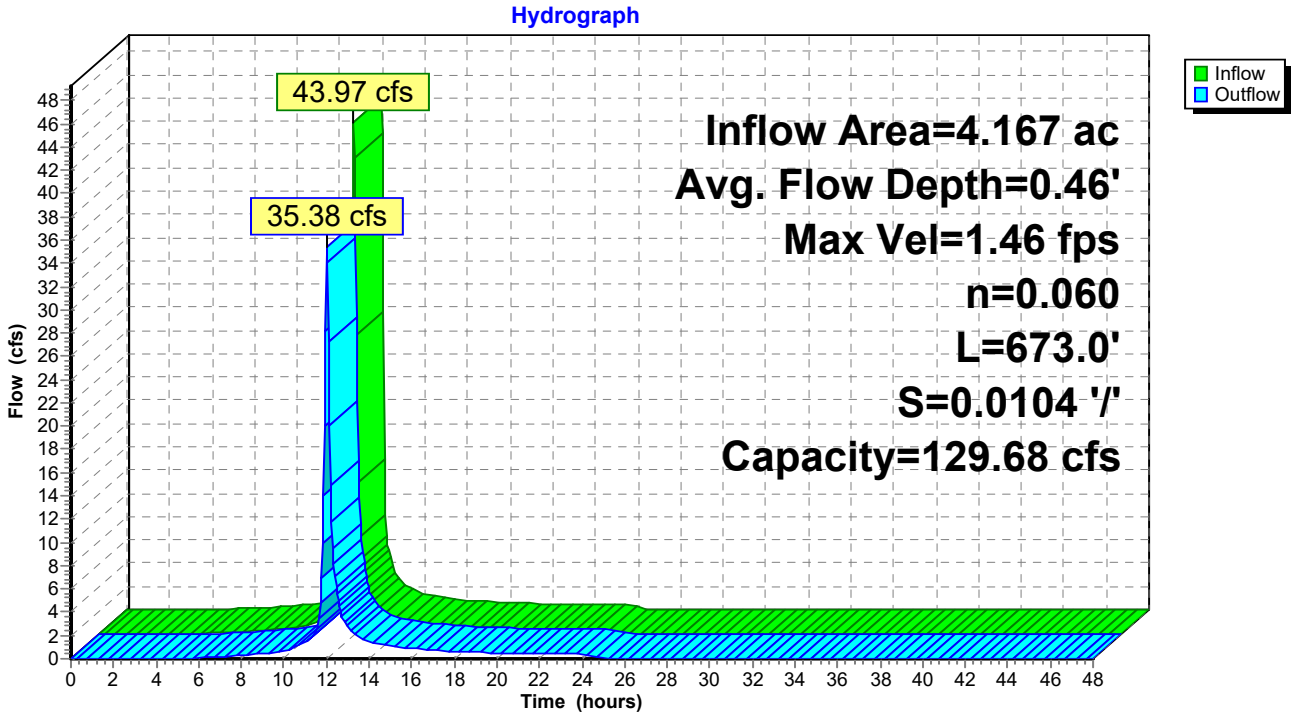
Peak Storage= 16,159 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.68 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 673.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 11.00'



‡

Reach 89R: East Channel 2



Summary for Reach 91R: East Channel 3

Inflow Area = 10.335 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 109.06 cfs @ 11.96 hrs, Volume= 5.622 af
Outflow = 82.73 cfs @ 12.03 hrs, Volume= 5.622 af, Atten= 24%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.00 fps, Min. Travel Time= 9.2 min
Avg. Velocity = 0.27 fps, Avg. Travel Time= 67.1 min

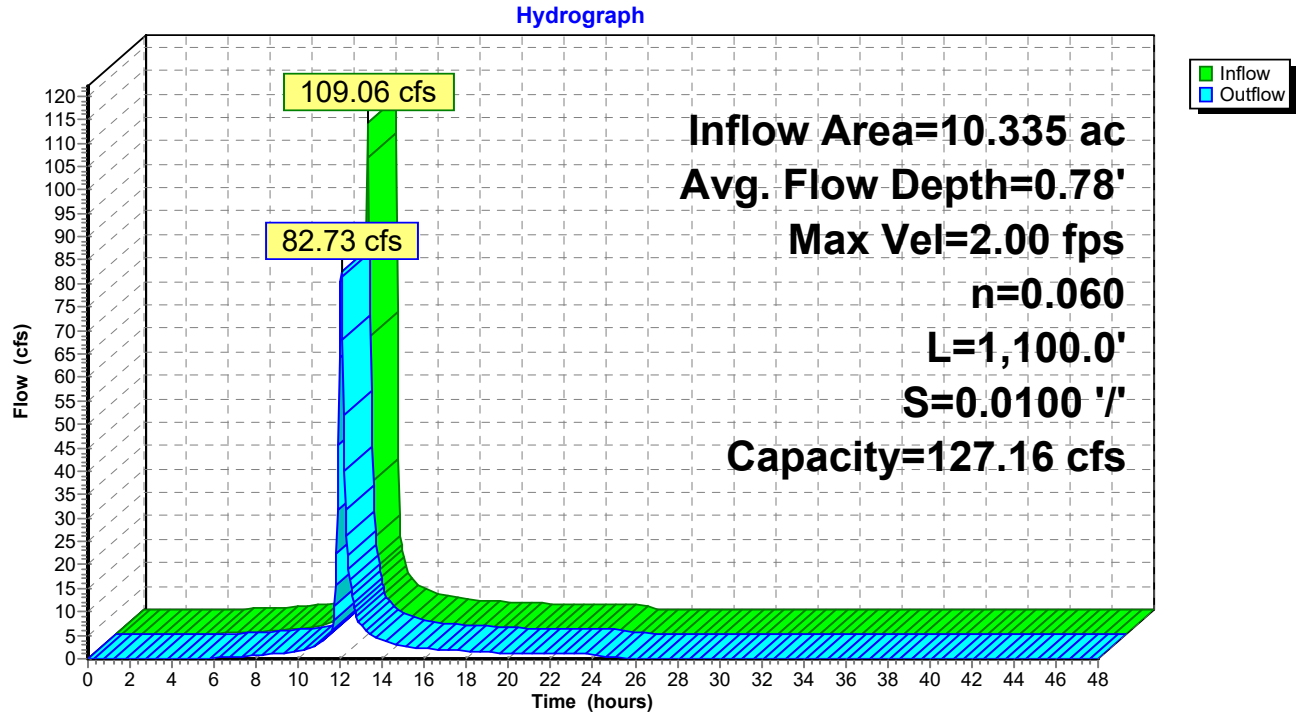
Peak Storage= 45,327 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.78'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,100.0' Slope= 0.0100 '/'
Inlet Invert= 22.00', Outlet Invert= 11.00'



‡

Reach 91R: East Channel 3



Summary for Reach 94R: West Channel 2

Inflow Area = 7.233 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 76.32 cfs @ 11.96 hrs, Volume= 3.935 af
Outflow = 59.45 cfs @ 12.02 hrs, Volume= 3.935 af, Atten= 22%, Lag= 3.6 min

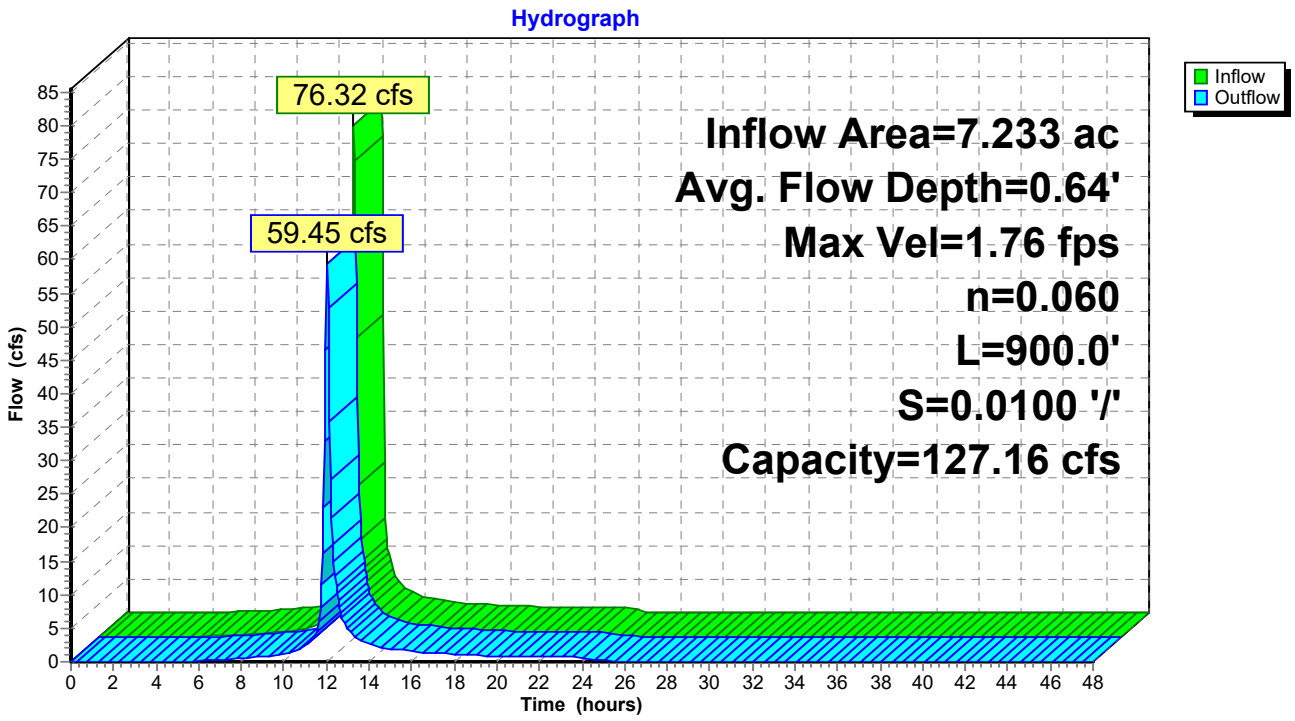
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.76 fps, Min. Travel Time= 8.5 min
Avg. Velocity = 0.26 fps, Avg. Travel Time= 58.6 min

Peak Storage= 30,176 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.64'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.16 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 900.0' Slope= 0.0100 '/'
Inlet Invert= 16.00', Outlet Invert= 7.00'



‡



Summary for Reach 95R: West Channel 4

Inflow Area = 11.630 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 122.72 cfs @ 11.96 hrs, Volume= 6.327 af
Outflow = 94.75 cfs @ 12.03 hrs, Volume= 6.327 af, Atten= 23%, Lag= 3.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.10 fps, Min. Travel Time= 8.7 min
Avg. Velocity = 0.28 fps, Avg. Travel Time= 64.2 min

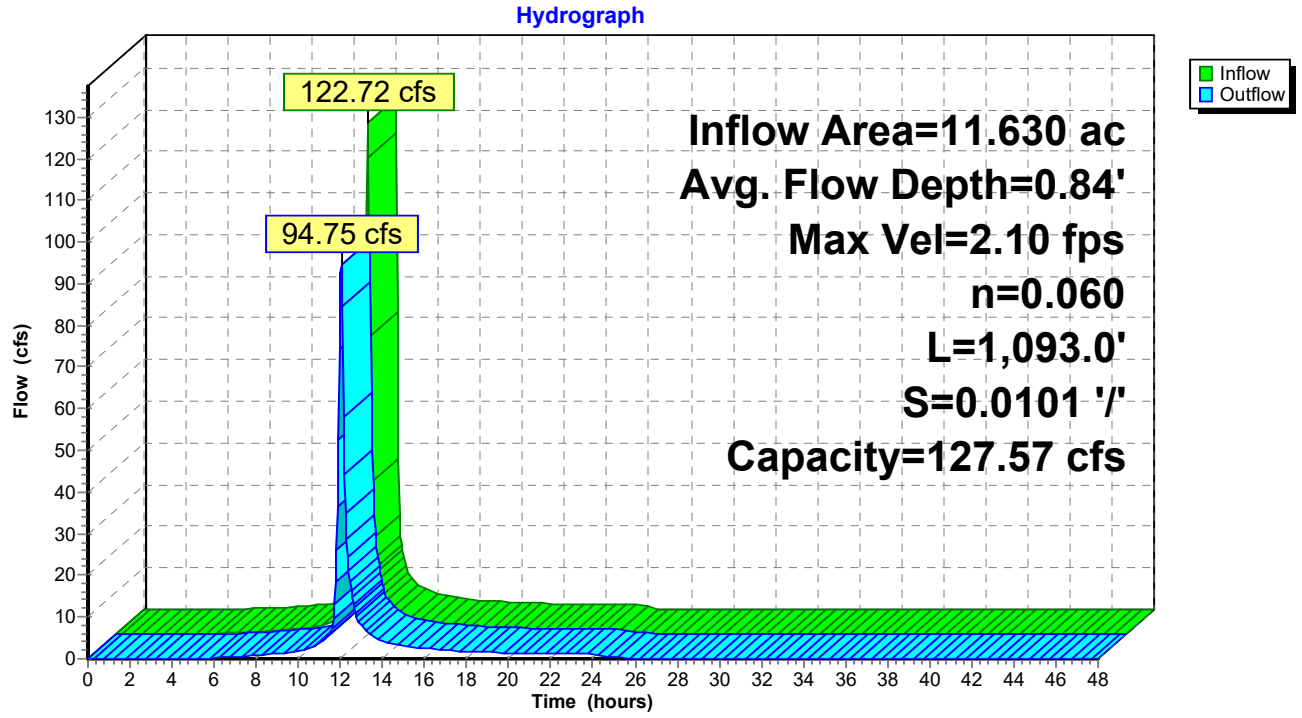
Peak Storage= 48,946 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.84'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 127.57 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 1,093.0' Slope= 0.0101 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 95R: West Channel 4



Summary for Reach 96R: West Channel 1

Inflow Area = 5.837 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 61.59 cfs @ 11.96 hrs, Volume= 3.175 af
Outflow = 44.96 cfs @ 12.03 hrs, Volume= 3.175 af, Atten= 27%, Lag= 4.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.47 fps, Min. Travel Time= 10.3 min
Avg. Velocity = 0.21 fps, Avg. Travel Time= 71.8 min

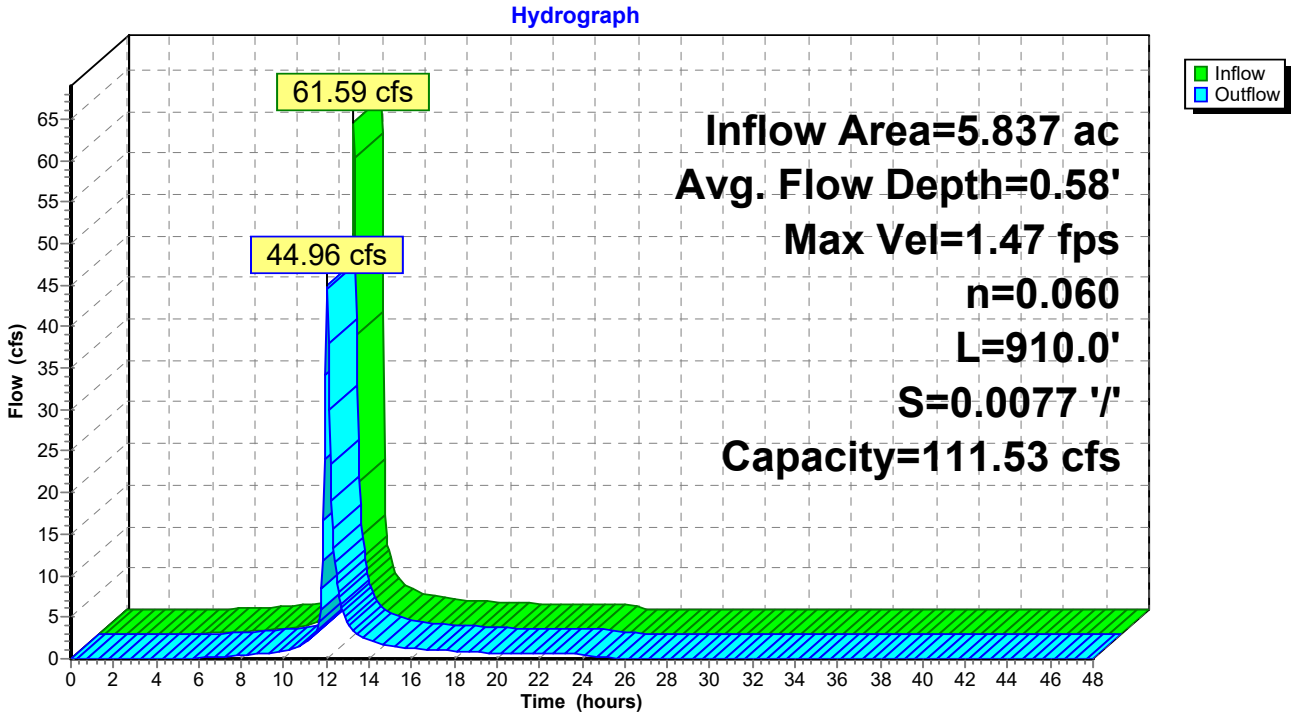
Peak Storage= 27,814 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.58'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 111.53 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 910.0' Slope= 0.0077 '/'
Inlet Invert= 14.00', Outlet Invert= 7.00'



‡

Reach 96R: West Channel 1



Summary for Reach 97R: West Channel 5

Inflow Area = 7.290 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 76.93 cfs @ 11.96 hrs, Volume= 3.966 af
Outflow = 58.92 cfs @ 12.03 hrs, Volume= 3.966 af, Atten= 23%, Lag= 3.7 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.82 fps, Min. Travel Time= 9.0 min
Avg. Velocity = 0.27 fps, Avg. Travel Time= 61.3 min

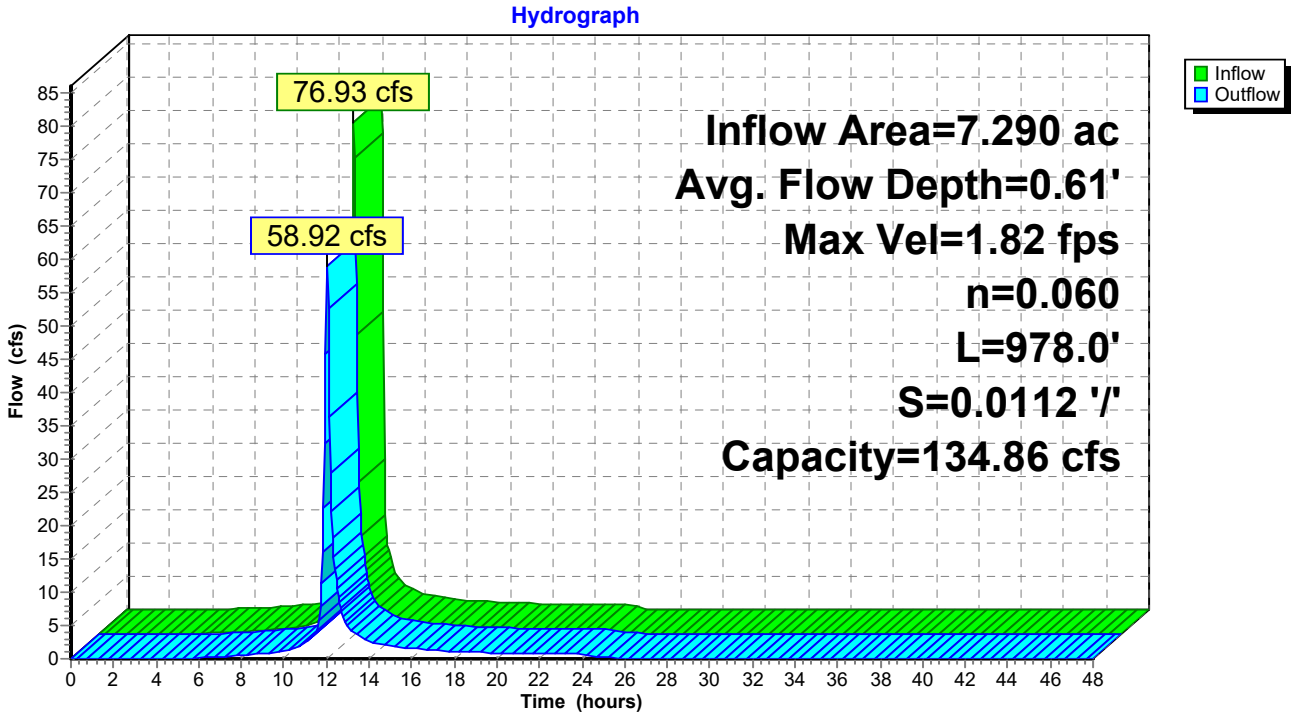
Peak Storage= 31,431 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 134.86 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 978.0' Slope= 0.0112 '/'
Inlet Invert= 18.00', Outlet Invert= 7.00'



‡

Reach 97R: West Channel 5



Summary for Reach 99R: Middle Channel 4

Inflow Area = 9.879 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 92.81 cfs @ 12.01 hrs, Volume= 5.374 af
Outflow = 75.47 cfs @ 12.07 hrs, Volume= 5.374 af, Atten= 19%, Lag= 3.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.95 fps, Min. Travel Time= 8.2 min
Avg. Velocity = 0.28 fps, Avg. Travel Time= 56.8 min

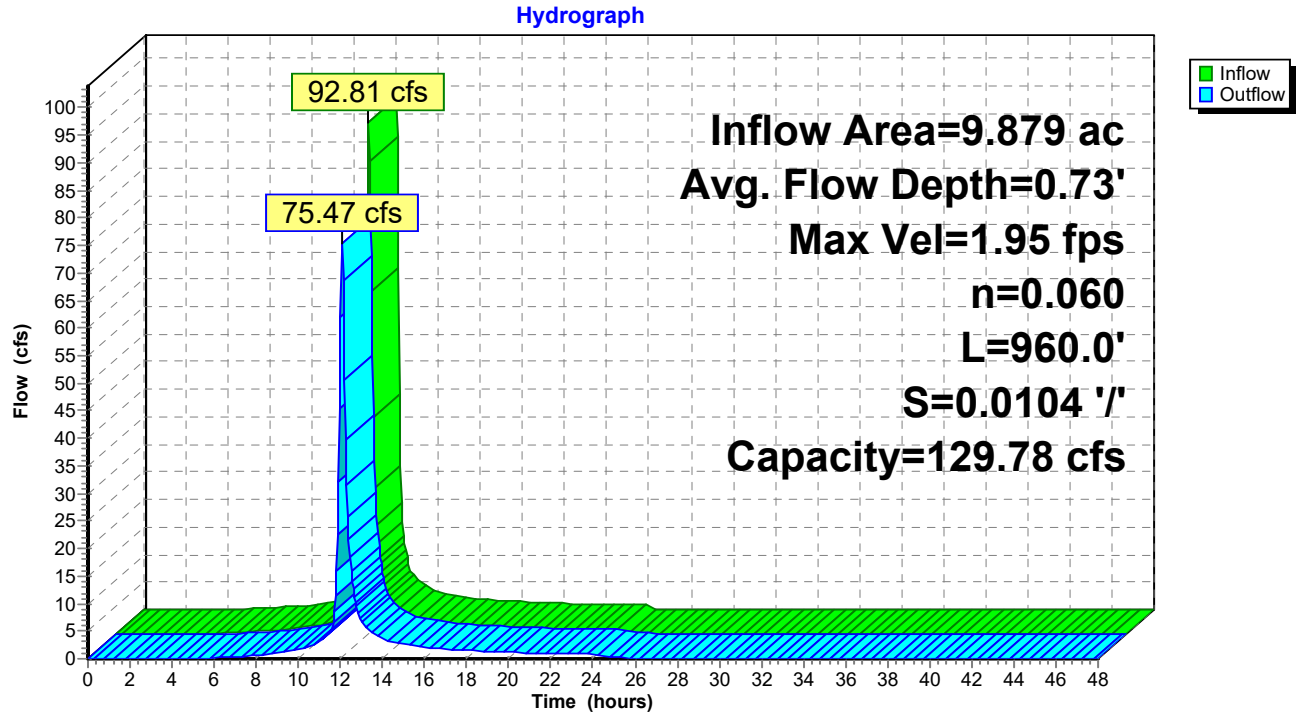
Peak Storage= 36,874 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.73'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 129.78 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 960.0' Slope= 0.0104 '/'
Inlet Invert= 18.00', Outlet Invert= 8.00'



‡

Reach 99R: Middle Channel 4



Summary for Reach 101R: Middle Channel 5

Inflow Area = 3.587 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 37.85 cfs @ 11.96 hrs, Volume= 1.951 af
Outflow = 28.65 cfs @ 12.03 hrs, Volume= 1.951 af, Atten= 24%, Lag= 3.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 1.36 fps, Min. Travel Time= 9.3 min
Avg. Velocity = 0.22 fps, Avg. Travel Time= 56.9 min

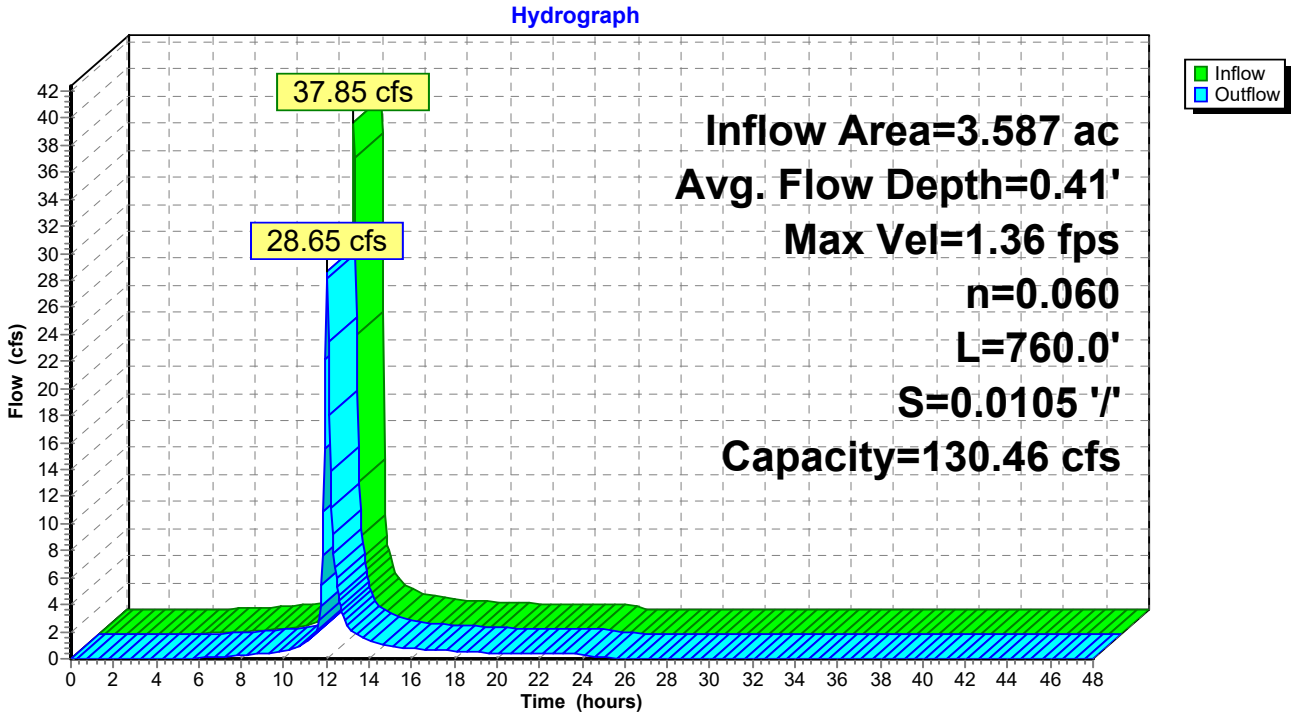
Peak Storage= 15,964 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 130.46 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 760.0' Slope= 0.0105 '/'
Inlet Invert= 16.00', Outlet Invert= 8.00'



‡

Reach 101R: Middle Channel 5



Summary for Reach 105R: East Channel 4

Inflow Area = 9.065 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 95.66 cfs @ 11.96 hrs, Volume= 4.931 af
Outflow = 86.94 cfs @ 12.00 hrs, Volume= 4.931 af, Atten= 9%, Lag= 2.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 2.03 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 0.31 fps, Avg. Travel Time= 27.6 min

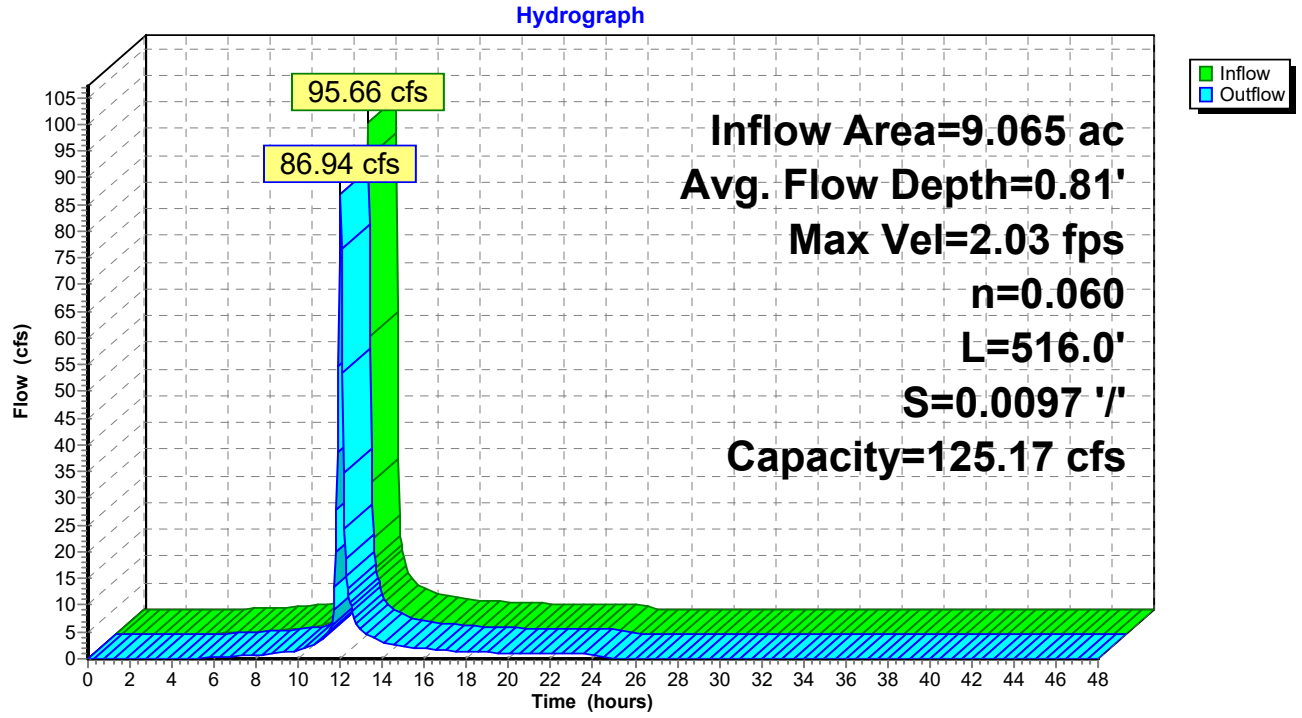
Peak Storage= 22,143 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.81'
Bank-Full Depth= 1.00' Flow Area= 54.0 sf, Capacity= 125.17 cfs

50.00' x 1.00' deep channel, n= 0.060
Side Slope Z-value= 4.0 '/' Top Width= 58.00'
Length= 516.0' Slope= 0.0097 '/'
Inlet Invert= 16.00', Outlet Invert= 11.00'



‡

Reach 105R: East Channel 4



Summary for Pond 28P: West Outlet/West Emergency Spillway

[62] Hint: Exceeded Reach 77R OUTLET depth by 3.64' @ 13.05 hrs
[62] Hint: Exceeded Reach 94R OUTLET depth by 3.73' @ 12.95 hrs
[62] Hint: Exceeded Reach 95R OUTLET depth by 3.68' @ 12.95 hrs
[62] Hint: Exceeded Reach 96R OUTLET depth by 3.73' @ 12.95 hrs
[62] Hint: Exceeded Reach 97R OUTLET depth by 3.73' @ 12.95 hrs

Inflow Area = 46.140 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 359.23 cfs @ 12.03 hrs, Volume= 25.100 af
Outflow = 41.10 cfs @ 12.80 hrs, Volume= 25.100 af, Atten= 89%, Lag= 45.9 min
Primary = 41.10 cfs @ 12.80 hrs, Volume= 25.100 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.88' @ 12.80 hrs Surf.Area= 249,756 sf Storage= 438,594 cf

Plug-Flow detention time= 91.0 min calculated for 25.074 af (100% of inflow)
Center-of-Mass det. time= 90.9 min (906.2 - 815.4)

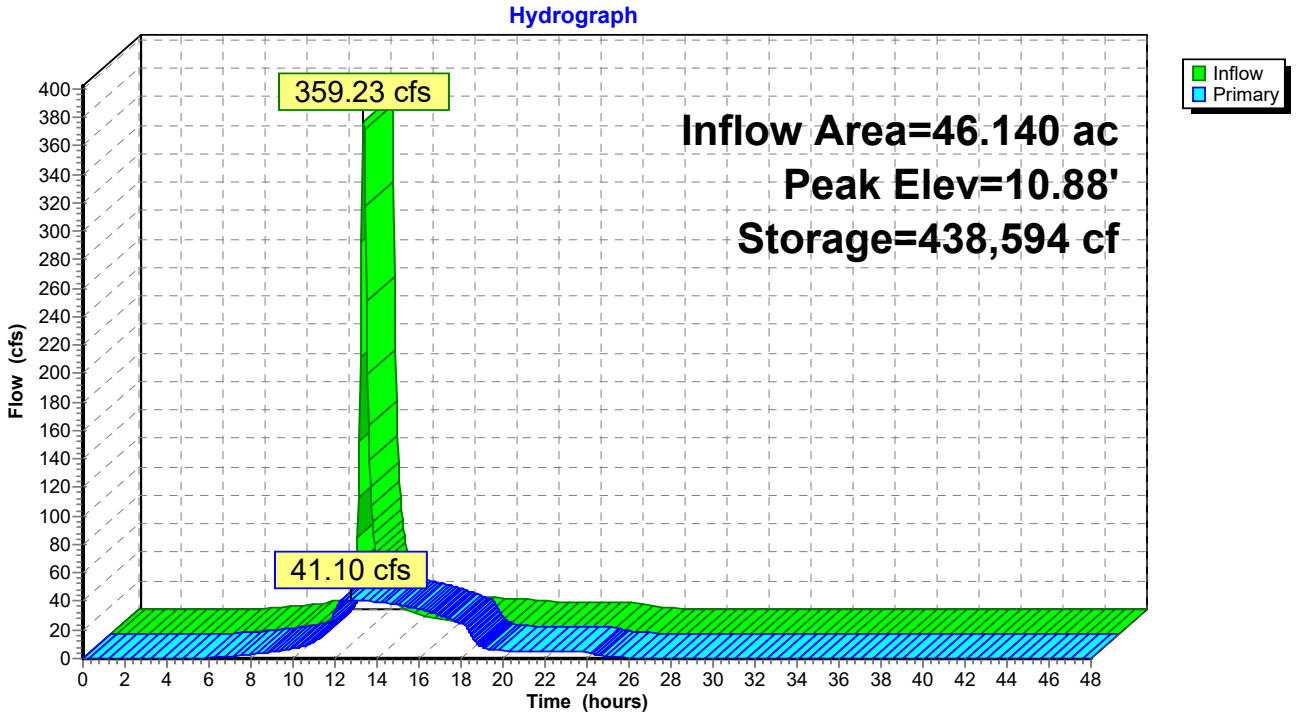
Volume	Invert	Avail.Storage	Storage Description
#1	6.00'	786,184 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
6.00	25	25.0	0	0	25
7.00	17,893	714.0	6,196	6,196	40,545
8.00	54,145	1,528.0	34,388	40,584	185,777
9.00	103,329	2,053.0	77,424	118,008	335,396
10.00	171,483	2,546.0	135,975	253,983	515,837
11.00	261,382	2,995.0	214,859	468,842	713,838
12.00	376,810	3,340.0	317,342	786,184	887,789

Device	Routing	Invert	Outlet Devices
#1	Primary	6.00'	**18.0" Round Culvert X 3.00** L= 205.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 6.00' / 5.00' S= 0.0049 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	11.00'	**100.0' long x 155.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=41.10 cfs @ 12.80 hrs HW=10.88' (Free Discharge)
1=Culvert (Barrel Controls 41.10 cfs @ 7.75 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 28P: West Outlet/West Emergency Spillway



Summary for Pond 29P: Middle Outlet/Middle Emergency Spillway

[62] Hint: Exceeded Reach 82R OUTLET depth by 4.04' @ 12.95 hrs
[62] Hint: Exceeded Reach 84R OUTLET depth by 3.98' @ 13.00 hrs
[62] Hint: Exceeded Reach 86R OUTLET depth by 3.91' @ 13.10 hrs
[62] Hint: Exceeded Reach 99R OUTLET depth by 4.00' @ 13.00 hrs
[62] Hint: Exceeded Reach 101R OUTLET depth by 4.08' @ 12.90 hrs

Inflow Area = 51.444 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 402.72 cfs @ 12.04 hrs, Volume= 27.986 af
Outflow = 43.20 cfs @ 12.82 hrs, Volume= 27.986 af, Atten= 89%, Lag= 46.8 min
Primary = 43.20 cfs @ 12.82 hrs, Volume= 27.986 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 12.18' @ 12.82 hrs Surf.Area= 282,909 sf Storage= 497,423 cf

Plug-Flow detention time= 97.3 min calculated for 27.986 af (100% of inflow)
Center-of-Mass det. time= 97.2 min (910.6 - 813.4)

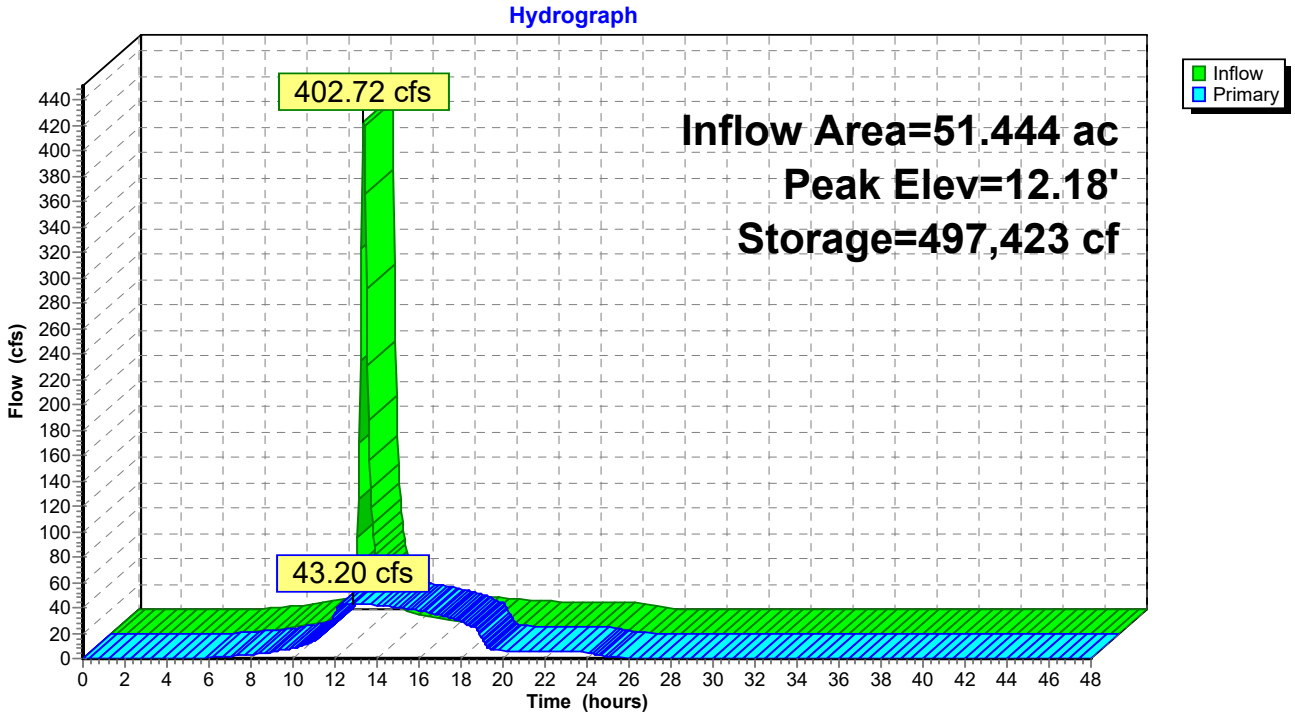
Volume	Invert	Avail.Storage	Storage Description
#1	7.00'	1,236,409 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
7.00	25	25.0	0	0	25
8.00	10,947	460.0	3,832	3,832	16,816
9.00	49,342	1,391.0	27,843	31,675	153,953
10.00	97,395	1,948.0	72,020	103,695	301,963
11.00	168,546	2,477.0	131,355	235,050	488,253
12.00	261,632	2,967.0	213,390	448,440	700,548
13.00	390,402	3,366.0	323,877	772,317	901,654
14.00	541,914	3,757.0	464,092	1,236,409	1,123,314

Device	Routing	Invert	Outlet Devices
#1	Primary	7.00'	**18.0" Round Culvert X 3.00** L= 195.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 7.00' / 6.00' S= 0.0051 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	12.50'	**100.0' long x 105.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=43.20 cfs @ 12.82 hrs HW=12.18' (Free Discharge)
1=Culvert (Barrel Controls 43.20 cfs @ 8.15 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 29P: Middle Outlet/Middle Emergency Spillway



Summary for Pond 30P: East Outlet/East Emergency Spillway

[62] Hint: Exceeded Reach 87R OUTLET depth by 2.62' @ 12.50 hrs
[62] Hint: Exceeded Reach 89R OUTLET depth by 2.56' @ 12.55 hrs
[62] Hint: Exceeded Reach 91R OUTLET depth by 2.45' @ 12.60 hrs
[62] Hint: Exceeded Reach 105R OUTLET depth by 2.50' @ 12.55 hrs

Inflow Area = 25.806 ac, 0.00% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 224.30 cfs @ 12.01 hrs, Volume= 14.039 af
Outflow = 38.19 cfs @ 12.43 hrs, Volume= 14.039 af, Atten= 83%, Lag= 25.2 min
Primary = 38.19 cfs @ 12.43 hrs, Volume= 14.039 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 13.72' @ 12.43 hrs Surf.Area= 141,894 sf Storage= 206,662 cf

Plug-Flow detention time= 41.3 min calculated for 14.039 af (100% of inflow)
Center-of-Mass det. time= 41.2 min (848.6 - 807.4)

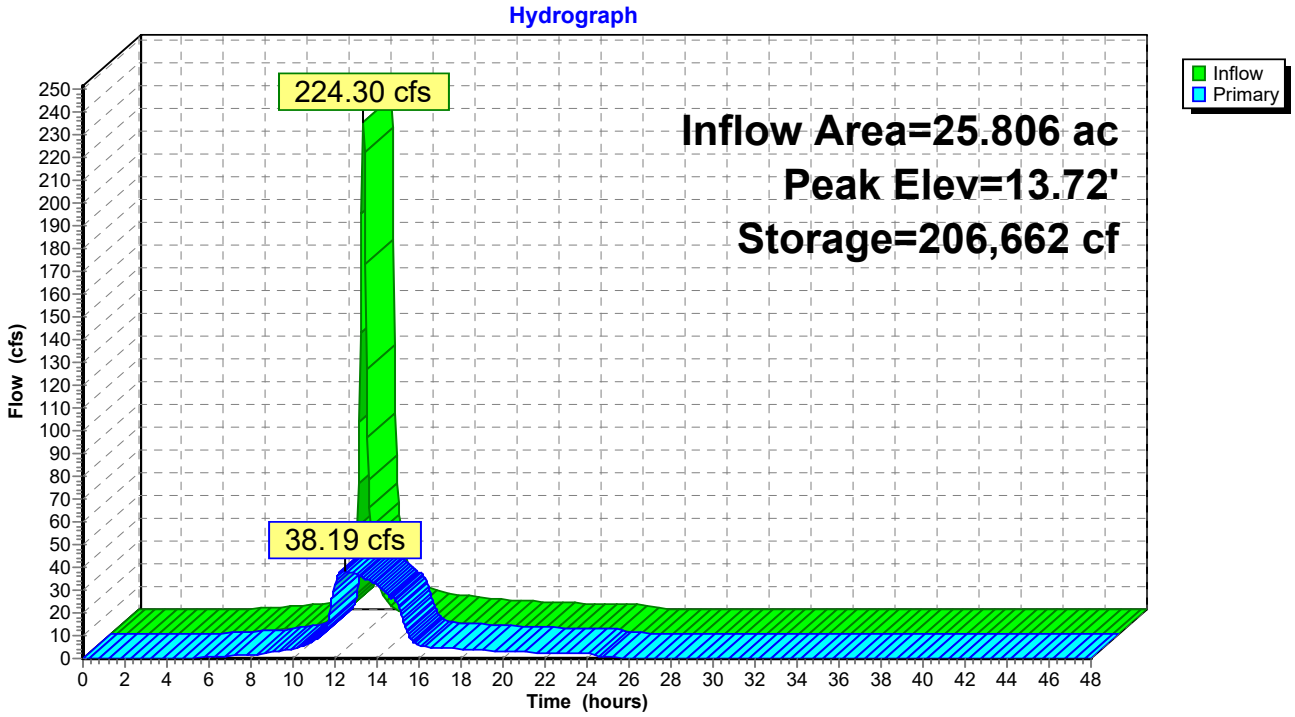
Volume	Invert	Avail.Storage	Storage Description
#1	10.00'	451,099 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
10.00	25	25.0	0	0	25
11.00	18,449	600.0	6,384	6,384	28,625
12.00	57,145	1,325.0	36,021	42,406	139,689
13.00	100,293	1,787.0	77,714	120,120	254,112
14.00	160,181	2,277.0	129,074	249,194	412,592
15.00	246,734	2,722.0	201,906	451,099	589,634

Device	Routing	Invert	Outlet Devices
#1	Primary	10.00'	**18.0" Round Culvert X 3.00** L= 160.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 10.00' / 9.00' S= 0.0063 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Primary	14.00'	**100.0' long x 127.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=38.19 cfs @ 12.43 hrs HW=13.72' (Free Discharge)
1=Culvert (Barrel Controls 38.19 cfs @ 7.20 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 30P: East Outlet/East Emergency Spillway



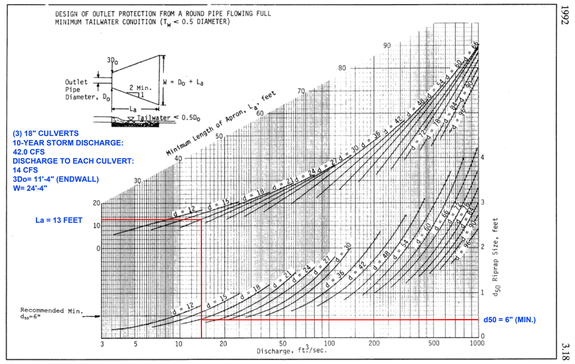
Appendix 3

Sediment Basin Design Calculations

WEST STORMWATER OUTLET

OP

Source: USDA-SCS

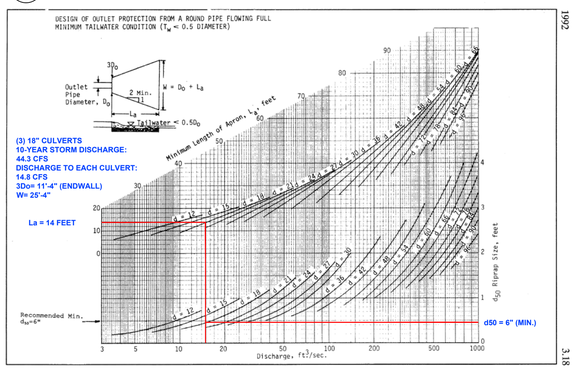


1992 — III - 164 — Plate 3.18-3 — 3.18

MIDDLE STORMWATER OUTLET

OP

Source: USDA-SCS

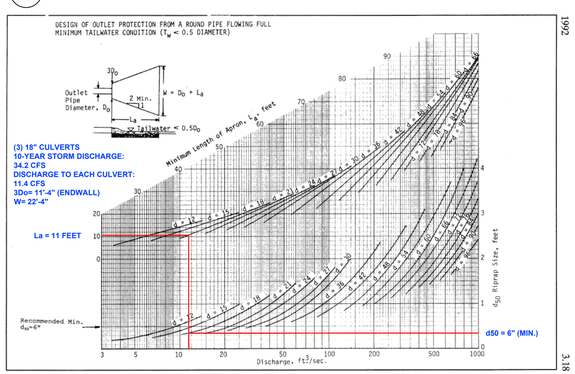


1992 — III - 164 — Plate 3.18-3 — 3.18

EAST STORMWATER OUTLET

OP

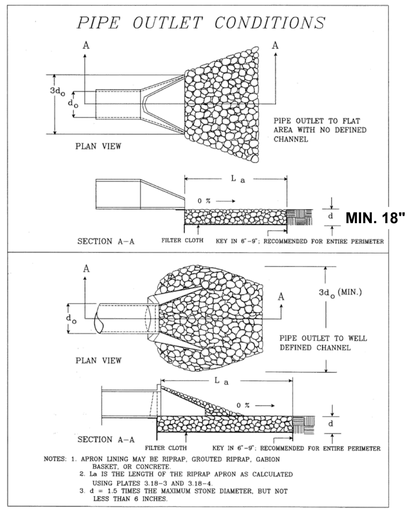
Source: USDA-SCS



1992 — III - 164 — Plate 3.18-3 — 3.18

1992 OP 3.18

PIPE OUTLET CONDITIONS



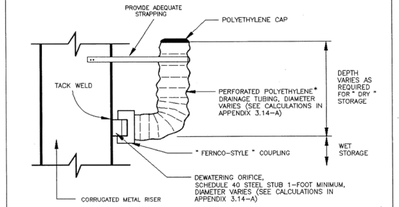
NOTES: 1. APRON LINING MAY BE RIPRAP, GROUTED RIPRAP, GABION BASKET, OR CONCRETE.
2. L_a IS THE LENGTH OF THE RIPRAP APRON AS CALCULATED USING PLATES 3.18-3 AND 3.18-4.
3. d = 1.5 TIMES THE MAXIMUM STONE DIAMETER, BUT NOT LESS THAN 6 INCHES.

Source: Va. DSWC — Plate 3.18-1

III - 157

1992 SB1 SB2 3.14

RECOMMENDED DEWATERING SYSTEM FOR SEDIMENT BASINS



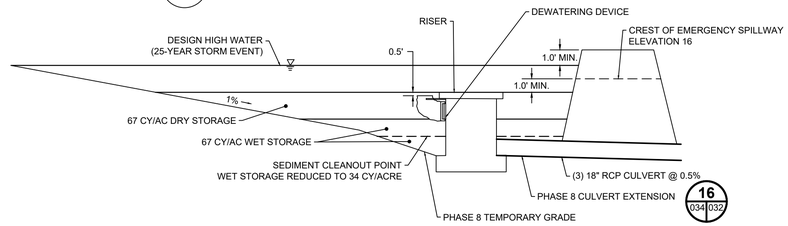
NOTE: WITH CONCRETE RISER, USE PVC SCHEDULE 40 STUB FOR DEWATERING ORIFICE

*DRAINAGE TUBING SHALL COMPLY WITH ASTM F667 AND AASHTO M294

Source: Va. DSWC — Plate 3.14-15

III - 111

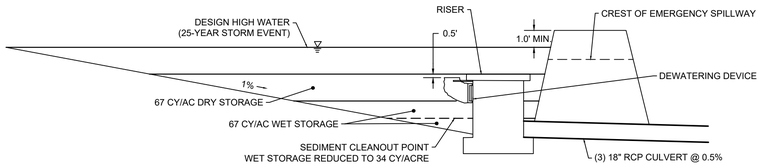
SB1 TEMPORARY SEDIMENT BASIN ELEVATION SCHEMATIC 1



NOTES:

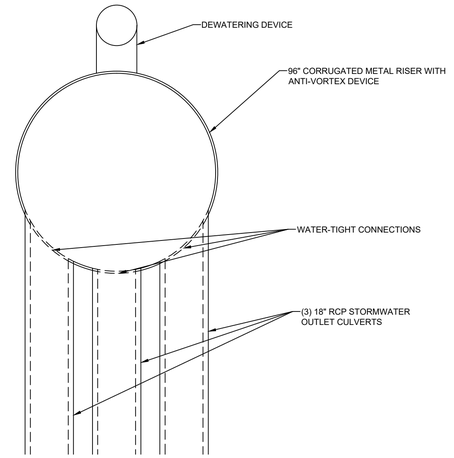
1. SEE PHASE 8 CULVERT EXTENSION PROFILE ON SHEET 032.
2. SEE TEMPORARY SEDIMENT BASIN RISER DETAIL ON THIS SHEET.

SB2 TEMPORARY SEDIMENT BASIN ELEVATION SCHEMATIC 2



NOTES:

1. SEE FINAL CONDITIONS CULVERT PROFILES ON SHEET 029.
2. SEE TEMPORARY SEDIMENT BASIN RISER DETAIL ON THIS SHEET.



SB1 SB2 TEMPORARY SEDIMENT BASIN RISER DETAIL

NOTES:

1. SEE RISER PIPE BASE CONDITIONS PLATE 3.14-3 ON THIS SHEET.
2. SEE ANTI-VORTEX DEVICE DESIGN PLATE 3.14-10 ON THIS SHEET.
3. SEE RECOMMENDED DEWATERING SYSTEM FOR SEDIMENT BASINS PLATE 3.14-15 ON THIS SHEET.

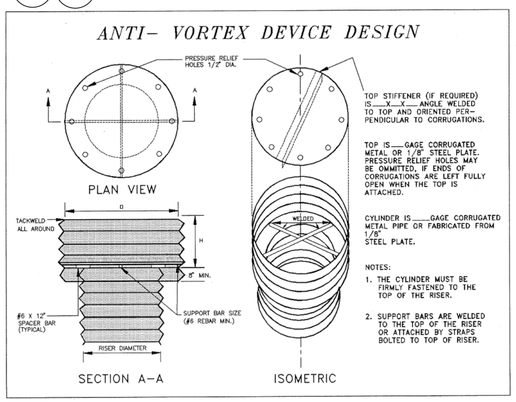
SEDIMENT BASIN SUMMARY

SCHEMATIC	BASIN	DRAINAGE AREA (ACRES)	WET STORAGE		DRY STORAGE		BOTTOM ELEVATION	DEWATERING DEVICE ELEVATION	DEWATERING ORIFICE DIAMETER (INCH)	DEWATERING DEVICE DRAINAGE TUBING DIAMETER (INCH)	RISER HEIGHT (FT)	RISER DIAMETER (INCH)	RISER CREST ELEVATION	SEDIMENT BASIN SPILLWAY ELEVATION	OUTLET BARREL			
			VOLUME REQUIRED (CY)	VOLUME PROVIDED (CY)	VOLUME REQUIRED (CY)	VOLUME PROVIDED (CY)									PIPE LENGTH (FT)	PIPE DIAMETER (INCH)	INVERT IN	INVERT OUT
1	WEST	46.6	3122	3193	3122	5647	6.0	8.7	12.0	15.0	4.0	96	10.0	16.0	256	(3) 18	6	3
2	WEST	46.6	3122	3193	3122	5647	6.0	8.7	12.0	15.0	4.0	96	10.0	11.0	214	(3) 18	6	3
1	MIDDLE	51.8	3471	3757	3471	7760	7.0	10.0	15.0	18.0	4.5	96	11.5	16.0	246	(3) 18	7	3
2	MIDDLE	51.8	3471	3757	3471	7760	7.0	10.0	15.0	18.0	4.5	96	11.5	12.5	203	(3) 18	7	3
2	EAST	26.5	1776	1785	1776	4598	10.0	12.1	14.0	15.0	3.5	96	13.5	14.0	215	(3) 18	10	3

SB1 SB2

Source: USDA-SCS

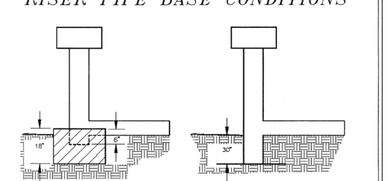
ANTI- VORTEX DEVICE DESIGN



1992 — III - 103 — Plate 3.14-10 — 3.14

1992 3.14

RISER PIPE BASE CONDITIONS



Source: Va. DSWC — Plate 3.14-3

SB1 SB2 NOTES:

1. RISER BASE SHALL BE INSTALLED PER VA EROSION AND SEDIMENT CONTROL HANDBOOK SPECIFICATION 3.14.

AECOM

TITLE

EROSION AND SEDIMENT CONTROL DETAILS I

CHESTERFIELD POWER STATION
CLOSURE PLAN - UPPER ASH POND
CHESTERFIELD COUNTY, VIRGINIA

FOR

ISSUED FOR CONSTRUCTION

SEAL

COMMONWEALTH OF VIRGINIA
GABRIEL WILLIAM LANG
Lic. No. 041875
PROFESSIONAL ENGINEER
5/1/20

Dominion Energy

SCALE: AS SHOWN	DES: MSR
DWG TYPE: .DWG	DFTR: JBM
JOB NO: 60614683	CHKD: RJB
DATE: 5-01-2020	ENGR: GWL
FILENAME: EROSION AND SEDIMENT CONTROL DETAILS.DWG	APPD: GWL
DWG SIZE	DRAWING NO.	REVISION
ANSI D 22.0"x34.0"	034	0

034 REV. 0

Concrete Reinforcing Steel Institute
933 North Plum Grove Road
Schaumburg, Illinois 60173
p: 847.517.1200 | f: 847.517.1206
www.crsi.org

Project		Sheet No.
Dominion Chesterfield		1 of 2
Made By	Checked By	Date
Subject: Most-up-to-date Sed. Basin		Project No.

Dewatering Orifice Elevation:

West

46.6 ac × 67 cy/ac = Wet/Dry Storage Req. 3122 CY → Elevation 8.7 → Hydro CAD 86,211 CF = 3193 CY (Wet Storage Provided)

Middle

51.8 ac × 67 cy/ac = 3471 CY → 10.0 → 101,447 CF = 3757 CY (Wet Storage Provided)

East

26.5 ac × 67 cy/ac = 1776 CY → 12.1 → 48,207 CF = 1785 CY (Wet Storage Provided)

Dry Storage:

West | Riser Elev. = 10 → Hydro CAD 238700 CF = 8840 CY

8840 - 3193 = 5647 CY Dry Provided

Middle | Riser Elev. = 11.5 → 310,964 CF = 11517 CY

11517 - 3757 = 7760 CY Dry Provided

East | Riser Elev. = 13.5 → 172,359 CF = 6383 CY

6383 - 1785 = 4598 CY Dry Provided

Concrete Reinforcing Steel Institute
933 North Plum Grove Road
Schaumburg, Illinois 60173
p: 847.517.1200 | f: 847.517.1206
www.crsi.org

Project		Sheet No. 2 of 2
Made By	Checked By	Date
Subject		Project No.

Dewatering Orifice Size

West

$$Q = \frac{S}{21{,}600\ \text{sec}} = \frac{5647\ \text{CY} \times 27}{21{,}600} = 7.06\ \text{cfs}$$

S = total Storage available in dry storage, CF

$$A = \frac{Q}{(64.32 \times h)^{1/2}(0.6)} = \frac{7.06}{(64.32 \times 3)^{1/2}(0.6)} = 0.85\ \text{ft}^2$$

$h = 6/2 = 3'$

$$d = 2 \times \left(\frac{A}{3.14}\right)^{1/2} = 2 \times \left(\frac{0.85}{3.14}\right)^{1/2} = 1.04' \approx 12''$$

(rounded down to prolong drawdown time)

Middle

$$Q = \frac{S}{21{,}600\ \text{sec}} = \frac{7760\ \text{CY} \times 27}{21{,}600} = 9.7\ \text{cfs}$$

$$A = \frac{Q}{(64.32 \times h)^{1/2}(0.6)} = \frac{9.7}{(64.32 \times 2.25)^{1/2}(0.6)} = 1.34\ \text{ft}^2$$

$h = 4.5/2 = 2.25'$

$$d = 2 \times \left(\frac{A}{3.14}\right)^{1/2} = 2 \times \left(\frac{1.34}{3.14}\right)^{1/2} = 1.31' \approx 15''$$

(rounded down to prolong drawdown time)

East

$$Q = \frac{S}{21{,}600\ \text{sec}} = \frac{4598\ \text{CY} \times 27}{21{,}600} = 5.75\ \text{cfs}$$

$$A = \frac{Q}{(64.32 \times h)^{1/2}(0.6)} = \frac{5.75}{(64.32 \times 1.25)^{1/2}(0.6)} = 1.07\ \text{ft}^2$$

$h = 2.5/2 = 1.25'$

$$d = 2 \times \left(\frac{A}{3.14}\right)^{1/2} = 2 \times \left(\frac{1.07}{3.14}\right)^{1/2} = 1.17' \approx 14''$$

Appendix 4

Water Quality Calculations (VRRM)

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: **2013 Draft Stds & Specs**

Site Summary

Project Title: Chesterfield Power Station
Date: 43998

Total Rainfall (in):	**43**
Total Disturbed Acreage:	**383.98**

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	94.63	94.63	24
Managed Turf (acres)	0.00	0.00	0.00	157.50	157.50	40
Impervious Cover (acres)	0.00	0.00	0.00	137.16	137.16	35
					389.29	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	343.59	343.59	88
Impervious Cover (acres)	0.00	0.00	0.00	45.70	45.70	12
					389.29	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.33	0.33	--	0.45
Treatment Volume (ft^3)	469,404	469,404	--	633,103
TP Load (lb/yr)	294.93	294.93	--	397.78

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.02	**0.76**	**0.76**

Total TP Load Reduction Required (lb/yr)	**-23.30**	-23.30	0

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	2109.85	2845.64

Site Compliance Summary

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	0.00
Total TN Load Reduction Achieved (lb/yr)	0.00
Remaining Post Development TP Load (lb/yr)	294.93
Remaining TP Load Reduction (lb/yr) Required	**0.00**

**** TARGET TP REDUCTION EXCEEDED BY 23.3 LB/YEAR ****

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - **Version 3.0**

☐ 2011 BMP Standards and Specifications ☑ 2013 Draft BMP Standards and Specifications

CLEAR ALL

data input cells | constant values | calculation cells | final results

Project Name:	Chesterfield Power Station
Date:	6/16/2020
Linear Development Project?	No

Site Information

Post-Development Project (Treatment Volume and Loads)

Enter Total Disturbed Area *(acres)* → 389.29

Check:

BMP Design Specifications List: 2013 Draft Stds & Specs

Maximum reduction required: 20%

Linear project? No

The site's net increase in impervious cover (acres) is: 0

Land cover areas entered correctly? ✔

Post-Development TP Load Reduction for Site (lb/yr): -23.30

Total disturbed area entered? ✔

TP LOAD REDUCTION NOT REQUIRED

Pre-ReDevelopment Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed forest/open space	0.00	0.00	0.00	94.63	94.63
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	157.50	157.50
Impervious Cover (acres)	0.00	0.00	0.00	137.16	137.16
					389.29

Post-Development Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	343.59	343.59
Impervious Cover (acres)	0.00	0.00	0.00	45.70	45.70
Area Check	OK.	OK.	OK.	OK.	389.29

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
Pj (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

LAND COVER SUMMARY -- PRE-REDEVELOPMENT

Land Cover Summary-Pre		
Pre-ReDevelopment	**Listed**	**Adjusted[1]**
Forest/Open Space Cover (acres)	94.63	94.63
Weighted Rv(forest)	0.05	0.05
% Forest	24%	24%
Managed Turf Cover (acres)	157.50	157.50
Weighted Rv(turf)	0.25	0.25
% Managed Turf	40%	40%
Impervious Cover (acres)	137.16	137.16
Rv(impervious)	0.95	0.95
% Impervious	35%	35%
Total Site Area (acres)	**389.29**	**389.29**
Site Rv	**0.45**	**0.45**

Treatment Volume and Nutrient Load

Pre-ReDevelopment Treatment Volume (acre-ft)	14.5340	14.5340
Pre-ReDevelopment Treatment Volume (cubic feet)	633,103	633,103
Pre-ReDevelopment TP Load (lb/yr)	**397.78**	**397.78**
Pre-ReDevelopment TP Load per acre (lb/acre/yr)	1.02	1.02
Baseline TP Load (lb/yr) (**0.41 lbs/acre/yr** applied to pre-redevelopment area excluding pervious land proposed for new impervious cover)		*159.61*

LAND COVER SUMMARY -- POST DEVELOPMENT

Land Cover Summary-Post (Final)	
Post ReDev. & New Impervious	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	343.59
Weighted Rv (turf)	0.25
% Managed Turf	88%
Impervious Cover (acres)	45.70
Rv(impervious)	0.95
% Impervious	12%
Final Site Area (acres)	**389.29**
Final Post Dev Site Rv	**0.33**

Land Cover Summary-Post	
Post-ReDevelopment	
Forest/Open Space Cover (acres)	0.00
Weighted Rv(forest)	0.00
% Forest	0%
Managed Turf Cover (acres)	343.59
Weighted Rv (turf)	0.25
% Managed Turf	88%
ReDev. Impervious Cover (acres)	45.70
Rv(impervious)	0.95
% Impervious	12%
Total ReDev. Site Area (acres)	**389.29**
ReDev Site Rv	**0.33**

Land Cover Summary-Post	
Post-Development New Impervious	
New Impervious Cover (acres)	0.00
Rv(impervious)	--

Treatment Volume and Nutrient Load

Final Post-Development Treatment Volume (acre-ft)	10.7760	**Post-ReDevelopment Treatment Volume (acre-ft)**	10.7760	**Post-Development Treatment Volume (acre-ft)**	--
Final Post-Development Treatment Volume (cubic feet)	469,404	**Post-ReDevelopment Treatment Volume (cubic feet)**	469,404	**Post-Development Treatment Volume (cubic feet)**	--
Final Post-Development TP Load (lb/yr)	**294.93**	**Post-ReDevelopment Load (TP) (lb/yr)***	**294.93**	**Post-Development TP Load (lb/yr)**	--
Final Post-Development TP Load per acre (lb/acre/yr)	0.76	Post-ReDevelopment TP Load per acre (lb/acre/yr)	0.76		
		Max. Reduction Required (Below Pre-ReDevelopment Load)	**20%**		
		TP Load Reduction Required for Redeveloped Area (lb/yr)	**-23.30**	**TP Load Reduction Required for New Impervious Area (lb/yr)**	**0**

[1] *Adjusted Land Cover Summary:*
Pre ReDevelopment land cover minus pervious land cover (forest/open space or managed turf) acreage proposed for new impervious cover.

Adjusted total acreage is consistent with Post-ReDevelopment acreage (minus acreage of new impervious cover).

Column I shows load reduction requriement for new impervious cover (based on new development load limit, 0.41 lbs/acre/year).

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr) -23.30 **

TP LOAD REDUCTION NOT REQUIRED

Nitrogen Loads (Informational Purposes Only)

Pre-ReDevelopment TN Load (lb/yr)	2845.64	Final Post-Development TN Load (Post-ReDevelopment & New Impervious) (lb/yr)	2109.85

Pre-ReDevelopment Land Cover (acres)	DA A: New CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.81	0.81
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				2.45	2.45
Impervious Cover (acres)				5.63	5.63
				Total	8.89

Post-ReDevelopment Land Cover (acres)	DA A: New CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				2.08	2.08
Impervious Cover (acres)				6.81	6.81
				Total	8.89

Pre-ReDevelopment Land Cover (acres)	DA D: UAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				122.52	122.52
Impervious Cover (acres)				17.37	17.37
				Total	139.89

Post-ReDevelopment Land Cover (acres)	DA D: UAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				135.11	135.11
Impervious Cover (acres)				4.78	4.78
				Total	139.89

Pre-ReDevelopment Land Cover (acres)	DA B: LVWWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				8.10	8.10
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				17.85	17.85
Impervious Cover (acres)				4.83	4.83
				Total	30.78

Post-ReDevelopment Land Cover (acres)	DA B: LVWWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				19.93	19.93
Impervious Cover (acres)				10.85	10.85
				Total	30.78

Pre-ReDevelopment Land Cover (acres)	DA E: FFCP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				85.72	85.72
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				0.28	0.28
Impervious Cover (acres)				0.35	0.35
				Total	86.35

Post-ReDevelopment Land Cover (acres)	DA E: FFCP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				76.30	76.30
Impervious Cover (acres)				10.05	10.05
				Total	86.35

Pre-ReDevelopment Land Cover (acres)	DA C: LAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				7.30	7.30
Impervious Cover (acres)				108.98	108.98
				Total	116.28

Post-ReDevelopment Land Cover (acres)	DA C: LAP				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				103.07	103.07
Impervious Cover (acres)				13.21	13.21
				Total	116.28

Pre-ReDevelopment Land Cover (acres)	DA F: Old CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				7.10	7.10
Impervious Cover (acres)				0.00	0.00
				Total	7.10

Post-ReDevelopment Land Cover (acres)	DA F: Old CSWTS				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed				7.10	7.10
Impervious Cover (acres)				0.00	0.00
				Total	7.10

Pre-ReDevelopment Land Cover (acres)	TOTAL				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	94.63	94.63
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	157.50	157.50
Impervious Cover (acres)	0.00	0.00	0.00	137.16	137.16
				Total	389.29

Post-ReDevelopment Land Cover (acres)	TOTAL				
	A soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00	0.00	0.00	343.59	343.59
Impervious Cover (acres)	0.00	0.00	0.00	45.70	45.70
				Total	389.29

Appendix D

Closure Cost Estimate

Solid Waste Disposal Facility
Cost Estimate Form, DEQ Form CE SWDF

Facility Name: Chesterfield Power Station Upper Ash Pond Permit No. SWP

Location Address: 451 Coxendale Road

City, State, Zip: Chester, VA, 23836

FA Holder: Virginia Electric and Power Company

Estimate Prepared by: Gabe Lang, AECOM

Indicate the plan versions for which this cost estimate was prepared, identifying the following information for each plan:

Closure Plan		Post-Closure Plan	
Title: Surface Impoundment Closure Plan: Upper Ash Pond		Title: N/A	
Plan Date: October, 2020	Approved:	Plan Date:	Approved:
Consultant: AECOM		Consultant:	
Corrective Action Plan		**Corrective Action Monitoring Plan**	
Title: N/A		Title: N/A	
Plan Date:	Approved:	Plan Date:	Approved:
Consultant:		Consultant:	

Cost Estimate Summary

Closure Cost Element	Total Cost	Notes
Total Closure Cost:	$ 367,518,631	
Total Post-Closure Cost:	$	
Total Corrective Action Cost:	$	
Total:	**$ 367,518,631**	

References: Please indicate references used to develop this cost estimate:

Unit costs were independently developed by AECOM as a part of the Closure Design process utilizing our internal costing experience and estimators.

CERTIFICATION BY PREPARER

This is to certify that the cost estimates pertaining to the engineering features and monitoring requirements of this solid waste management facility have been prepared by me and are representative of the design specified in the facility's Closure Plan. The estimate is based on the cost of hiring a third party and does not incorporate any salvage value that may be realized by the sale of wastes, facility structures, or equipment, land or other facility assets at the time of closure. In my professional judgment, the cost estimates are a true, correct, and complete representation of the financial liabilities for closure and postclosure care of the facility and comply with the requirements of 9 VAC 20-70 and all other DEQ rules and statutes of the Commonwealth of Virginia.

SIGNATURE:  DATE: 12/4/2020

NAME: Gabriel Lang

TITLE: Vice President/Program Manager

Acknowledgement by Owner / Operator:

SIGNATURE: Robert W. Sauer
Robert W. Sauer (Dec 18, 2020 09:33 EST) DATE: Dec 18, 2020

NAME: Robert W. Sauer

TITLE: VP System Operations

Chesterfield Power Station
Upper Ash Pond Closure by Removal Cost Estimate

Item #	Line Item	Units	Quantity	Unit Rate ($US)	Bid Item Total ($US)	Notes/Assumptions
1	General Conditions	LS	1	$ 11,486,000	$ 11,486,000	Incidental costs associated with the project including Project Management, Job Office & associated costs, Safety Manager(s), Safety Training and Supplies, Quality Control, Environmental Protection Plan compliance, pumps for water control, and other incidental overhead costs.
2	Construction Surveying	LS	1	$ 1,288,000	$ 1,288,000	Includes, but is not limited to, existing site control tie in (horizontal and vertical), establishment of Limits of Disturbance (LOD), wetlands, RPA, etc., As-built/record drawings, and all required layout items.
3	Mobilization	LS	1	$ 207,000	$ 207,000	Temporary facilities, owned/leased/rented equipment, temporary sanitary facilities, electrical/telecom connection and equipment, and all required permits and plans.
4	Site Preparation	LS	1	$ 710,000	$ 710,000	Lay down area development, truck wash operation and maintenance, and Instrumentation installation and monitoring (in accordance with the Instrumentation Monitoring Plan).
5	Monitoring Wells	LS	1	$ 511,000	$ 511,000	Monitoring well protection (65 wells), adjustment (18 wells), and abandonment (14 wells).
6	Temporary Access Road Construction	LS	1	$ 2,841,746	$ 2,841,746	Aggregate, typical asphalt, and concrete temporary access roads.
7	Demolition	LS	1	$ 1,533,000	$ 1,533,000	Removal of the existing toe drain pump stations, stormwater management facility outlet structure, riser, and liner system, miscellaneous stormwater management items, and pavement/road removal.
8	Dewatering System	LS	1	$ 26,028,000	$ 26,028,000	Procurement of all required materials, and all labor and equipment for the installation, commissioning, testing, operation, maintenance, and demolition/removal of the dewatering system.
9	Contact Water Management System	LS	1	$ 12,066,000	$ 12,066,000	Procurement of all required materials, and all labor and equipment for the installation, commissioning, testing, operation, maintenance, and demolition/removal of the contact water management system to maintain separation of the contact water from any stormwater.
10	Stormwater Management System	LS	1	$ 4,491,000	$ 4,491,000	Procurement of all required materials, and all labor and equipment for the installation, commissioning, testing, operation, maintenance, and demolition/removal of the stormwater management system to maintain separation of the stormwater from any contact water.
11	CCR Material Handling				$ 165,366,000	
11A	Excavation, Hauling, Placing, and Compacting at On-Site Landfill (FFCP)	CY	4,900,000	$ 17.34	$ 84,966,000	Labor, resources, equipment, and materials required to test, excavate, haul, place, and compact CCR at the FFCP landfill.
11B	Excavation, Screening, Moisture Conditioning, Hauling, and Delivery to On-Site Recycler Load-out/Processing Facility at Ballfield	CY	7,000,000	$ 10.95	$ 76,650,000	Labor, resources, equipment, and materials required to test, excavate, screen, moisture conditioned , haul, and deliver to On-site Recycler Load-Out/Processing Facility at the Ballfield.
11C	Excavation and Hauling to Off-Site Landfill	Ton	125,000	$ 30.00	$ 3,750,000	Labor, resources, equipment, and materials required to test, excavate, and haul via truck to an Off-site Landfill.
12	Sub-Soil (6" Over excavation) Material Handling	CY	85,000	$ 16.94	$ 1,439,900	Labor, resources, equipment, and materials required to excavate, haul, place, and compact at the FFCP landfill.
13	On-site Fill	CY	1,000	$ 5.20	$ 5,200	Excavate, Haul, Place, and Compact On-Site Fill Material.
14	Off-site Fill	CY	2,200,000	$ 37.89	$ 83,358,000	Purchase, Haul, Place, and Compact Off-Site Fill Material.
15	Earthwork	CY	700,000	$ 4.66	$ 3,262,000	Berm modifications/lowering and all earthwork items outside the limits of the UAP.
16	Stormwater	LS	1	$ 337,000	$ 337,000	Procurement of all required materials and all labor and equipment for the installation of all stormwater outlets, including RCP, Endwalls, bedding and backfill, outlet protection, emergency spillway, and all appurtenances.
17	Erosion and Sediment Controls	LS	1	$ 14,246,000	$ 14,246,000	Controls used during CCR Excavation (as needed) and Final Site Plan Grading to reduce erosion and sedimentation, including but not limited to construction entrance, silt fence, super silt fence, inlet protection, temporary diversion berm, temporary sediment trap, temporary sediment basin, temporary slope drain, outlet protection, rock check dams, riprap, turbidity curtains, concrete lined channels, temporary seeding, permanent seeding, mulching, rolled erosion control products, flexible growth medium, soil amendments, maintenance, and removal.
18	Pavement Installation	LS	1	$ 2,038,000	$ 2,038,000	Procurement of required materials, and all labor and equipment for the installation including the Henricus Park Road improvements along the UAP.
19	Fence and Gates	LS	1	$ 598,000	$ 598,000	Procurement of required materials, and all labor and equipment for the installation of the security fence, wooden fence, and all gates.
20	Demobilization	LS	1	$ 106,000	$ 106,000	Removal of all items not required for ponds post closure operation and maintenance, including items within pond closure construction laydown area development and mobilization.
21	Groundwater Monitoring	Year	30	$ 73,000	$ 2,190,000	Yearly groundwater monitoring and required annual reporting.
22	Contingency (10%)	%	1	$ 33,410,785	$ 33,410,785	
				Total	$ 367,518,631	

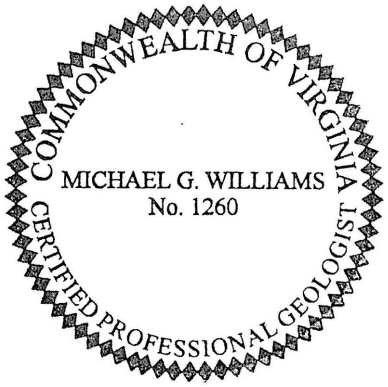
The enclosed Opinion of Probable Cost is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to; local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events and developing bidding conditions, etc. may affect the accuracy of this estimate. AECOM is not responsible for any variance from this Opinion of Probable Cost or actual prices and conditions obtained.

Attachment V

Groundwater Monitoring Plan

GROUNDWATER MONITORING PLAN

Chesterfield Power Station, Upper and Lower Ash Ponds
Solid Waste Permit No. 619
500 Coxendale Road
Chester, Virginia 23836



Prepared For:

Dominion Energy Services
120 Tredegar Street
Richmond, Virginia 23219

Prepared By:

Golder Associates Inc.
2108 West Laburnum Ave., Suite 200
Richmond, Virginia, USA 23227

September 2017
Revised October 2020

Project No. 2013-9767

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 LOCATION INFORMATION 2

2.1 Site Topography and Land Use 2

2.2 Climate 3

2.3 Site History 3

2.3.1 Lower Ash Pond Site History 3

2.3.2 Upper Ash Pond Site History 4

3.0 GEOLOGY AND HYDROGEOLOGY 6

3.1 Site Soil Units 7

3.2 Regional Geology 7

3.2.1 Site Geology 8

3.2.1.1 Basement Bedrock 8

3.2.1.2 Newark Supergroup (Triassic inferred) Rocks 9

3.2.1.3 Potomac Formation 10

3.2.1.4 Tertiary and Quaternary Sediments 10

3.3 Site Hydrogeology 11

3.3.1 Description of the Uppermost Columbia Aquifer 12

3.3.1.1 Uppermost Aquifer Hydraulic Properties 13

3.3.1.2 Horizontal Component of Flow 13

3.3.1.3 Vertical Component of Flow 15

3.3.2 Description of the Confined Potomac Aquifer 16

3.3.2.1 Potomac Hydraulic properties 17

3.3.2.2 Potomac Horizontal Flow 17

3.3.2.3 Potomac Vertical Flow 18

3.3.3 Description of the Confined Bedrock Aquifer 20

3.3.3.1 Bedrock Hydraulic Properties 21

3.3.3.2 Bedrock Horizontal Flow 21

3.3.4 Water Supply Wells 22

TABLE OF CONTENTS - CONTINUED

4.0 DESIGN OF THE GROUNDWATER MONITORING SYSTEM 24
4.1 Special Conditions 24
4.2 Monitoring Well Placement 25
4.2.1 Background Wells 26
4.2.2 Lower Ash Pond Compliance Wells 27
4.2.2.1 Scheduled Lower Ash Pond Well Replacement Activities 27
4.2.3 Upper Ash Pond Compliance Wells 28
4.2.4 Station Observation Wells 28
4.3 Monitoring Well Construction 29
4.3.1 Drilling Methods 30
4.3.2 Well Screens 30
4.3.3 Wellhead Completions 30
4.3.4 Well Development 31
4.3.5 Pump Installations 31
4.3.6 Documentation 31
4.4 Monitoring Well Decommissioning Procedures 31
4.4.1 Documentation 31
4.5 Monitoring Well Replacement 32
4.5.1 Documentation 32
4.6 Well Operations and Maintenance 32
4.6.1 Floodplain Wells 33
5.0 GROUNDWATER MONITORING PROGRAM 35
5.1 Modified Detection Monitoring Program 36
5.1.1 Constituents 36
5.1.2 Background Sampling 36
5.1.3 Sampling Schedule 37
5.1.4 Verification Sampling Events 37
5.1.5 Analytical Data Evaluation 37
5.1.6 Reporting 37
5.1.6.1 Statistical Exceedance Notification 38

TABLE OF CONTENTS - CONTINUED

5.1.6.2 Semi-Annual Report 38
5.1.6.3 Annual Report 39
5.1.6.4 Alternate Source Demonstration 40
5.1.6.5 Well Installation Report 40
5.1.6.6 Well Decommissioning Report 40
5.1.6.7 Well Non-performance Notification 40
5.2 Modified Assessment Monitoring Program 40
5.2.1 Constituents 41
5.2.2 Sampling Schedule 41
5.2.3 Verification Sampling Events 42
5.2.4 Establishing Groundwater Protection Standards 42
5.2.5 Analytical Data Evaluation 43
5.2.6 Data Validation 43
5.2.7 Assessment Monitoring Program Reporting Requirements 43
5.2.7.1 Facility Background Determination Report 43
5.2.7.2 Groundwater Protection Standard Exceedance Notifications 44
5.2.7.3 Semi-Annual Report 44
5.2.7.4 Annual Report 45
5.2.7.5 Alternate Source Demonstration 46
5.2.7.6 Well Installation Report 46
5.2.7.7 Well Decommissioning Report 46
5.2.7.8 Well Non-performance Notification 46
5.2.7.9 Modified Detection Monitoring Program Reversion Notification 46
5.2.7.10 Groundwater Protection Standard Update Notifications 47
5.2.7.11 Off-site Plume Notification 47
6.0 SAMPLE AND ANALYSIS PROGRAM 48
6.1 Sampling Order 48

TABLE OF CONTENTS - CONTINUED

6.2 Water Level Gauging 48
6.3 Purging Procedure 48
6.4 Sample Collection 50
6.5 Sample Documentation 50
6.6 Sample Seals 50
6.7 Sample Event Documentation 50
6.8 Field Quality Assurance/Quality Control Procedures 51
6.8.1 Trip Blanks 51
6.8.2 Field Blanks 51
6.8.3 Equipment Blanks 51
6.8.4 Field Duplicates 51
6.9 Laboratory Quality Control Procedures 52
6.9.1 Laboratory Documentation 52
6.9.2 Laboratory Analyses 53
6.9.3 Limits of Quantitation (LOQs) 53
6.9.4 Limits of Detection (LODs) 53
6.9.5 Method Blanks 54
6.9.6 Matrix Spike and Matrix Spike Duplicate Samples 54
6.10 Data Validation 54
7.0 DATA EVALUATION 55
7.1 Groundwater Data Evaluation 55
7.1.1 Correcting for Linear Trends 55
7.2 Statistical Methodology 56
7.2.1 Reporting of Low and Zero Values 57
7.2.2 Normality Testing 57
7.2.3 Missing Data Values 58
7.2.4 Outliers 58
7.3 Verification Procedure 58
7.4 Comparison to Groundwater Protection Standards 59
7.4.1 Background-Based GWPS / GPS 59

TABLE OF CONTENTS - CONTINUED

7.4.2 MCL- or Alternate Concentration-Based GWPS / GPS 59
7.4.3 GWPS / GPS Comparison Process 59
8.0 HYDROGEOLOGIC ASSESSMENT 61
9.0 REFERENCES 62

TABLES

Table 1 Summary of Existing Well Construction Information
Table 2 Summary of Estimated Hydraulic Conductivity
Table 3 Summary of Modified Detection Monitoring Program Constituents and Parameters
Table 4 Summary of Modified Assessment Monitoring Program Constituents and Parameters
Table 5 Summary of Sample Container Information and Hold Times

DRAWINGS

Drawing 1 Site Location Map
Drawing 2 Lower and Upper Ash Pond Groundwater Monitoring Plan
Drawing 3 Geologic Map
Drawing 4 Structual Contour Map for Basement Bedrock
Drawing 5 Structual Contour Map for the Top of Cretaceous Potomac Formation
Drawing 6 Cross Sections A-A’ and B-B’
Drawing 7 Cross Sections C-C’ and D-D’
Drawing 8 Cross Section E-E’
Drawing 9 Cross Sections F-F’ and G-G’
Drawing 10 Cross Section H-H’
Drawing 11 Groundwater Surface Contour Map – Uppermost Aquifer
Drawing 12 Groundwater Surface Contour Map – Potomac Aquifer
Drawing 13 Groundwater Surface Contour Map – Bedrock Aquifer

APPENDICES

Appendix A Monitoring Well Construction Logs and Available Geophysical Logs

TABLE OF CONTENTS - CONTINUED

Appendix B Groundwater Monitoring Well Construction Specifications, Well Development Guidance, Well Decommissioning Guidance, and Figure 1 – Monitoring Well Details

Appendix C Example Chain-of-Custody Form, Sample Label, and Chain-of-Custody Seal

Appendix D Groundwater Protection Standards

1.0 INTRODUCTION

This *Groundwater Monitoring Plan* (GMP) has been prepared for Virginia Electric and Power Company (VEPCO) dba Dominion Energy Virginia (Dominion Energy) for two Coal Combustion Residuals (CCR) surface impoundments, the Upper Ash Pond (UAP) and Lower Ash Pond (LAP), located at the Chesterfield Power Station (Station) in Chesterfield County, Virginia. This GMP is designed to meet:

- applicable provisions of the U.S. Environmental Protection Agency's (USEPA's) *Disposal of Coal Combustion Residuals* (CCR) *from Electric Utilities* (CCR Rule; Federal Register Vol. 80, No. 74, 21302-21501) published on April 17, 2015 (40 CFR 257 *et seq*.) as amended per the following:
  - USEPA's CCR Rule amendment (Federal Register Vol. 81, No. 151, 51802-51808) published on August 5, 2016;
  - USEPA's CCR Rule amendment (Federal Register Vol. 83, No. 146, 36435-36456) published on July 30, 2018;
  - USEPA's CCR Rule amendment (Federal Register Vol. 85, No. 168, 53516-53566) published on August 28, 2020 (effective date of September 28, 2020); and
- applicable provisions of the CCR Rule as adopted in the Virginia Solid Waste Management Regulations (VSWMR, 2016) on January 27, 2016, including adoption of 40 CFR Part 257 Subpart D by reference - Title 9 Virginia Administrative Code (VAC) Agency 20, Chapter 81-800 *et seq*. (9VAC20-81-800).

This GMP sets forth the requirements and procedures for collecting, analyzing, and managing groundwater samples and data from the uppermost aquifer underlying the UAP and LAP at the Station. In the event that future amendments to the VSWMR or Federal regulations conflict with any provisions of this GMP, the applicable regulation will supersede this GMP with the exception of DEQ-approved variances and Alternate Source Demonstrations (ASDs) and permit-specific conditions.

Revisions to this GMP may be required in the future due to changes in the monitoring network, sampling action, revisions to USEPA or VSWMR regulations, or at the request of the unit owner. Any revisions made to the GMP will be posted to the operating record and will be submitted to DEQ within 60 days of completion.

2.0 LOCATION INFORMATION

As presented on Drawing 1, the Station is located in Chesterfield County, east of I-95 on the south side of the James River (Dutch Gap Cutoff Channel) near its confluence with the Old Channel of the James River. The UAP and LAP are located on property owned and controlled by Dominion Energy and are part of the Station.

As presented on Drawing 2, the Station covers approximately 841.82 acres and is comprised of seven parcels of property as follows:

Parcel Identification	Parcel Area (acres)	Primary Feature
8026654390	190	Industrial Landfill
8056662525	38	Greenspace
8066648063	206.31	Power Plant
8056627764	59.276	Offices/Training Facilities
8066628465	53.204	Wastewater Treatment Facility
8076601776	150.93	LAP
8116603332	144.1	UAP

The LAP, covering approximately 111 acres, is located to the south of the power plant on parcel No. 8076601776. The UAP, covering approximately 113 acres, is located to the southeast of the LAP on parcel No. 8116603332.

Site access to the Station is via Coxendale road near the intersection of Henricus Park Road. Access to the LAP is controlled with vehicle access provided via a locking gated entrance from Coxendale Road. Similarly, access to the UAP is controlled with vehicle access provided via a locking gated entrance entering from Henricus Park Road.

The LAP is bordered to the north by the Station; to the east by Henricus Park Road, across which is Aiken Swamp and Henricus Park; to the southeast by the UAP; to the south by the surface waters and undeveloped tidal flats and river bottom associated with Farrar Gut; and to the west by the Station's thermal discharge channel.

The UAP is bordered to the northwest by the LAP; to the north by Henricus Park Road, across which is Aiken Swamp and Henricus Park; to the east by Henricus Park and the Citie of Henricus; to the south and west by surface water and undeveloped tidal flats and river bottom associated with Farrar Gut.

2.1 Site Topography and Land Use

As shown on Drawing 1, a portion of the USGS 7½-minute topographic maps of Dutch Gap, Drewry's Bluff, Chester, and Hopewell, Virginia, the area in the vicinity of the Station has variable topography with incised uplands located to the west and low lying river floodplain topography in the vicinity of the LAP and UAP and towards the north, east, and south. The local topography is dissected by drainages that discharge to the James River. Topographic elevations at the Station range from near sea level around the perimeter of the LAP and UAP to more than 90 feet

above mean sea level (AMSL) in the vicinity of the Station's Fossil Fuel Combustion Products (FFCP) Management Facility on the west side of Proctors Creek.

In general, the Station property consists of wooded, open, and developed land on the south bank of the James River. The Station's northern, eastern, and southern boundaries are bordered primarily by the James River and associated floodplain areas. The western side is bordered by a combination of undeveloped and developed (industrial and commercial) properties.

2.2 Climate

Based on online National Oceanic and Atmospheric Administration (NOAA) data from Weatherspark (https://weatherspark.com/y/20218/Average-Weather-in-Chester-Virginia-United-States-Year-Round), the prevailing wind in the vicinity of the Station is from the south and west approximately 60% of the year on average with a prevailing wind from the north the remainder of the year (primarily in the months of February, March, September, and October). The wind speed averages approximately 5 miles per hour (mph), with November through April being the months with the highest average wind speed of 6.2 mph. The average monthly temperatures range from 89 F/70 F in July to 48 F/30 F in January.

Based on statistics presented in the *Soil Survey of Chesterfield County, Virginia* (https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/virginia/chesterfieldVA1906/chesterfieldVA1906.pdf), the average annual precipitation amount for the Station area ranges from 43.19 inches per year (Richmond) to 47.09 inches per year (Petersburg).

2.3 Site History

Available site history for the LAP and UAPs is discussed in the following sections.

2.3.1 Lower Ash Pond Site History

VEPCO acquired the LAP property in 1959. The LAP was commissioned in 1964 by constructing dikes on its east, south and west sides. The east and west dikes tie into surrounding grades along the north side of the Station. The dikes are founded on native soils consisting of recent fine- and coarse-grained alluvial soils. The western, southern, and eastern dikes were raised approximately 5 feet in the late 1960's to increase the storage capacity of the LAP. The maximum height of the LAP dikes is approximately 19 feet above mean sea level (AMSL). Available design information for the LAP indicates that the base of the impoundment is located at an approximate elevation of 1.5 feet AMSL (Dames and Moore, 1984) with more recent CCR material delineation activities mapping the bottom of ash at a variable depth ranging from 10 feet below mean sea level (MSL) to 4 feet AMSL. Available site records indicate that the LAP historically received CCR and associated coal combustion process waste materials (O'Brien and Gere, 2010; Dames and Moore, 1983).

In October 2016, following the installation of additional monitoring wells around the perimeter of the active LAP, background sampling activities under the CCR Rule were initiated. The background sampling activities for the LAP under the CCR Rule were completed in August 2017. The initial CCR Rule Detection Monitoring Program event for the LAP was completed in September 2017. Based on the results from the initial CCR Rule Detection Monitoring Program sampling event, a CCR Rule Assessment Monitoring Program was initiated (initial CCR Rule Appendix III and IV sampling event) for the LAP following placement of the statistically significant increase notification in the operating record on December 25, 2017, consistent with the CCR Rule. The initial assessment monitoring event for the LAP was completed in February 2018, followed by the first semi-annual assessment monitoring event completed in May 2018.

Based on the evaluation of the 2018 groundwater monitoring program data, there were confirmed federal Groundwater Protection Standard (GWPS) exceedances during the 2018 first semi-annual sampling event for arsenic, cobalt, and total radium at MW-27.

Due to these exceedances, Dominion Energy initiated an Assessment of Corrective Measures (ACM) consistent with the CCR Rule requirements. The ACM Report, completed on May 17, 2019, summarized the results of the assessment of remedial alternatives for addressing the reported federal GWPS exceedances based on the results of the field investigation and Commonwealth of Virginia statutory requirements promulgated during the 2019 General Assembly for CCR source removal from unlined impoundments.

The LAP will be closed by removal. The CCR material will be excavated and relocated to either the Dominion Energy owned FFCP Management Facility or an offsite permitted industrial waste landfill for disposal, or beneficially reused offsite.

2.3.2 Upper Ash Pond Site History

The UAP was formerly operated by Lone Star Industries, Inc. as a sand and gravel pit. The UAP property was originally leased by VEPCO for construction and operation of the UAP *circa* 1983. Subsequently, Dominion Energy acquired the UAP property and annexed it to the Station. The UAP was constructed within earthen perimeter embankments with a crest elevation of approximately 42 feet AMSL. Available design information for the UAP indicates that the base of the impoundment is located at an approximate elevation of 2.5 feet AMSL. Available site records indicate that the UAP received CCR and associated coal combustion process waste.

In October 2016, following the installation of additional monitoring wells around the perimeter of the active UAP, background sampling activities under the CCR Rule were initiated. The background sampling activities for the UAP under the CCR Rule were completed in August 2017 and the initial CCR Rule Detection Monitoring Program event was completed in September 2017. Based on the results from the initial CCR Rule Detection Monitoring Program sampling event, a CCR Rule Assessment Monitoring Program was initiated (initial CCR Rule Appendix III and IV

sampling event) for the UAP following placement of the statistically significant increase notification in the operating record on February 6, 2018, consistent with the CCR Rule. The initial assessment monitoring event for the UAP was completed in March 2018, followed by the first semi-annual assessment monitoring event completed in July 2018.

Based on the evaluation of the 2018 groundwater monitoring program data, there were confirmed federal GWPS exceedances during the 2018 first semi-annual sampling event for arsenic, cobalt, lithium, and total radium.

Due to these exceedances, Dominion Energy initiated an ACM consistent with the CCR Rule requirements. The ACM Report, completed on May 17, 2019, summarized the results of the assessment of remedial alternatives for addressing the reported GWPS exceedances based on the results of the field investigation and Commonwealth of Virginia statutory requirements promulgated during the 2019 General Assembly for CCR source removal from unlined impoundments.

The UAP will be closed by removal. The CCR material will be excavated and relocated to either the Dominion Energy owned FFCP Management Facility or an offsite permitted industrial waste landfill for disposal, or beneficially resulted offsite.

3.0 GEOLOGY AND HYDROGEOLOGY

A number of water quality and hydrogeological investigations have been completed for the Station and surrounding area. A list of the investigations and reports that have been used to prepare the Site Conceptual Model that is presented herein is presented as follows:

- *Water Quality Impact Evaluation from Proposed Ash Tailings Impoundment at VEPCO's Chesterfield Power Station, Farrar Island, Virginia*. Prepared by Dames and Moore, Bethesda, Maryland, July 15, 1983.
- *Late Mesozoic and Cenozoic Stratigraphic and Structural Framework near Hopewell, Virginia*. Dischinger, Jr., J.B., 1987. U.S. Geological Survey Bulletin 1567.
- *Ground-Water Resources of the York-James Peninsula of Virginia*. Laczniak, R.J., and A.A. Meng III, 1988. U.S. Geological Survey, Water-Resources Investigation Report No. 88-4059.
- *Hydrogeology and Analysis of the Ground-Water Flow System in the Coastal Plain of Southeastern Virginia*. Hamilton, P.A., and Larson, J.D., 1988. Virginia State Water Control Board: U.S. Geological Survey.
- *Geologic Map and Generalized Cross Sections of the Coastal Plain and Adjacent Parts of the Piedmont, Virginia.* Mixon, R.B., C.R. Berquist, Jr., W.L. Newell, G.H. Johnson, D.S. Powars, J.S. Schindler, and R.K. Radar, 1989. United States Department of the Interior, U.S. Geological Survey. Miscellaneous Investigation Series. MAP I-2033. 1:250,000 scale.
- *Oil Discharge Contingency Plan, Groundwater Characterization Study, Virginia Power, Chesterfield Power Station*. Prepared by Environmental Service and Technology Corporation, May 1, 1993.
- *Supplemental Investigation of Groundwater Conditions at the Bellwood Extrusion Plant, Chesterfield County*, Virginia. Environmental Resource Management (ERM), September 2001.
- *The Virginia Coastal Plain Hydrogeologic Framework*, Professional Paper No. 1731. McFarland, E.R., and T.S. Bruce, 2006. U.S. Department of Interior, U.S. Geological Survey.
- *Hydrogeologic and Geotechnical Report for the Dominion Chesterfield Power Station Fossil Fuel Combustion Products Management Facility, Chesterfield County, Virginia.* Golder Associates Inc., July 2010.

- *Revised Groundwater Quality and Risk Assessment Report, Chesterfield Power Station – Old Ash Pond, VPDES Permit No. VA0004146, 500 Coxendale Road, Chesterfield County, Virginia*. URS Corporation, Richmond, Virginia, March 22, 2012.

- *Facility Background Concentration Report for Groundwater Analytes, Chesterfield Power Station Fossil Fuel Combustion Products Management Facility*. Golder Associates Inc., May 2012.

- *Assessment of Corrective Measures Report, Lower and Upper Ash Ponds, Chesterfield Power Station*. Haley & Aldrich, Inc. May 2019.

Based on review of the information presented in these investigations, a summary of the regional and site hydrogeology information comprising the Site Conceptual Model is presented in the following sections.

3.1 Site Soil Units

The United States Department of Agriculture (USDA) has mapped a variety of soils in the vicinity of the LAP and UAP, including Ochrepts and Udults soils, Fluvaquent soils, Chewacla loam, Toccoa fine sandy loam, Buncombe loamy fine sand, Chastin loam, and the Pamunkey loam (USDA, 2006). The Fluvaquent soils are classified as hydric soils and the remaining soils as upland soils. The distribution of Fluvaquent soils, as mapped by the USDA, correlates well with the surveyed site-specific wetland delineation limits.

3.2 Regional Geology

The Station is located approximately 2.5 miles east of the Fall Line in the western part of the Virginia Coastal Plain physiographic province. The surrounding area is characterized by gently rolling topography incised by a number of dendritically patterned, well established stream channels flowing in a general easterly direction towards the James River. The Coastal Plain physiographic province is composed of an extensive complex of interlayered, unconsolidated to semi-consolidated strata deposited between the Quaternary and Cretaceous Periods. The thickness of the strata is variable within the Coastal Plain, varying from a “feather’s edge” where the sediments overlap the Piedmont physiographic province rocks and saprolitic sediment, to massively bedded formations near the continental shelf.

A geologic map for the Station is presented as Drawing 3 (Mixon *et al.*, 1989). As presented, structurally, the Station is located within the easterly dipping Coastal Plain physiographic province, with the northern limits of the inactive, steep-angled, reverse Dutch Gap Fault (reactivated normal fault with a west footwall) mapped immediately southeast of the Station and extending beneath the UAP along the south bank of the James River (Old Channel).

The uppermost sediments at the Station are mapped as Quaternary alluvium associated with the present-day James River. The Quaternary sediments are underlain by Tertiary and Cretaceous sedimentary deposits of variable

thickness. The Cretaceous sediments overlie the Petersburg Granite (mapped to the west) and other undifferentiated basement rock that varies in texture from a relatively uniform aphanitic to phaneritic textured rock to a heterogeneous gneissic texture. The Petersburg Granite is variously described as a Paleozoic crystalline basement rock composed primarily of quartz, sodic plagioclase, potassium feldspar, biotite, and hornblende, with minor amounts of ilmenite, magnetite, pyrite, zircon, apatite, titanite, muscovite, and fluorite (VDMR, 1993). Locally (site investigations in 2016), the lower basement bedrock is overlain by consolidated sediments (mudstone, arkose, and conglomerate) that are believed to date to the Triassic. The basement bedrock surface in the vicinity of the Station is interpreted to be inclined to the east.

3.2.1 Site Geology

Numerous soil borings have been drilled in the vicinity of the LAP and UAP as part of the various site investigations that have been completed for the units. Construction details for selected soil borings, observation wells, and monitoring wells are summarized in Table 1 and presented on the soil boring and well construction logs in Appendix A. The locations for some of these boreholes along with key geological contact elevation data are presented on Drawing 4. Information from these soil borings, including visual descriptions and geophysical logs, have been compiled and evaluated to formalize the Site Conceptual Model for the area of the Station surrounding the LAP and UAP. The Site Conceptual Model is illustrated on Drawings 4 through 10, with the cross section locations shown on Drawings 4 and 5. This information supplements published literature and was used herein in the design of the groundwater monitoring systems for the LAP and UAP.

3.2.1.1 Basement Bedrock

Drawing 4 shows the locations of selected soil borings, monitoring wells, and observation wells that have been advanced in the vicinity of the LAP and UAP. Using surveyed elevation data and recorded geologic information from the soil borings, a structural contour map for the top of basement bedrock was developed and is presented as an overlay on Drawing 4. The top of bedrock surface reflects the unconformable contact between overlying sediments and the underlying basement bedrock, including saprolite, partially weathered rock, and the competent parent rock. For this Station, basement bedrock is defined as igneous and metamorphic rocks that underlie the general sequence of sedimentary rocks and sediments of the Coastal Plain physiographic province in Virginia.

Core samples and other drill cuttings for the basement rock at this Station yield bedrock descriptions that range from homogenous fine-grained phaneritic granite (correlated with the Petersburg Granite) to aphanitic massive to gneissic-textured metamorphic rocks. In general, the basement bedrock types on the southern and western sides of the LAP were granitic in texture, and the rocks to the north and east exhibited more of a fine-grained homogeneous or coarse-grained banded gneissic texture. Minimal saprolite overburden (generally less than 10 feet) was observed in areas where granitic-textured rocks were observed, with significant (up to 50 feet or more) saprolite observed over basement bedrock that is described as gneissic in texture. The saprolite ranges in grade

from fully decomposed rock with no relic rock fabric to partially weathered rock with significant relic rock fabric. The competent basement bedrock (Rock Quality Designation of 75% or higher) was observed to be fractured with some healed fractures observed in the core sections. Fracture patterns were generally observed to be shallow dipping oblique in nature. Significant fractures were not observed in the gneissic-textured rocks that were recovered during the investigation.

Groundwater movement within the basement bedrock is expected to occur within the secondary porosity that is developed in the bedrock. For granitic rock, the secondary porosity is primarily comprised of joints and other discontinuities. For the gneissic-textured rocks, the secondary porosity is expected to be primarily comprised of weathered rock zones with some discontinuity contributions. Additional groundwater movement is expected to occur within the northerly trending fault zones.

As presented on Drawing 4 and cross sections A-A' through H-H' (Drawings 6 through 10), the basement bedrock elevation at the Station ranges from -40 feet mean sea level (MSL) beneath the western side of the LAP to lower than -210 feet MSL beneath the eastern portion of the UAP. The variable depth is currently interpreted as a function of en echelon faulting that is inferred to be associated with a buried rift basin from the Triassic Period. Specifically, available structural data for basement bedrock elevations suggest that a series of northerly trending en echelon normal faults (interpreted) is present to the west of the northernmost mapped extent of the reactivated Dutch Gap Fault (see Drawing 4). These interpreted faults are believed to be associated with basin rifting activities during the Mesozoic Era, and are interpreted to be associated with the buried rift basin that has been identified beneath the easternmost portion of the UAP.

As interpreted, a normal fault bounded horst is believed to be present beneath the central area of the LAP. Based on elevation data, the throw on the western fault is estimated at 90 feet and the throw on the eastern fault is estimated at 60 feet. The horst appears to be bounded by an easterly dipping graben fault block to the west and a westerly dipping graben block to the east. A fourth easterly dipping fault block appears to be present on the west side of the Dutch Gap Fault, and basement bedrock elevations fall off with a steep gradient to the east of the delineated Dutch Gap Fault zone.

3.2.1.2 Newark Supergroup (Triassic inferred) Rocks

Also presented on Drawing 4 are contours for the top of interpreted Newark Supergroup (Triassic) sediments. Locally, the Triassic sediments are weathered to saprolite with increasing competence observed with depth, and a maximum observed thickness of approximately 180 feet near borehole O on the eastern side of the UAP (see Drawing 4 and cross section E-E' on Drawing 8). The rocks encountered on the east side of the Dutch Gap Fault were generally described as varying from red to reddish-brown to brown mudstone to arkose to conglomerate. The

conglomerate materials appeared to be primarily comprised of rounded boulders and cobbles of silica-rich igneous origin with trace amounts of diabase.

As illustrated on Drawing 4 and cross sections F-F' (Drawing 9) and H-H' (Drawing 10), a smaller area of isolated Triassic sediment appears to be present beneath the west-central area of the UAP on the eastern flank of the horst. These rocks were highly weathered and consisted of conglomeratic materials. Locally, mudstone and arkose comprised the majority of the Newark Supergroup sediments that were encountered.

Groundwater movement within the Newark Supergroup sediment is expected to be controlled by the texture of the original rock and the degree of weathering. In general, the highly weathered sections of mudstone and arkose exhibit lower hydraulic conductivity values than less weathered or coarser grained rocks.

3.2.1.3 Potomac Formation

Drawing 5 presents a structural contour map for the top of the Cretaceous Potomac Formation as delineated beneath the Station. The Potomac Formation sediments at the site are generally described as green to grayish green to gray compacted fine sand interbedded with lenses of sandy gravel, and dense clayey silt and clayey sand. The gravels are generally comprised of well-rounded quartz gravel. The formation generally exhibits a fining upward sequence with the deposit capped by a dark gray clayey member over most of the Station (locally the clayey member is absent).

As shown on Drawing 5 and the cross sections on Drawings 6 through 10, the elevation for the top of the Potomac Formation is variable, ranging from several feet above MSL on the eastern side of the Dutch Gap Fault to less than -50 feet MSL beneath the paleo easterly trending James River channel that passes north of the UAP and beneath the southern portion of the LAP. The undulating nature of the Potomac Formation is believed to reflect a combination of post-deposition erosion and displacement by the Dutch Gap Fault.

The Potomac Formation sediments are fully saturated, and groundwater movement within the Potomac Formation sediment is expected to primarily be controlled by primary porosity and hydraulic gradients. The hydraulic conductivity of the clayey sediments is generally low relative to the sand units, with the greatest hydraulic conductivity expected within the gravel units.

3.2.1.4 Tertiary and Quaternary Sediments

The Tertiary and Quaternary sediments overlie the lower Potomac Formation and generally are not differentiated at the Station. In general, the surficial sediments are mapped as Quaternary sediments. The upper Quaternary sediments are generally described as tan to gray fine-grained materials (clay, clayey silt, clayey fine sand, and dense mica-rich silt) with a basal gravel or coarse sand, and organic materials within the upper sections of the unit interbedded with lenses of organic orange-brown medium to fine sand. Clay-rich deposits tend to be mottled with

black coloration. Locally, organic materials are present in the form of roots, wood fragments, peaty materials, and charcoal-type layers. The deposits beneath the LAP are generally fine-grained with a dense clay unit (possible over-bank deposits) mapped beneath the entire LAP. The clayey unit thins out to the south of the buried easterly trending paleo-channel, and the deposits in the vicinity of the UAP are generally coarser grained with more variability, presumably due to channeling and reworking by the current-day James River. Thickness of the upper Quaternary deposits is variable across the Station with the maximum thickness observed on the southwestern side of the UAP and the southern side of the LAP (*e.g.*, area of infilled river channel).

The lower Tertiary deposits are generally described as yellow to orange to orange brown sand and sandy gravel to clayey gravel, with blue and greenish-gray dense clayey silt and silt zones. The sediments general fine upward and the gravels are well rounded to sub-rounded with zones of cobbles and boulders. Locally, the lower Tertiary deposits appear to have been eroded with interpreted organic-rich Quaternary deposits directly in contact with the lower Cretaceous sediments.

The uppermost aquifer beneath the Station is an unconfined aquifer and is found within the Quaternary-Tertiary sediments. Groundwater movement within the uppermost aquifer is expected to primarily be controlled by primary porosity and hydraulic gradients relative to recharge and discharge areas. The hydraulic conductivity of the clayey sediments is generally low relative to the sand and gravel units, with the greatest hydraulic conductivity expected within the sandy gravel units.

3.3 Site Hydrogeology

The groundwater surface generally mimics area topography with groundwater movement from topographically high areas to topographically low areas (*i.e.*, James River channel). The uppermost aquifer beneath the Station is unconfined and found in the surficially exposed overburden, and is comprised of Quaternary and upper Tertiary sediments, hereafter referred to as the Columbia Aquifer (the water table aquifer system, which includes unconfined sections of the Yorktown Formation). The Columbia Aquifer is an unconfined water table aquifer that is underlain by various undifferentiated Tertiary sedimentary units and the Cretaceous Potomac Formation. Regionally, the Potomac Formation is a confined aquifer, and a fine-grained confining unit is present at the top of the formation across most of the Station (locally the fine-grained confining unit appears to have been eroded). The Potomac Aquifer overlies the fractured bedrock aquifer associated with the Petersburg Granite and other undifferentiated basement bedrock. The Triassic sediments are considered to be part of the bedrock aquifer system, with groundwater expected to flow vertically and laterally across geologic boundaries based on the hydraulic properties of the aquifer matrix. Locally, the highly weathered fine-grained sediments of the Triassic deposits serve as confining layers for water-bearing zones within the unit.

3.3.1 Description of the Uppermost Columbia Aquifer

As presented on Drawings 6 through 10, the uppermost aquifer for this Station is the Columbia Aquifer, herein defined as being comprised of Quaternary and Tertiary sediments, and locally, some of the lower hydraulically connected Potomac Formation sediments where they are unconfined. The uppermost aquifer is a water table aquifer (unconfined), lower sections of which are locally semi-confined. In the vicinity of the site, the Columbia Aquifer thickness ranges from approximately 60 feet to less than 20 feet, with an estimated average saturated thickness of approximately 40 to 50 feet around the perimeter of the LAP and UAP.

Available published on-line information (https://tides.mobilegeographics.com) indicates that the tidal range for the James River in the vicinity of the Station (latitude 37.3833 North and longitude 77.3783 West) is variable and averages approximately 3 feet, with a typical river elevation range of 0.35 feet AMSL at low tide to 3.35 feet AMSL at high tide. The tidal range is observed to influence the groundwater table within the Columbia Aquifer for those areas that are located at elevations that are less than 3 to 5 feet AMSL. Specifically, site data document a hydraulic connection between the uppermost aquifer and the James River, with lagging tidal fluctuations (upward of 2 feet) observed in observation and monitoring well water level data. Based on site conditions, the gradient reversal associated with the tidal fluctuation is not significant in lateral extent (observed along the fringe of the ponds where they abut tidal surface water bodies), with the most significant impact of the gradient reversal being a mixing zone along the western side of the LAP and the western and southern sides of the UAP.

In addition to the natural recharge and discharge cycles associated with precipitation infiltration and vertical recharge to stratigraphically lower water-bearing units and gradient controlling discharges to the James River, the water table surface in the Columbia Aquifer beneath the UAP is influenced by a perimeter toe drain that was installed around the outside of the UAP berm when it was constructed in the 1980's. The approximate location of the perimeter toe drain is shown on Drawings 2, 11, 12, and 13. The toe drain was installed as an engineering control during construction of the UAP to remove collected water from the impoundment berm to maintain and protect the berm's structural integrity. The toe drain is constructed in the Columbia Aquifer. Based on review of the design drawings for the toe drain, approximate invert elevations for the toe drain are indicated on Drawings 2, 11, 12, and 13 every 500 feet (approximate). These invert elevations, where they are lower than the inferred groundwater surface, indicate that the toe drain will influence the water table elevation when the toe drain is being pumped. The toe drain is currently in operation and is scheduled for removal as part of the UAP closure activities.

Beneath the LAP, the average thickness of the Columbia Aquifer is approximately 35 to 45 feet, and the water-bearing portion of the Columbia Aquifer is semi-confined (fully saturated) due to the presence of a sandy clay confining unit that underlies the LAP. Beneath the UAP, the average thickness of the Columbia Aquifer has been reduced by pre-pond sand and gravel mining activities that are believed to have resulted in the removal of the upper confining layer and a significant portion of the underlying sand and gravel material. The average observed thickness

is approximately 20 to 25 feet, with the unit fully saturated except beneath the eastern area of the UAP due to uplift on the east side of the Dutch Gap Fault.

The depth to groundwater in the Columbia Aquifer is variable depending on topographic elevation. In the immediate vicinity of the LAP and UAP, the groundwater elevation ranges from sea level along the banks of the James River up to approximately 10 to 15 feet AMSL where the LAP and UAP abut, with higher groundwater elevations documented in the western portion of the Station to the west of the LAP.

Depth-to-water measurements have been obtained periodically from site wells since the 1980's. These measurements indicate that the regional water table is present at an elevation near MSL, with some mounding beneath the LAP and UAP. The mounding is believed to be associated with the infiltration of residual impounded process water and impounded precipitation. As shown on Drawing 11, the groundwater flow within the Columbia Aquifer beneath the LAP and UAP is radial in nature for both ponds, with flow originating from beneath the impoundments (recharge area) toward nearby receiving surface water bodies (James River and associated systems).

3.3.1.1 Uppermost Aquifer Hydraulic Properties

Available hydraulic testing data (slug test and drawdown and recovery test) for various observation and monitoring wells in the area of the LAP and UAP, and generally within the Station boundary, are summarized in Table 2 by screened aquifer unit. As presented, the data indicate that the hydraulic conductivity of the sediments comprising the uppermost Columbia Aquifer range over approximately six (6) orders of magnitude as expected based on the variability of the depositional environments and sediments, with a geometric average of 1.45E-03 centimeters per second (cm/s), or 4.1 feet per day. Based on review of the materials that comprise the uppermost aquifer, the average effective porosity of the unconfined aquifer is estimated at 20% (Saunders, 1998).

3.3.1.2 Horizontal Component of Flow

Using the groundwater contours presented as an overlay on Drawing 11, the average hydraulic gradient for the aquifer in the vicinity of the LAP was calculated at 2.8E-02 (unitless) as shown below.

$$i_{gw} = \left({}^{h_L}/_{L}\right)$$

Where: i_{gw} = groundwater potentiometric surface gradient

h_L = head loss (elevation difference)

L = length (horizontal distance)

i_{west} = h_L/L = (5 ft AMSL – 2.5 ft AMSL) / 260 feet = 4.0E-02

i_{east} = h_L/L = (20 ft AMSL – 5 ft AMSL) / 793 feet = 1.9E-02

$i_{geometric}$ (average) = 2.8E-02

Similarly, using the groundwater contours presented as an overlay on Drawing 11, the average hydraulic gradient for the aquifer in the vicinity of the UAP was calculated at 2.9E-02 (unitless) as follows:

i_{north} = h_L/L = (10 ft AMSL – 2.5 ft AMSL) / 255 feet = 2.9E-02

i_{south} = h_L/L = (10 ft AMSL – 2.5 ft AMSL) / 241 feet = 3.1E-03

$i_{geometric}$ (average) = 2.9E-02

Using the estimated effective porosity value of 20%, the estimated average hydraulic conductivity value of 4.1 ft/day, and the calculated gradient, the average rate of groundwater flow (*Vgw*) in the Columbia Aquifer beneath the LAP was calculated using the algorithm below.

$$V_{gw} = K\, i \left({}^{1}/_{n_e}\right)$$

Where: V_{gw} = Groundwater velocity

K = Hydraulic conductivity

i = Hydraulic gradient

n_e = Effective porosity

V_{gw}= [(4.1 ft per day) x (2.8E-02)] / 0.20

V_{gw}= 6.0E-01 ft per day, or 2.2E+02 ft per year (220 ft per year)

Similarly, the average rate of groundwater flow (*Vgw*) in the Columbia Aquifer beneath the UAP was calculated as follows:

V_{gw}= [(4.1 ft per day) x (2.9E-02)] / 0.20

V_{gw}= 6.0E-01 ft per day, or 2.2E+02 ft per year (220 ft per year)

As presented above, the estimated horizontal rate of groundwater flow in the Columbia Aquifer beneath the LAP and UAP is expected to average approximately 220 feet per year.

3.3.1.3 Vertical Component of Flow

Using depth to water and elevation data from nested wells screened between the Columbia Aquifer and the underlying Potomac Aquifer, the vertical component of flow within the water-bearing formations beneath the Station were evaluated. Calculations for the vertical gradient between the upper Columbia Aquifer and the lower Potomac Aquifer are summarized in the following table based on well construction information (see Table 1) and measured groundwater elevation data. Gradient results that are negative indicate an upward flow. The calculations were performed using the following algorithm:

$$i_{gw} = \left({}^{h_L}/_{L}\right)$$

Where: i_{gw} = groundwater potentiometric surface gradient

h_L = head loss (elevation difference)

L = length (vertical distance – midpoint of the well screens)

Columbia			Potomac			Head Loss	Head Loss Length	Hydraulic Gradient
Well	Screen (ft MSL)	GW Elev. (ft MSL)	Well	Screen (ft MSL)	GW Elev. (ft MSL)			
MW-1	20-30	2.96	MW-1D	45-55	2.55	0.41	25	1.6E-02
MW-6	49-59	5.59	MW-6D	70-90	6.77	-1.18	26	-4.5E-02
MW-16	24-34	2.62	MW-16D	60-70	1.60	1.02	36	2.8E-02
MW-29U	8-18	2.68	MW-30U	44-54	3.10	-0.42	36	-1.2E-02
MW-35S	54-64	7.22	MW-35D	89-99	2.98	4.24	35	1.2E-01

The gradient results indicate that both downward and upward flow conditions are present at the Station and that these variable conditions likely relate to the degree of confining between the well screens. Wells pairs with significant confining units between the screened intervals appear to have upward gradients. Well pairs with no significant confining units have a downward gradient.

Based on the depositional environment, the vertical hydraulic conductivity value for the Columbia Aquifer is estimated at 0.41 ft/day (estimated at 10% of the horizontal hydraulic conductivity). The effective porosity as discussed previously is estimated at 20% on average. Using the following algorithm, the vertical groundwater velocity for the upper Columbia Aquifer was estimated in the following table.

$$V_{gw} = Kv\, i\, (1/n_e)$$

Where: V_{gw} = Groundwater velocity

K_v = Vertical Hydraulic conductivity

i = Hydraulic gradient

n_e = Effective porosity

Well Pair		Hydraulic Gradient	Effective Porosity	Hydraulic Conductivity (ft/d)	Velocity (ft/year)
MW-1	MW-1D	1.6E-02	0.20	0.41	12
MW-6	MW-6D	-4.5E-02			-34
MW-16	MW-16D	2.8E-02			22
MW-29U	MW-30U	-1.2E-02			-9.2
MW-35S	MW-35D	1.2E-01			92

As presented, the vertical flow rates are expected to be variable, ranging from 92 feet per year downward to 34 feet per year upward.

3.3.2 Description of the Confined Potomac Aquifer

As presented on Drawings 6 through 10, the uppermost Columbia Aquifer is underlain by the confined Potomac Aquifer. The Potomac Aquifer is found within the Cretaceous Potomac Formation sediments and is largely comprised of sand and sandy gravel beds with thin beds and lenses of finer grained materials. For the purposes of this Site Conceptual Model, the Potomac Aquifer is confined to semi-confined with thickness ranges from more than 160 feet in some of the infilled grabens to less than 10 feet on the footwall side of the graben faults.

Except where it is unconfined and hydraulically connected to the upper Columbia Aquifer (primarily along the southern side of the UAP), the Potomac Aquifer does not exhibit any significant tidal impacts. In areas where the Potomac Aquifer is hydraulically connected to the upper Columbia Aquifer, the tidal effects are similar to those observed for the Columbia Aquifer.

Recharge to the lower Potomac Aquifer is expected via vertical recharge from the overlying Columbia Aquifer where the two units are hydraulically connected, and from up-dip horizontal recharge where the Potomac Formation sediments are exposed at grade.

Using depth to water measurements that have been obtained from site wells, a potentiometric surface map was prepared for the Potomac Aquifer. The map is presented as an overlay on Drawing 12. As presented, the potentiometric surface elevation ranges from 2 to 8 feet above MSL. The highest elevations are observed beneath the eastern limits of the UAP where the Potomac Formation sediments are confined and have been uplifted by the Dutch Gap Fault. Lower elevations are observed along the southern side of the LAP and UAP where the Potomac Aquifer is hydraulically connected to the upper Columbia Aquifer along the gradient-controlling discharge boundary associated with the James River. As presented on Drawing 12, the groundwater flow direction within the Potomac Aquifer beneath the LAP and UAP is towards the south and south-southwest.

3.3.2.1 Potomac Hydraulic properties

Available slug test data for various observation and monitoring wells in the area of the LAP and UAP, and generally within the Station boundary, are summarized in Table 2 by screened aquifer unit. As presented, slug testing data indicate that the hydraulic conductivity of the sediments comprising the Potomac Aquifer range over approximately four (4) orders of magnitude as expected based on the variability of the depositional environments and sediments, with a geometric average of 2.18E-03 cm/s, or 6.18 feet per day. Based on review of the materials that comprise the uppermost aquifer, the average effective porosity of the unconfined aquifer is estimated at 20% (Saunders, 1998).

3.3.2.2 Potomac Horizontal Flow

Using the groundwater contours presented as an overlay on Drawing 12, the average hydraulic gradient for the Potomac Aquifer in the vicinity of the UAP and LAP is calculated at 2.7E-03 (unitless) as shown below.

$$i_{gw} = \left({}^{h_L}/_{L}\right)$$

Where: i_{gw} = groundwater potentiometric surface gradient

h_L = head loss (elevation difference)

L = length (horizontal distance)

$i_{gw} = h_L/L$ = (8.0 ft AMSL – 2.0 ft AMSL) / 2,172 feet = 2.7E-03

Using the estimated effective porosity value of 20%, the estimated average hydraulic conductivity value of 6.18 ft/day, and the calculated gradient, the average rate of groundwater flow (V_{gw}) in the Potomac Aquifer beneath the UAP and LAP was calculated using the algorithm below.

$$V_{gw} = K\, i \left(1/n_e\right)$$

Where: V_{gw} = Groundwater velocity

K = Hydraulic conductivity

i = Hydraulic gradient

n_e = Effective porosity

V_{gw}= [(6.18 ft per day) x (2.7E-03)] / 0.20

V_{gw}= 8.5E-02 ft per day, or 31 ft per year

As presented above, the estimated horizontal rate of groundwater flow in the Potomac Aquifer beneath the UAP and LAP is expected to average approximately 31 feet per year.

3.3.2.3 Potomac Vertical Flow

Using depth to water and elevation data from nested wells screened between the Potomac Aquifer and the underlying bedrock aquifer, the vertical component of flow between these two units was evaluated. Calculations for the vertical gradient between the Potomac Aquifer and the lower bedrock aquifer are summarized in the following table based on well construction information (see Table 1) and measured groundwater elevation data. Gradient results that are negative indicate an upward flow.

Potomac			Bedrock			Head Loss	Head Loss Length	Hydraulic Gradient
Well	Screen (ft MSL)	GW Elev. (ft MSL)	Well	Screen (ft MSL)	GW Elev. (ft MSL)			
MW-1D	45-55	2.55	MW-1DD	171-181	3.51	-0.96	126	-7.6E-03
MW-6D	70-90	6.77	MW-6DD	220-230	5.21	1.56	140	1.1E-02
MW-16D	60-70	1.60	MW-16DD	150-160	6.30	-4.70	90	-5.2E-02
MW-30U	44-54	3.10	MW-31U	120-140	4.98	-1.88	81	-2.3E-02
MW-35D	89-99	2.98	MW-35B	165-175	2.14	0.84	76	1.1E-02

The gradient results indicate that both downward and upward flow conditions are present at the Station between the Potomac Aquifer and the lower bedrock aquifer. Of interest, an upward gradient is observed near the groundwater discharge boundary for the Columbia Aquifer (near the river), with a downward gradient observed in the upland recharge area of the MW-35 nested wells and a downward gradient observed at the MW-6 nested wells, which measures the gradient between the Potomac Aquifer and the lower Triassic bedrock.

Based on the depositional environment, the vertical hydraulic conductivity value for the Potomac Aquifer is estimated at 0.618 ft/day (estimated at 10% of the horizontal hydraulic conductivity). The effective porosity as discussed previously is estimated at 20% on average. Using the following algorithm, the vertical groundwater velocity (negative values indicate upward flow) for the Potomac Aquifer was estimated in the following table.

$$V_{gw} = Kv\, i\, (1/n_e)$$

Where: V_{gw} = Groundwater velocity

K_v = Vertical Hydraulic conductivity

i = Hydraulic gradient

n_e = Effective porosity

Well Pair		Hydraulic Gradient	Effective Porosity	Hydraulic Conductivity (ft/d)	Velocity (ft/year)
MW-1D	MW-1DD	-7.6E-03	0.20	0.618	-8.4
MW-6D	MW-6DD	1.1E-02			12
MW-16D	MW-16DD	-5.2E-02			-57
MW-30U	MW-31U	-2.3E-02			-25
MW-35D	MW-35B	1.1E-02			12

As presented, the vertical flow rates are expected to be variable, ranging from 12 feet per year downward to 57 feet per year upward.

3.3.3 Description of the Confined Bedrock Aquifer

As presented on Drawings 5 through 10, the Potomac Aquifer is underlain by bedrock associated with the Triassic Basin (eastern area beneath the UAP) or the continental basement bedrock (igneous and metamorphic rocks). For the purposes of this Site Conceptual Model, the Triassic sedimentary rocks and basement bedrock are considered one aquifer system. The bedrock aquifer is considered to be confined beneath the entire study area. Recharge to the bedrock aquifer system is expected via vertical recharge from the overlying water-bearing units where downward potentiometric gradients exist, and from up-dip horizontal recharge where the bedrock (and/or associated saprolite) is exposed at grade.

Using depth to water measurements that have been obtained from site wells, a potentiometric surface map was prepared for the bedrock aquifer. The map is presented as an overlay on Drawing 13. As presented, the potentiometric surface elevation within the study area ranges from 0 feet MSL to approximately 6 feet AMSL. The highest elevations are observed to the south of the LAP and UAP with flow towards the north and northeast. Elevational differences between the Triassic bedrock and basement bedrock suggest that the hydraulic connection between the two bedrock systems is restricted (*i.e.*, the hydraulic conductivity of the two bedrock units is different) and/or that the conductivity of the Dutch Gap Fault zone is higher than that of either bedrock system. Specifically, groundwater elevations in the Triassic bedrock are higher than expected based on their spatial location relative to elevations observed in the adjacent basement bedrock wells, with evidence for gradient convergence on the Dutch Gap Fault zone.

3.3.3.1 Bedrock Hydraulic Properties

Available slug test data for various observation and monitoring wells in the area of the LAP and UAP, and generally within the Station boundary, are summarized in Table 2 by screened aquifer unit. As presented, slug testing data for one well are available (MW-35B). The results from this well suggest a hydraulic conductivity of 2.6E-07 cm/s, or 7.4E-04 foot per day. The hydraulic conductivity of the bedrock system within the basement bedrock suite is expected to be a function of secondary porosity, such that the conductivity is primarily a function of the presence and density of discontinuities (*e.g.*, fractures, joints, faults) within the rock. Based on experience with similar basement bedrock systems in central Virginia, the hydraulic conductivity value reported for MW-35B is believed to be on the low range of expected conductivity values for the similar basement bedrock systems. Based on experience, the effective porosity of the basement bedrock system is expected to range from 0.1% (whole rock average) to 50% for open joints in the basement bedrock. Based on available geological information and gradient observations, the hydraulic conductivity of the Triassic bedrock system is expected to be around 1.0E-04 ft/day, with an effective porosity of approximately 10% to 15% depending on the degree of weathering and the sediment characteristics (clays, silts, sands, gravels, *etc.*).

3.3.3.2 Bedrock Horizontal Flow

Using the groundwater contours presented as an overlay on Drawing 13, the average hydraulic gradient for the bedrock aquifer in the vicinity of the LAP was calculated at 1.8E-03 (unitless) as shown below.

$$i_{gw} = \left({}^{h_L}/_{L}\right)$$

Where: i_{gw} = groundwater potentiometric surface gradient

h_L = head loss (elevation difference)

L = length (horizontal distance)

$i_{gw} = h_L/L$ = (6.0 ft AMSL – 0.0 ft AMSL) / 3,347 feet = 1.8E-03

Similarly, using the groundwater contours presented as an overlay on Drawing 13, the average hydraulic gradient for the bedrock aquifer in the vicinity of the UAP was calculated at 1.5E-03 (unitless) as follows:

$I_{North} = h_L/L$ = (4.0 ft AMSL – 0.0 ft AMSL) / 2,626 feet = 1.5E-03

$I_{South} = h_L/L$ = (5.0 ft AMSL – 0.0 ft AMSL) / 3,539 feet = 1.4E-03

$i_{geometric}$ (average) = 1.5E-03

Using the estimated effective porosity value of 1%, an estimated average hydraulic conductivity value of 10 ft/day (3.5E-03 cm/s), and the calculated gradient, the average rate of groundwater flow (V_{gw}) in the bedrock aquifer beneath the LAP was calculated using the algorithm below.

$$V_{gw} = K\, i \left({}^{1}/_{n_e}\right)$$

Where: V_{gw} = Groundwater velocity

K = Hydraulic conductivity

i = Hydraulic gradient

n_e = Effective porosity

V_{gw}= [(10 ft per day) x (1.8E-03)] / 0.01

V_{gw}= 1.8 ft per day, or 6.6E+02 ft per year (660 ft per year)

Similarly, the average rate of groundwater flow (V_{gw}) in the bedrock aquifer beneath the UAP was calculated as follows:

V_{gw}= [(10 ft per day) x (1.5E-03)] / 0.01

V_{gw}= 1.5 ft per day, or 5.5E+02 ft per year (550 ft per year)

As presented above, the estimated horizontal rate of groundwater flow in the bedrock aquifer beneath the LAP is expected to average approximately 660 feet per year, and beneath the UAP it is expected to average approximately 550 feet per year.

3.3.4 Water Supply Wells

Based on site observations and available public records, potable water is provided to the Station and surrounding properties by a municipal water supply system. Consequently, there are no known production water wells

(residential or industrial) in close vicinity to the Station that could impact the design of the groundwater monitoring system outlined herein.

4.0 DESIGN OF THE GROUNDWATER MONITORING SYSTEM

The monitoring wells for the compliance monitoring network are located and constructed with a sufficient number of wells to yield groundwater samples representative of the conditions in the uppermost unconfined aquifer beneath the Station that:

- Accurately represent the quality of background groundwater that has not been affected by leakage from the waste management unit (CCR unit), and
- Accurately represent the quality of groundwater passing the waste boundary of the waste management unit (CCR unit). The downgradient monitoring system installed at the waste boundary will ensure detection of groundwater contamination in the uppermost aquifer. Dominion Energy will monitor potential contaminant pathways related to the waste management unit (CCR unit).

Dominion Energy obtained a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of the CCR Rule [§257.91(f)] as adopted under the VSWMR on October 16, 2017. The certification has been placed in the Station operating record in accordance with the recordkeeping requirements of §257.105 as adopted by the VSWMR. In addition, the certification has been placed on Dominion Energy's publicly accessible internet site.

Well placement, construction, development, and decommissioning procedures are discussed in the following sections. Recommended monitoring well construction, development, and decommissioning procedures are included in Appendix B.

4.1 Special Conditions

Special conditions are site conditions that can affect the design of a groundwater monitoring system. These conditions may include:

- Waste management units, including CCR units, located above mounded groundwater table;
- Waste management units, including CCR units, located above aquifers with seasonally variable groundwater flow directions;
- Waste management units, including CCR units, located in areas where nearby surface water features or proximity to tidally influenced surface water bodies may influence groundwater levels or expected flow directions;
- Waste management units, including CCR units, located near intermittently or continuously used groundwater production wells; and/or

- Waste management units, including CCR units, located in karst (carbonate bedrock) or faulted areas where subsurface geologic features may modify expected groundwater flow paths.

Based on the available hydrogeologic information for the Station, other than the considerations listed below, Dominion Energy is not aware of any special conditions, including those listed above, that would affect the design of a downgradient groundwater monitoring network that can effectively monitor the uppermost aquifer:

- Due to the surrounding low lying topography, recharge characteristics, the design of the ponds, and gradient-controlling discharges to the James River, a radial flow regime is indicated in the Columbia Aquifer (uppermost aquifer system) beneath both the LAP and UAP; and
- A perimeter toe drain system intersects the uppermost water table aquifer around the northern, western, and southern limits of the UAP.

Other than a mixing zone along the fringe of the LAP and UAP, the tidal fluctuations observed in the Columbia Aquifer and the lower hydraulically connected sections of the Potomac Aquifer along the James River do not appear to exhibit any significant impacts in terms of elevation range or gradient reversal within the Columbia Aquifer. This observation is not expected to have any adverse impact on the ability to monitor the downgradient boundary of the LAP and UAP using a conventional groundwater monitoring network.

Due to the location of the LAP and UAP, both of which are generally bounded by the James River and a former channel of the James River, and the radial-like flow systems observed in the Columbia Aquifer beneath the UAP and LAP, a suitable upgradient well location(s) that reflects upgradient groundwater quality that could not potentially be impacted by the LAP or UAP is not available. Therefore, the background wells for the LAP and UAP are not located in areas that are hydraulically upgradient of either the LAP or UAP. Additional details on the background wells are presented in the following sections.

Based on available hydraulic information and interpolated potentiometric surface maps for the study area, the Dutch Gap Fault zone and associated Triassic faults interpreted to the west of the Dutch Gap Fault are not expected to impact the groundwater flow direction within the uppermost aquifer. Additionally, it is not clear at this time whether these interpreted fault zones exhibit any significant impact on groundwater flow in the lower bedrock system. Rather, the data suggest that the difference in hydraulic properties between the sedimentary bedrock and the igneous/metamorphic basement bedrock is responsible for gradient variations in the bedrock aquifer system.

4.2 Monitoring Well Placement

The monitoring network described herein is designed to meet the performance standards specified in the VSWMR consistent with the CCR Final Rule, and to ensure protection of human health and the environment. Accordingly, the monitoring network is designed so that adequate monitoring coverage is provided to represent the quality of

groundwater downgradient of the waste management unit (CCR unit), and in areas of the Station where groundwater has not been impacted by the waste management unit (CCR unit). Consistent with Dominion Energy's policy, the monitoring wells are installed on property that is owned by Dominion Energy.

4.2.1 Background Wells

Based on site conditions, the Site Conceptual Model, our understanding of the vertical and lateral presence of subsurface confining units, and groundwater flow directions, the background compliance wells for the uppermost aquifer beneath the LAP (Columbia Aquifer only) and the UAP (Columbia and Potomac Aquifer) are presented as follows:

Lower Ash Pond Background Compliance Wells		
Well	**Aquifer**	**Use**
MW-29U	Columbia	Background Compliance
MW-35S	Columbia	Background Compliance

Upper Ash Pond Background Compliance Wells		
Well	**Aquifer**	**Use**
MW-29U	Columbia	Background Compliance
MW-30U	Potomac	Background Compliance
MW-35S	Columbia	Background Compliance
MW-35D	Potomac	Background Compliance

A summary of the well construction information for the existing wells, including nearby observation wells, is provided in Table 1.

Due to the hydraulic flow regime and property ownership limitations it is not feasible at this time to install a background well(s) for the Triassic aquifer beneath the eastern side of the Upper Ash Pond. Therefore, the consolidated background concentrations for the Columbia and Potomac Aquifers is used for background concentrations with wells that are screened within the Triassic aquifer. This approach is justified on the basis that

sediments of the Columbia and Potomac Formations are present above the Triassic aquifer and therefore, vertical recharge to the Triassic aquifer is expected to infiltrate through these sediments imparting a matrix-representative geochemical signature to the recharge water. This approach does not account for geochemical changes that may occur within the Triassic aquifer once the recharge passes through the Triassic aquifer matrix. As such, modifications to the background network for the Triassic aquifer may be warranted in the future if spatial variability between the consolidated Columbia/Potomac Aquifers and the Triassic aquifer is significant.

4.2.2 Lower Ash Pond Compliance Wells

The LAP is underlain by a confining unit that separates the upper Columbia and lower Potomac Aquifers. Therefore, the downgradient compliance monitoring network for the uppermost aquifer (Columbia Aquifer) beneath the LAP is as follows:

Lower Ash Pond Downgradient Compliance Wells				
MW-20	MW-21	MW-22	MW-23	MW-24
MW-25	MW-26	MW-27	MW-28	MW-32
MW-33	MW-34	MW-B40A	MW-B50	--

A summary of the well construction information for the existing wells, including nearby observation wells, is provided in Table 1.

4.2.2.1 Scheduled Lower Ash Pond Well Replacement Activities

As part of the closure activities for the LAP, Dominion Energy anticipates having to relocate selected wells to facilitate construction activities that are required for closure by removal of the LAP. Based on current planning activities, the following compliance wells will be impacted by the closure activities. These wells will be decommissioned and replaced in accordance with the procedures and reporting requirements presented in this GMP. The replacement wells, approximate locations shown on Drawing 2, will be constructed in the same general vicinity as the well being replaced and screened in the same water-bearing stratum. Following construction and development, the replacement wells will be incorporated into the compliance network prior to the next semi-annual compliance event.

Lower Ash Pond Compliance Wells Scheduled for Replacement	
Wells Proposed for Decommissioning	**Replacement Well Identification**
MW-21	MW-21R

Lower Ash Pond Compliance Wells Scheduled for Replacement	
Wells Proposed for Decommissioning	**Replacement Well Identification**
MW-22	MW-22R
MW-23	MW-23R
MW-32	MW-32SR
MW-33	MW-33R

4.2.3 Upper Ash Pond Compliance Wells

Due to the removal of the natural confining layer between the upper Columbia Aquifer and the lower Potomac Aquifer by historical mining activities and/or natural depositional processes, the downgradient monitoring system for the UAP monitors the upper Columbia (C), the lower Potomac (P) Aquifer systems, and beneath the eastern side of the Station, the Triassic (T) aquifer system. Specifically, the downgradient compliance monitoring network for the uppermost aquifer beneath the UAP and the associated aquifer [indicated with postscripts (C), (P), and (T)] is as follows:

Upper Ash Pond Downgradient Compliance Wells				
MW-1 (C)	MW-1D (P)	MW-2 (C)	MW-3 (C)	MW-3D (T)
MW-4 (P)	MW-5 (C)	MW-6 (P)	MW-6D (T)	MW-7 (P)
MW-8R (C)	MW-9R (C)	MW-10 (P)	MW-11 (C)	MW-12 (C)
MW-13 (C)	MW-14 (P)	MW-15 (C)	MW-16 (C)	MW-16D (P)
MW-17S (C)	MW-B31 (C)	MW-B32 (C)	--	--

A summary of the well construction information for the existing wells, including nearby observation wells, is provided in Table 1.

4.2.4 Station Observation Wells

In addition to the background wells and downgradient wells for the compliance network, Dominion Energy maintains several observation wells that are used for periodic water level gauging and water quality assessments.

4.3 Monitoring Well Construction

Historical logs for MW-B31 and MW-B32 are not readily available. Based on historical tabulated information and downhole video logging, which indicates that these two wells are constructed with 10 feet of 2-inch inner diameter (ID) polyvinyl chloride (PVC) screen located within the upper portion of the Columbia Aquifer, well construction logs for the two wells were prepared and are presented in Appendix A. Historical soil boring and well construction logs for the remaining monitoring wells and some of the observation wells that have been installed at the Station are also presented in Appendix A, along with geophysical logs for MW-1DD, MW-6DD, MW-16DD, and MW-31U.

As summarized in Table 1, the monitoring wells are generally constructed with 10 feet (some of the deep wells have 20 feet) of 2-inch ID PVC casing and 0.010-inch factory slotted, flush-threaded well screen. The bottom of the wells are equipped with a flush-threaded end cap and the well casings are extended to approximately 30 inches above grade (for wells that are not located in the 100-year floodplain). The wells were constructed so that the top of the screened interval is at least 5 feet below the seasonal low water table surface or the bottom of the adjacent pond, whichever is lower. Additionally, based on the Site Conceptual Model, the top of the well screens for wells MW-1 through MW-17 were located to extend from at least 5 feet below the invert elevation of the adjoining toe drain (where it intersects the water table).

Monitoring wells that are located above the 100-year floodplain elevation were completed with a locking protective standpipe, a concrete apron for surface protection, and concrete-filled bollards that were strategically located to protect the well head from vehicular traffic.

Monitoring wells that were installed in areas that are below the 100-year floodplain elevation were finished with a water-tight casing equipped with a self-vented, self-sealing air release value. The casings were equipped with a water-tight clean-out that allows access to the well head for sampling. The normally open air-release valve allows the well casing to breathe as the water level in the well fluctuates and will automatically close (via flotation) in the event that floodwaters begin to encroach upon the well casing. Wells equipped with the water-tight casings are secured in locking fiberglass construction utility cabinets that are secured to a concrete pad centered on the well casing. As with the stick-up well constructions, the floodplain well heads were finished with concrete-filled bollards that were strategically located to protect the well head from vehicular traffic and possible floating debris.

Details for the water-tight well casings are presented on Figure 1 in Appendix B. The design was selected to prevent surface water from entering the wells in the event of a flood, and to protect the wells from floating debris, while providing access to the wells for sampling with dedicated equipment during normal site conditions (*i.e.*, non-flood conditions).

If additional wells are required in the future, construction will be performed in general accordance with the specifications presented in Appendix B. Monitoring wells will be maintained such that they perform to design

specifications throughout the life of the monitoring program. Dominion Energy will document and include in the Station operating record the design, installation, and development of any monitoring wells, piezometers, and other measurement, sampling, and analytical devices as required by §257.91(e)(1) and in accordance with the recordkeeping requirements of §257.105 as adopted in the VSWMR.

Soil boring and well construction logs for new wells as installed will be incorporated into Appendix A upon construction within 120 days of DEQ's approval of the GMP.

4.3.1 Drilling Methods

Drilling of new monitoring wells will be performed in general accordance with the specifications presented in Appendix B. It is anticipated that a number of different drilling technologies may be used at this Station based on the geologic conditions that have been encountered. A qualified groundwater scientist will prepare and certify a boring and well construction log for each new well within 30 days of installation. Dominion Energy will transmit the boring logs, well construction logs, and appropriate maps for any wells to be included in the permitted network to the DEQ within 14 days of certification by the qualified groundwater scientist in accordance with the VSWMR. Available boring logs and well construction diagrams for current monitoring wells are provided in Appendix A.

4.3.2 Well Screens

Monitoring well screens should, in most circumstances, be a maximum of 10 feet in length. The design of new monitoring wells should take into consideration the hydrogeologic conditions at the site, the fate and transport considerations of the potential contaminants being monitored, and the procedure(s) being used to sample the monitoring well(s). Ideally, to preserve the geochemical integrity of the water samples, well screens should be designed and placed (vertically) in a manner that prevents a change in the well screen exposure during sampling (relative to the exposure between sampling events) so that conditions during the sampling event do not change from the conditions that are present between sampling events. For CCR facilities, DEQ requires that all monitoring wells be screened solely within the saturated zone of the uppermost aquifer (no portion of the screen should be exposed above the zone of saturation). In addition, wells shall be screened in naturally occurring geologic formations, not in manmade deposits (*e.g.,* fill, mine spoil).

4.3.3 Wellhead Completions

Wells will be completed with a locking protective standpipe and a concrete apron for surface protection. Construction of new monitoring wells will be performed in general accordance with the specifications presented in Appendix B. Protective bollards for monitoring wells will be installed at the time of well construction as needed for wells located adjacent to high traffic areas or the 100-year floodplain, or later if it is determined that protective bollards are warranted. Bollards will generally be painted with high-visibility paint to assist with wellhead protection.

4.3.4 Well Development

The existing wells have been developed. If new wells are installed, the new wells will be developed prior to sampling to remove particulates that are present in the well casing, filter pack, and adjacent aquifer matrix due to construction activities. Development of new monitoring wells will be performed at least 24 hours after well construction. Wells may be developed with disposable bailers, a well development pump, or other approved method. Well development procedures are presented in Appendix B.

Samples withdrawn from the Station's monitoring wells should be clay- and silt-free; therefore, wells may require redevelopment from time to time based upon observed turbidity levels during sampling activities. If redevelopment of a monitoring well is required, it will be performed and documented in a manner similar to that used for a new well.

4.3.5 Pump Installations

Wells designated for use in the compliance monitoring network have dedicated bladder pumps, or similar pumps, installed to facilitate micropurge sampling activities. The pumps and associated tubing are constructed of environment-inert materials suitable for use in compliance and corrective action monitoring programs. Each pump should be placed within the middle portion of the well screen, and no closer than 2 feet from the bottom of the well.

4.3.6 Documentation

Documentation of future well construction activities will be in accordance with the VSWMR and CCR Final Rule. New wells will be surveyed by a licensed surveyor to within ±0.05 foot on the horizontal plane and ±0.01 foot vertically in reference to mean sea level. A boring log, well construction log, groundwater monitoring network map, and installation certification will be submitted to the DEQ within 14 days of certification by the qualified groundwater scientist in accordance with the VSWMR. Separately, a copy of the boring log, well construction log, groundwater monitoring network map, and installation certification will be incorporated into the Station operating record as required under §257.105 of the CCR Final Rule as adopted in the VSWMR. The certification shall occur within 30 days of well construction (including the licensed well survey).

4.4 Monitoring Well Decommissioning Procedures

If a monitoring well becomes unusable during the life of the monitoring program, Dominion Energy will make reasonable attempts to decommission the monitoring well in accordance with procedures presented in Appendix B.

4.4.1 Documentation

DEQ approval will be obtained prior to decommissioning any monitoring wells that are in the Station's compliance monitoring network. A report describing the decommissioning procedures will be transmitted to DEQ following completion of the decommissioning activities. Separately, a copy of the report will be included in the Station operating record in accordance with the recordkeeping requirements of §257.105 as adopted in the VSWMR.

4.5 Monitoring Well Replacement

Any monitoring well that fails to perform as designed shall be replaced prior to the next regularly scheduled groundwater sampling event, or as warranted. Non-performance of permitted groundwater monitoring wells should be reported to DEQ within 30 days of recognition.

If a monitoring well becomes unusable during the life of the monitoring program, Dominion Energy will make reasonable attempts to decommission the monitoring well in accordance with the procedures presented in Appendix B.

4.5.1 Documentation

DEQ approval will be obtained prior to decommissioning any monitoring wells that are in the compliance monitoring networks. A report describing the decommissioning procedures will be transmitted to DEQ following completion of the decommissioning activities. The report will be prepared in accordance with the provisions in Appendix B.

4.6 Well Operations and Maintenance

In accordance with the VSWMR and §257.91(e)(2), the compliance monitoring wells will be operated and maintained so they perform to their design specifications throughout the life of the monitoring program. Maintenance activities for the compliance wells are as follows:

Activity	Schedule
Lock Inspection	Each Monitoring Event
Protective Casing Inspection	Annually
Pump Inspection & Cleaning	Annually
Depth to Well Bottom	Annually
Concrete Pad Inspection	Annually
Surface Water Infiltration Evaluation	Annually
Grass Mowing	Semi-Annually as needed
Air Vent Testing (floodplain wells)	Annually

The results from the well inspections will be recorded on a Well Inspection Log during the routine semi-annual sampling events. Samples of typical well inspection logs are presented in Appendix B.

4.6.1 Floodplain Wells

Existing compliance wells located in the 100-year floodplain are installed with a floodplain resistant wellhead similar in design to the specification detailed in Figure 1 of Appendix B. This well head is designed to allow the well to breath under normal conditions (atmospheric pressure) and will close to prevent well flooding if the surrounding water level overtakes the vent housing. Additionally, the compliance wells in the floodplain are protected from rafted debris with bollards on the four corners of the surface pad.

Wells with this or similar floodplain protection designs should be inspected after every flooding event to ensure that there is no surficial damage from the flood that could impact the integrity of the well or future groundwater samples. If damage is observed, Dominion Energy will affect repairs before the next sampling event and will document the damage and completed repairs for the operating record.

For observation wells that are not constructed with the floodplain well housing, Dominion Energy will coordinate for removal and/or sealing of the wells with watertight compression caps as feasible prior to flooding events. Such measures will prevent surface water from entering the well and impacting the uppermost aquifer. After the highwater has passed, each well will be accessed to determine if surficial damage that could impact the integrity of the well or future groundwater samples has occurred. If damage is observed, Dominion Energy will affect repairs before the next sampling event and will document the damage and completed repairs for the operating record.

If Dominion Energy is not able to seal one or more wells prior to a flooding event, the well will be assessed after the flood event is over to determine the extent of impacts, if any. If available data indicates that the well head was submerged, the well will be re-developed to remove silt and other materials that may have entered the well. The goal of the redevelopment activities will be silt removal and to flush the well and surrounding aquifer with aquifer water. Development activities will be conducted until such time as the pH and specific conductance of the water recovered from the well is measured to be to be similar (within the bound of) to the upper and lower confidence limits for the targeted parameters based on measurements collected during any previously conducted sampling events. If development activities are not able to restore the water quality, the DEQ will be contacted at that time to discuss alternative solutions.

As of the date of this revision, the following wells have a flood-resistant wellhead:

MW-1	MW-13	MW-21I
MW-1D	MW-14	MW-22
MW-1DD	MW-15	MW-23

MW-1	MW-13	MW-21I
MW-2	MW-B32	MW-25
MW-2I	MW-17S	MW-26
MW-B31	MW-29U	MW-27
MW-3S	MW-30U	MW-32
MW-3D	MW-31U	MW-33
MW-4	MW-20I	MW-34
MW-5	MW-21	--

5.0 GROUNDWATER MONITORING PROGRAM

This GMP is intended to provide a framework for consistent sampling and analysis procedures (as provided in Section 6.0) that are designed to ensure monitoring results from the detection and assessment monitoring programs provide an accurate representation of groundwater quality at the background and downgradient wells.

Groundwater monitoring activities for the LAP and UAP have historically been performed in compliance with two regulatory programs:

1. Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004146 – Groundwater monitoring and reporting activities are currently being conducted in accordance with the conditions in the Chesterfield Power Station VPDES Permit and the affiliated VPDES GWP.

2. CCR Rule – Groundwater monitoring for the LAP and UAP began in October 2016 under the Detection Monitoring Program which included eight background sampling events and the initial Detection Monitoring Program event which was conducted in September 2017. Evaluation of Detection Monitoring Program data identified statistically significant increases (SSIs) over background for several CCR Rule Appendix III constituents. The SSI determination was completed in December 2017 for the LAP and February 2018 for the UAP. Based on the SSI findings, Dominion Energy initiated the CCR Rule Assessment Monitoring Program with the initial Assessment Monitoring Program sampling event for the LAP conducted in February 2018 and the UAP in March 2018.

In order to comply with the requirements of the CCR Rule, as well as the pending Solid Waste Permit, Dominion Energy has prepared this GMP which presents a “modified” program modeled on the requirements of the CCR Rule and the pending solid waste Permit, and as directed by DEQ. The modified Detection Monitoring Program is designed to meet the requirements of VSWMR’s First Determination Monitoring Program and CCR’s Detection Monitoring Program. The modified Assessment Monitoring Program is designed to meet the requirements of VSWMR’s Phase II Monitoring Program and CCR’s Assessment Monitoring Program. To the extent a conflict exists between the requirements of the CCR Rule and VSWMR, this GMP utilizes the more stringent of requirements. Current monitoring programs for the LAP and UAP are conducted pursuant to the CCR Rule Assessment Monitoring Program and the VPDES permit requirements.

Records of the background groundwater quality data and subsequent measurements, including concentration data, are (will be) kept in the operating record, provided to DEQ, and placed on the publicly available website in accordance with the recordkeeping and notification requirements of §257.105, §257.106, and §257.107 as adopted in the VSWMR. These records will be maintained throughout the active lives and post-closure care periods for the impoundments.

For each parameter, the laboratory certificates-of-analysis will identify the analytical Limit of Quantitation (LOQ), the analytical Limit of Detection (LOD), the reported concentration, and applicable laboratory quality assurance/quality control (QA/QC) data on surrogate and standards analyses. Statistical evaluations of the analytical data (if completed), federal GWPS and Virginia Groundwater Protection Standard (GPS) comparisons, static water level determinations and evaluations, and use of other measurement, sampling, and analytical devices, will be retained throughout the active lives and post-closure care periods for the impoundments.

Details for the Modified Detection and Assessment Monitoring Programs are presented in the following sections.

5.1 Modified Detection Monitoring Program

Details regarding the modified Detection Monitoring Program are presented herein in the event that one or more impoundments meets the requirements for monitoring under the modified Detection Monitoring Program at a future time. Note that future implementation of the Modified Detection Monitoring Program would require Dominion Energy to complete a major permit modification.

The modified Detection Monitoring Program is designed to identify the presence and concentration of targeted potential CCR and solid waste constituents in the uppermost aquifer beneath the impoundments. Components of the modified Detection Monitoring Program, including analytical requirements, sampling frequency, and data evaluation, are discussed in the following sections.

5.1.1 Constituents

The modified Detection Monitoring Program will include sampling and analysis of the inorganic constituents (metals) listed in Table 3.1 Column A of the VSWMR and Appendix III of the CCR Rule. Samples will be analyzed using the appropriate analytical method from the latest edition of USEPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846* (USEPA, 2015), if available. Suggested analytical methods and Practical Quantitation Limits (PQL) are presented in Table 3.

5.1.2 Background Sampling

The VSWMR and the CCR Rule differ in the minimum number of independent samples required to establish background; as a result, the more stringent of the regulatory requirements will be followed. Therefore, a minimum of eight independent background samples for monitored constituents and parameters will be collected from each background and downgradient well for the modified Detection Monitoring Program. The background sampling events will be performed on a temporal schedule (if feasible) that accounts for both seasonal and spatial variability in groundwater quality for the constituents listed in Tables 3 and 4. The Detection Monitoring Program background sampling activities for the LAP and UAP have been completed.

Background sampling (eight events) for new compliance wells that may be installed will be completed within the initial semi-annual compliance period for the new monitoring well. Replacement wells that are screened in the same zone and at the same general location as the well that is being replaced will not require background sampling.

5.1.3 Sampling Schedule

After establishing background concentrations for the impoundments, the modified Detection Monitoring Program sampling schedule will be based on a semi-annual schedule (once every 180 days plus or minus 30 days) with the sample analyses completed within the calendar year semi-annual period consistent with the CCR Rule.

5.1.4 Verification Sampling Events

If verification sampling events are undertaken to verify suspect analytical results, the verification sampling activities, including laboratory analyses, must be completed within the combined 30-day determination and 14-day reporting window for reporting statistical exceedances (total of 44 days from the date of receipt of the laboratory certificates of analysis for the sampling event).

5.1.5 Analytical Data Evaluation

The VSWMR and the CCR Rule differ in the required evaluation period after the receipt of laboratory analytical results; as a result, the more stringent of the regulatory requirements will be followed. Therefore, within 30 days of receiving the laboratory analytical results, the groundwater data will be evaluated statistically as described in Section 7.0 of this GMP. The results of the statistical analyses will then be evaluated as follows:

- Provided that there are no statistically significant detections over the impoundment background concentrations, the modified Detection Monitoring Program will continue on a semi-annual schedule with the results of the statistical analyses presented in the semi-annual and annual reports prepared for the impoundment.
- If one or more monitored constituents are detected at statistically significant concentrations over the impoundment background concentrations the Dominion Energy shall within 14 days of this finding notify the DEQ of its intention to:
  - Implement the modified Assessment Monitoring Program; or
  - Prepare and submit an ASD to the DEQ and obtain DEQ's approval of said ASD within 90 days unless a longer timeframe is granted by DEQ.

5.1.6 Reporting

Dominion Energy will comply with the requirements of the CCR Rule and VSWMR for data collection, storage, and reporting including:

- Recordkeeping requirements specified in 40 CFR 257.105(h);
- Recordkeeping requirements specified in 9VAC20-81-250.E.1;
- Reporting requirements specified in 9VAC20-81-250.E.2;
- Notification requirements specified in 40 CFR 257.106(h); and
- Publicly accessible Internet site requirements specified in 40 CFR 257.107(h).

Reports required under the modified Detection Monitoring Program include statistical exceedance notifications, if required; semi-annual reports; annual reports; and a Facility Background Determination Report. The minimum required information for each report and submittal timeframes for the reports are discussed in the following sections.

5.1.6.1 Statistical Exceedance Notification

In the event that one or more constituents are detected at a statistically significant concentration relative to the impoundment background concentrations, Dominion Energy is required to notify the DEQ within 14 days of this determination. The notification shall identify the impoundment, the constituent exceeding the background concentration, the well identification, and Dominion Energy's intent to either initiate a modified Assessment Monitoring Program for that impoundment or to submit and obtain DEQ approval of an ASD.

5.1.6.2 Semi-Annual Report

For each impoundment, no later than 120 days of completing the first semi-annual event of each year (*i.e.*, after receiving the laboratory analytical results), Dominion Energy will submit a semi-annual report to DEQ. Each semi-annual report will include the following:

- Signature page signed by a professional geologist or qualified groundwater scientist;
- Impoundment name and permit number;
- Statement noting whether or not all monitoring points within the permitted network for the impoundment installed to meet the requirements of the VSWMR were sampled as required during the event;
- Calculated rate of groundwater flow during the sampling period;
- The groundwater flow direction as determined during the sampling period presented as either plain text or graphically as a potentiometric surface map;
- Statement noting whether or not there were SSIs over background during the sampling period, the supporting statistical calculations, and reference to the date the director was notified of the increase pursuant to timeframes in the VSWMR, if applicable;

- Copy of the full Laboratory Analytical Report including dated signature page (laboratory manager or representative) to demonstrate compliance with the VSWMR timeframes. The DEQ will accept the lab report in CD-ROM format; and
- A brief discussion of the sampling and analysis activities.

5.1.6.3 Annual Report

For each impoundment, Dominion Energy will prepare an annual report for submission to the DEQ no later than January 31st of each year pursuant to §257.90.e of the CCR Rule or 120 days from the date the second semi-annual sampling and analysis activities are complete pursuant to 9VAC20-81-250.E.2 of the VSWMR, whichever occurs first. The annual report will include the following:

- A signature page;
- A completed QA/QC DEQ Form ARSC-01.
- The impoundment's name, type, permit number, current owner or operator, and location keyed to a United States Geological Survey (USGS) topographic map;
- Summary of the design type, operational history, and size (acres) of the impoundment, including key dates such as beginning, and termination of waste disposal actions and dates different groundwater monitoring phases were entered;
- Description of the surrounding land use noting whether any adjoining landowners utilize private wells as a potable water source;
- A discussion of the topographic, geologic, and hydrologic setting of the impoundment including a discussion on the nature of the uppermost aquifer (*i.e.*, confined versus unconfined) and proximity to surface waters;
- A discussion of the monitoring wells network noting any modifications that were made to the network during the year or any nonperformance issues and a statement noting that the monitoring well network meets (or did not meet) the VSWMR performance requirements;
- A listing of the groundwater sampling events undertaken during the previous calendar year;
- A historical table listing the detected constituents, and their concentrations identified in each well during the sampling period; and
- Evaluations of and appropriate responses to the groundwater elevation data; groundwater flow rate as calculated using the prior year's elevation data; groundwater flow direction (as illustrated on a potentiometric surface map); and sampling and analytical data obtained during the past calendar year.

In addition to the above requirements, Dominion Energy must comply with the CCR Rule recordkeeping requirements specified in §257.105(h)(1), the notification requirements specified in §257.106(h)(1), and the internet requirements specified in §257.107(h)(1).

5.1.6.4 Alternate Source Demonstration

Dominion Energy may demonstrate that a source other than the impoundment caused the contamination, or that a statistically significant detection resulted from an error in sampling procedures, analysis, statistical procedures, or natural variation in groundwater quality. The ASD must be submitted to and approved by the DEQ within 90 days of confirming the statistical exceedance to avoid advancing into the modified Assessment Monitoring Program.

If the ASD is approved by the DEQ, the operator may continue with the modified Detection Monitoring Program. If the ASD is not approved by the DEQ, the operator will initiate the modified Assessment Monitoring Program within 90 days of the statistically significant detection.

5.1.6.5 Well Installation Report

Well installation reports as may be required shall be submitted to the DEQ within 44 days of well completion (including the licensed survey). The well installation reports shall include permit-required information and shall be certified by a qualified groundwater scientist. After installation is complete, eight background samples will be collected.

5.1.6.6 Well Decommissioning Report

Well decommissioning reports as may be required shall be submitted to the DEQ within 44 days of completing the physical well decommissioning activities. The well decommissioning reports shall include permit-required information and shall be certified by a qualified groundwater scientist.

5.1.6.7 Well Non-performance Notification

Well non-performance reports as may be required shall be submitted to the DEQ within 30 days of recognizing the non-performance issue.

5.2 Modified Assessment Monitoring Program

The modified Assessment Monitoring Program is designed to identify the presence and concentration of targeted potential solid waste constituents in the uppermost aquifer beneath the LAP and UAP, and to determine if those constituents are derived from the CCR units at concentrations that would require groundwater corrective action. Components of the modified Assessment Monitoring Program, including analytical requirements, sampling frequency, and data evaluation, are discussed in the following sections. The LAP and UAP are currently monitored under the provisions of the CCR Rule Assessment Monitoring Program and the Station's VPDES Permit. The

modified Assessment Monitoring Program will be implemented following issuance of the Virginia Solid Waste Permit.

In accordance with the CCR Final Rule as adopted in the VSWMR, a notification must be prepared and placed within the operating record for each impoundment and on the publicly available website stating that an Assessment Monitoring Program has been established. Pursuant to §257.106 as adopted in the VSWMR, the DEQ must be notified when the notice has been placed. The required notification has been placed in the Station's operating record.

As requested by the DEQ, Dominion Energy will establish a background concentration for the constituents in the modified Assessment Monitoring Program. The background concentrations will be submitted to the DEQ as a *Facility Background Determination Report* consistent with the timeframes in the VSWMR.

Components of the modified Assessment Monitoring Program, including analytical requirements, sampling frequency, and data evaluation, are discussed in the following sections.

5.2.1 Constituents

The modified Assessment Monitoring Program will consist of the following constituents:

- CCR Rule Appendix III constituents;
- CCR Rule Appendix IV constituents (annual event with semi-annual events for detected constituents);
- VSWMR Table 3.1 Column B metals not included in the CCR Rule; and
- Speciation of chromium (total and hexavalent).

Samples will be analyzed using the appropriate analytical method from the latest edition of USEPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846,* if available. The suggested analytical methods and PQL for the proposed modified Assessment Monitoring Program constituents are presented in Table 4. Final laboratory results will be reported in parts per billion for all metals constituents

5.2.2 Sampling Schedule

Sampling under the modified Assessment Monitoring Program will occur semi-annually (180 days plus or minus 30 days) with the sample analyses completed within the calendar year semi-annual period consistent with the CCR Rule.

5.2.3 Verification Sampling Events

If verification sampling events are undertaken to verify suspect analytical results, the verification sampling activities, including laboratory analyses, must be completed within the combined 30-day determination and 14-day reporting window for federal GWPS / Virginia GPS exceedances (total of 44 days from the date of receipt of the laboratory certificates of analysis for the sampling event).

5.2.4 Establishing Groundwater Protection Standards

The federal GWPS were established for the LAP and UAP consistent with the timeframe in the CCR Rule.

Following implementation of the modified Assessment Monitoring Program, impoundment- and aquifer-specific Virginia GPS will be calculated using the background well data for CCR Appendix IV constituents, VSWMR Table 3.1 Column B constituents, and boron. The Virginia GPS will be established in accordance with §257.95(h) as adopted in the VSWMR. The proposed Virginia GPS will be developed based on the following requirements unless the requirements for establishing Virginia GPS are revised by the USEPA with future revisions to the CCR Rule, in which case the CCR Rule provisions will supersede these provisions:

- For constituents for which a USEPA Maximum Contaminant Level (MCL) has been established, the MCL for that constituent will be used as Virginia GPS;
- For constituents for which MCLs have not been established, the impoundment- and aquifer-specific background concentration established from the background wells will be used as Virginia GPS; or
- For constituents for which the impoundment- and aquifer-specific background level is higher than the MCL, the background concentration established from the background wells will be used as Virginia GPS, as approved by the DEQ.

The established federal GWPS and Virginia GPS will be included in the annual monitoring report required by §257.90(e) as adopted by the VSWMR and the corrective action report (if required). The MCL-based federal GWPS and Virginia GPS will be updated upon USEPA's promulgation of new or revised MCLs. Following approval of the Virginia GPS by the DEQ, the background-based Virginia GPS will be updated every 2 years such that the eight most recent background well sampling results will replace the oldest eight background well sampling results.

Following initiation of the modified Assessment Monitoring Program and the establishment of background concentrations for the Table 4 constituents to be presented to the DEQ in a *Facility Background Determination Report*, proposed Virginia GPS for the applicable constituents (CCR Rule Appendix IV constituents, boron, and VSWMR Table 3.1 Column B constituents) will be submitted to the DEQ consistent with the VSWMR and the CCR Rule. The Virginia GPS based on MCLs will become effective immediately upon proposal. The Virginia GPS based on background concentrations will become effective upon written DEQ approval.

The federal GWPS will be submitted to the operating record after completing the initial modified Assessment Monitoring Program event and no later than 30 days after establishing background concentrations for required monitoring constituents. The existing federal GWPS are presented in Appendix D and have been placed in the Station's operating record.

5.2.5 Analytical Data Evaluation

Groundwater data will be evaluated statistically as described in Section 7.0 of this GMP. The results of the statistical analyses will then be evaluated as follows:

- If the concentration of any monitored constituent is present in the groundwater at a concentration that is above the impoundment-specific background concentration, but below the current federal GWPS / Virginia GPS, Dominion Energy shall continue the modified Assessment Monitoring Program.
- If any monitored constituent is present at a concentration that exceeds the impoundment-specific background concentration and/or the most current established federal GWPS or Virginia GPS, Dominion Energy may:
  - Submit an ASD certified by a qualified professional engineer within 90 days of determining the exceedance of federal GWPS / Virginia GPS; or
  - Begin the initial steps toward groundwater Corrective Action. The Corrective Action Program will be consistent with both VSWMR 9VAC20-81-260 and §257.96, §257.97, and §257.98 of the CCR Rule.

5.2.6 Data Validation

In accordance with 9VAC20-81-250.A.4.j, voluntary third-party data validation of laboratory data may be completed during the 30-day statistical determination period.

5.2.7 Assessment Monitoring Program Reporting Requirements

Reports required under the modified Assessment Monitoring Program include a federal GWPS / Virginia GPS exceedance notification (if required), a semi-annual report, and an annual report. Consistent with the CCR Rule reporting requirements, required reports will be provided to the DEQ Regional Office upon posting in the Station's operating record and publicly accessible internet site.

The minimum required information for each report and submittal timeframes for the reports are discussed in the following sections.

5.2.7.1 Facility Background Determination Report

A *Facility Background Determination Report* will be prepared for the LAP and UAP within 30 days of initially establishing background or re-establishing background. The *Facility Background Determination Report* will present

the impoundment's established background concentrations for the constituents listed in Table 4. The *Facility Background Determination Report* will be placed in the operating record within 30 days of completion.

5.2.7.2 Groundwater Protection Standard Exceedance Notifications

Consistent with §257.93(h)(2) of the CCR Rule and 9VAC20-81-250.C.3.e(3)(a) of the VSWMR, Dominion Energy will submit a federal GWPS / Virginia GPS exceedance notification for Table 4 constituents that have established federal GWPS / Virginia GPS to the DEQ within 14 days of identifying a statistical exceedance of a federal GWPS / Virginia GPS (44 days of issuance of the laboratory report).

The notification shall identify the constituent exceeding the federal GWPS / Virginia GPS, the impoundment, the well identification, and Dominion Energy's intent to either initiate a Corrective Action Program and proceed with a Nature and Extent Study and ACM within 90 days of noting the federal GWPS / Virginia GPS exceedance, or to submit and obtain DEQ approval of an ASD.

For the LAP and UAP, based on the evaluation of the 2018 groundwater monitoring program data, there were confirmed federal GWPS exceedances. As a result of these findings, Dominion Energy initiated an ACM within the required timeframe pursuant to 40 CFR Part 257.96. The LAP and UAP combined ACM was completed with a copy placed in the Station's operating record on May 17, 2019.

5.2.7.3 Semi-Annual Report

No later than 120 days of completing the first semi-annual event of each year (*i.e.*, after receiving the laboratory analytical results), Dominion Energy will submit a semi-annual report for each impoundment to DEQ. Each semi-annual report will include the following:

- Signature page signed by a professional geologist or qualified groundwater scientist;
- Impoundment name and permit number;
- Statement noting whether or not all monitoring points within the permitted network installed to meet the requirements of the VSWMR were sampled as required during the event;
- Calculated rate of groundwater flow during the sampling period;
- The groundwater flow direction as determined during the sampling period presented as either plain text or graphically as a potentiometric surface map;
- Statement noting whether or not there were SSIs over background during the sampling period, the supporting statistical calculations, and reference to the date the director was notified of the increase pursuant to timeframes in the VSWMR, if applicable;

- Copy of the full Laboratory Analytical Report including dated signature page (laboratory manager or representative) to demonstrate compliance with the VSWMR timeframes. The DEQ will accept the lab report in CD-ROM format; and
- A brief discussion of the sampling and analysis activities.

5.2.7.4 Annual Report

Annual reports for each impoundment will be prepared and submitted to DEQ no later than 120 days after completing the second semi-annual event of each year (*i.e.*, after receiving the laboratory analytical results) or no later than January 31st of the following calendar year. The annual reports will include the following:

- A signature page;
- A completed QA/QC DEQ Form ARSC-01.
- The impoundment's name, type, permit number, current owner or operator, and location keyed to a United States Geological Survey (USGS) topographic map;
- Summary of the design type, operational history (*i.e.*, trench fill versus area fill), and size (acres) of the impoundment including key dates such as beginning, and termination of waste disposal actions and dates different groundwater monitoring phases were entered;
- Description of the surrounding land use noting whether any adjoining landowners utilize private wells as a potable water source;
- A discussion of the topographic, geologic, and hydrologic setting of the impoundment including a discussion on the nature of the uppermost aquifer (*i.e.*, confined versus unconfined) and proximity to surface waters;
- A discussion of the monitoring wells network noting any modifications that were made to the network during the year or any nonperformance issues and a statement noting that the monitoring well network meets (or did not meet) the VSWMR performance requirements;
- A listing of the groundwater sampling events undertaken during the previous calendar year;
- A historical table listing the detected constituents, and their concentrations identified in each well during the sampling period; and
- Evaluations of and appropriate responses to the groundwater elevation data; groundwater flow rate as calculated using the prior year's elevation data; groundwater flow direction (as illustrated on a potentiometric surface map); and sampling and analytical data obtained during the past calendar year.

In addition to the above requirements, Dominion Energy must comply with the CCR Rule recordkeeping requirements specified in §257.105(h)(1), the notification requirements specified in §257.106(h)(1), and the internet requirements specified in §257.107(h)(1).

5.2.7.5 Alternate Source Demonstration

Dominion Energy may demonstrate that a source other than the impoundment caused a statistically significant detection of one or more monitored constituents or statistical exceedances of a federal GWPS or Virginia GPS, or that the statistical increase resulted from an error in sampling procedures, analysis, statistical procedures, or natural variation in groundwater quality. The ASD must be submitted to the DEQ within 90 days of the sampling event from which the exceedance originated.

If an ASD associated with a federal GWPS or Virginia GPS exceedance is approved by the DEQ, Dominion Energy may continue with the modified Assessment Monitoring Program. If such an ASD is not approved by the DEQ, Dominion Energy must initiate an ACM and a Corrective Action Program.

5.2.7.6 Well Installation Report

Well installation reports (for new wells) as may be required shall be submitted to the DEQ within 44 days of well completion (including the licensed survey). The well installation reports shall include permit-required information and shall be certified by a qualified groundwater scientist. If the well is a new compliance well, eight background samples will be collected following installation. If the well is a replacement compliance well being installed in the same formation within the same general area, background sampling may be completed, but is not required.

5.2.7.7 Well Decommissioning Report

Following issuance of a solid waste permit by the DEQ, well decommissioning reports as may be required shall be submitted to the DEQ within 44 days of completing the physical well decommissioning activities. The well decommissioning reports shall include permit-required information and shall be certified by a qualified groundwater scientist.

5.2.7.8 Well Non-performance Notification

Following issuance of a solid waste permit by the DEQ, well non-performance reports as may be required shall be submitted to the DEQ within 30 days of recognizing the non-performance issue.

5.2.7.9 Modified Detection Monitoring Program Reversion Notification

Consistent with §257.95(e) as adopted in the VSWMR, if there are no SSIs over background concentrations for two consecutive monitoring events, Dominion Energy may revert the groundwater monitoring program to the modified Detection Monitoring Program with DEQ's concurrence. This reversion shall be documented in a notification submitted to the DEQ before the next compliance monitoring event.

5.2.7.10 Groundwater Protection Standard Update Notifications

Notifications for federal GWPS / Virginia GPS updates due to changes in USEPA MCLs and/or impoundment-and aquifer-specific background concentrations shall be submitted to the DEQ within 30 days of the update.

5.2.7.11 Off-site Plume Notification

In the event that a groundwater plume (concentrations above the federal GWPS and/or the Virginia GPS) is determined to extend off site onto adjacent downgradient property, Dominion Energy will notify the DEQ and the affected landowner within 15 days of the determination consistent with provisions in the VSWMR.

Consistent with the CCR Rule, an adjacent landowner notification was provided to the County of Chesterfield on July 18, 2019, for groundwater in the vicinity of the UAP as part of the ACM for the UAP.

6.0 SAMPLE AND ANALYSIS PROGRAM

Proper sampling procedures are an important and fundamental aspect in an effective monitoring program. The following sections, which are consistent with USEPA guidance, the requirements of the CCR Final Rule, and the VSWMR, outline the proposed sample collection procedures.

6.1 Sampling Order

The compliance wells are/will be equipped with dedicated purging and sampling equipment; therefore, the likelihood of cross-contamination is minimized. Accordingly, the anticipated sampling order will follow a sequence based on consideration of field conditions at the time of sampling.

6.2 Water Level Gauging

Prior to purging each monitoring well, the static water level will be gauged using an electronic water level indicator accurate to 0.01 foot. The measurement will be obtained from the surveyed measuring point on each well.

Prior to initial use and between wells, the portion of the water level indicator that comes in contact with the groundwater in the well will be decontaminated to avoid cross-contamination between monitoring wells. In addition to decontaminating the downhole equipment, sampling personnel will don new gloves between wells, and more frequently as needed, to avoid cross-contamination between monitoring wells. The compliance monitoring well network will be gauged within a 24-hour period during each compliance sampling event.

6.3 Purging Procedure

The monitoring wells in the monitoring network will be sampled using a micropurge technique. Micropurge sampling can greatly reduce the volume of water that must be purged from a well before representative samples can be collected, and typically provides for the collection of more representative samples than do other purge methods, as well as consistency in analytical results between sampling events. Micropurging is accomplished through the use of dedicated low-flow sampling devices. Bailers and portable pumps are not recommended because they cause mixing of the standing water column within the well (Robin and Gilham, 1987). This mixing action requires the removal of the traditional large purge volumes before sampling. Introducing any device into the well prior to sampling causes a surging effect that may increase turbidity and interfere with the normal flow of water through the well screen. This disturbance may remain in effect for as long as 24 to 48 hours (Kearl *et al.*, 1992).

For monitoring wells with dedicated bladder pumps equipped with check values that hold stagnant water in the discharge tubing between sampling events, the discharge tubing shall be purged prior to commencing micropurge activities to ensure that fresh formation water is sampled following the completion of micropurging. The discharge tube purge volume will be determined using the following equation:

Discharge Tube Volume (milliliters) = DTP * V_F

Where: DTP = Depth to the top of the pump to the nearest 0.1 foot

V_F = Volume Factor as follows:

10 = 1/4-inch diameter tubing

22 = 3/8-inch diameter tubing

39 = 1/2-inch diameter tubing

If discharge tube purging is required, the purge should be conducted at a rate equal to the well yield to avoid drawing stagnant well column water into the pump (*i.e.*, between 100 and 500 milliliters per minute). During the discharge tubing purge, the flow rate and the depth to groundwater should be monitored on regular intervals (every 3 to 5 minutes) to verify that the purge activities are not removing stagnant water from the water column in the monitoring well.

After completing the discharge tubing purge, if required, water quality parameters (pH, temperature, conductivity) will be monitored during the micropurge consistent with USEPA guidance on micropurging. The stabilization of these parameters (generally 10% for three consecutive readings) indicates when the discharge water is representative of formation water and samples can be collected for analysis. Measurements of turbidity may also be collected for the purpose of evaluating the purging technique. Water quality measurements will be collected on approximate 3- to 5-minute intervals and will be recorded on a Field Log or in the Field Book to document purge stabilization.

In addition to the water quality parameters, the flow rate may be monitored on regular intervals during the micropurge to verify that the micropurge activities are not removing stagnant water from the water column in the monitoring wells. In general, purge rates when using micropurge sampling procedures should not exceed 500 milliliters per minute. Any measurements taken should be recorded on a Field Log or in the Field Book to document steady-state flow conditions during the purge. The purge water will be managed in accordance with regulatory requirements.

On rare occasions, the yield of a monitoring well will be insufficient to keep up with the micropurge. In cases where the yield of the monitoring well is less than 50 milliliters per minute as documented by the recorded flow rate and continually decreasing head level as the well is purged, the required samples may be collected prior to stabilization of the water column provided the water quality parameters have stabilized within the required 10% range.

In the event that dedicated pumping equipment malfunctions during a sampling event, non-dedicated equipment may be used to micropurge the affected well(s) provided the pump can be decontaminated prior to use in each well.

The pump and associated discharge hoses must be decontaminated using a non-phosphate-based detergent and water mixture followed by a deionized water rinse to avoid cross-contamination between monitoring wells.

6.4 Sample Collection

Once the water quality data indicate that the micropurge activities have been completed, required samples should be collected directly from the discharge hose on the pump into laboratory-provided, pre-preserved sample containers selected for the required parameters or compatible parameters. Samples collected for the compliance program will not be filtered in the field or at the laboratory. Sample collection should be performed at the same rate (or lower) that was used during the micropurge. Following collection, samples will be placed in a cooler on ice under chain-of-custody control. Samples will be kept at no more than 6°C from collection to laboratory delivery.

Anticipated sample container, minimum volume, chemical preservative, and holding times for each analysis type are provided in Table 5. These standards may change depending on laboratory requirements. Sample preservation methods will be used to retard biological action, retard hydrolysis, and reduce sorption effects. These methods include chemical addition, refrigeration, and protection from light.

6.5 Sample Documentation

Chain-of-custody control is critical for documenting the integrity of the samples following collection, during transport to the laboratory, and at the laboratory. Consequently, the label for each sample container shall be completed to document the sample collection activities. An example sample container label is presented in Appendix C.

The chain-of-custody form should be signed by the sampling personnel and the receiving agent, with the date and time of transfer noted. In the event that the samples are being shipped to a laboratory, the signature of the receiving agent is not required; however, it is recommended that the tracking number for the shipping label be recorded on the chain-of-custody form. After completing the chain-of-custody form, it should be maintained with the samples. An example chain-of-custody form is presented in Appendix C.

6.6 Sample Seals

It is recommended that the shipping container be sealed to ensure that the samples have not been disturbed during transport to the laboratory. If sample seals are used, the tape should be labeled with instructions to notify the shipper if the seal is broken prior to receipt at the laboratory. An example chain-of-custody seal is presented in Appendix C.

6.7 Sample Event Documentation

The sampling event field notes should document the field activities such that they, along with the chain-of-custody form(s), are sufficient to allow for reconstruction of the sampling event by a third party.

6.8 Field Quality Assurance/Quality Control Procedures

Trip blanks, equipment blanks, and field blanks provide QA/QC measures for the monitoring program. The QA/QC measures are discussed in the following sections.

6.8.1 Trip Blanks

Trip blanks are a required part of the field sampling QA/QC program only whenever analytical parameters include volatile organic compounds (VOCs). Trip blanks are not required for this groundwater monitoring program.

6.8.2 Field Blanks

Field blanks may also be collected as part of the field sampling QA/QC program. The purpose of the field blank is to detect any contamination that might be introduced into the groundwater samples through the air or through sampling activities. For sampling programs involving VOCs, at least one field blank is recommended to be collected and analyzed for the same parameters as those for which groundwater samples are analyzed.

Field blanks must be prepared in the field (at the sampling site) using laboratory-supplied bottles and deionized or laboratory reagent-quality water. Each field blank is prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. Preservatives are added to specific sample bottles as required. The well at which the field blank is prepared must be identified on the Field Log along with any observations that may help explain anomalous results (*e.g.*, prevailing wind direction, up-wind potential sources of contamination). Once a field blank is collected, it is handled and shipped in the same manner as the rest of the samples.

6.8.3 Equipment Blanks

For wells that must be sampled with non-dedicated equipment, decontamination procedures consist of rinsing the equipment once with deionized or laboratory reagent-quality water, brushing the equipment using laboratory-quality soap, and triple rinsing the equipment with deionized or laboratory reagent-quality water. One equipment blank may be collected during each sampling event and analyzed for the same parameters as those for which groundwater samples are analyzed. Equipment blanks are collected by pouring deionized or laboratory reagent-quality water into or over the sampling device (*e.g.*, the water level indicator), and then filling a set of sample bottles.

If the analytes for the equipment blank would normally be filtered, this water should be placed into a pre-filtration bottle and subsequently filtered. Whether or not it is filtered, this water is placed into the equipment blank bottles, and the proper preservative added (as required).

6.8.4 Field Duplicates

Duplicate samples are generally collected to demonstrate the reproducibility of the sampling technique. Duplicate samples may be collected on a 5% (1 in 20) frequency. This is a separate duplicate from the duplicates a laboratory

must run and cannot be replaced by a laboratory-generated duplicate. Duplicates are representative of field sampling precision, whereas laboratory duplicates are a measure of analytical precision. Both pieces of information are essential to determining the quality of data generated for a project.

6.9 Laboratory Quality Control Procedures

The quality assurance program for the selected Virginia Environmental Laboratory Accreditation Program (VELAP)-accredited analytical laboratory will be documented in their Quality Assurance Program Plan (QAPP). This document describes mechanisms employed by the VELAP-accredited laboratory to ensure that reported data meet or exceed applicable USEPA and Virginia requirements. The QAPP describes the laboratory's experience, its organizational structure, and procedures in place to ensure quality of the analytical data. The QAPP outlines the sampling, analysis, and reporting procedures used by the laboratory. The laboratory is responsible for the implementation of and adherence to the QA/QC requirements outlined in the QAPP. A copy of the laboratory's QAPP will be available to the DEQ or Station personnel upon request.

Audits are an important component of the quality assurance program at the laboratory. Audits are conducted by the laboratory. Internal system and performance audits are conducted periodically to ensure adherence by all laboratory departments to the QAPP. External audits are conducted by accrediting agencies or states. These reports are transmitted to department managers for review and response. Corrective measures must be taken for any finding or deficiency found in an audit.

Data Quality Reviews (DQRs), or equivalent, are requests submitted to the laboratory to formally review results that differ from historical results, or that exceed certain permit requirements or quality control criteria. The laboratory prepares a formal written response to DQRs explaining discrepancies. The DQR is the first line of investigation following any anomalous result.

6.9.1 Laboratory Documentation

Upon receipt of the samples at the laboratory, the following activities are recommended:

- The date, time of sample collection, and analysis to be performed will be provided to the VELAP-accredited laboratory.
- The samples will be examined upon receipt to ensure collection in USEPA-approved containers for the requested analysis. The sample collection data and time will also be reviewed to ensure the USEPA-required sample holding time has not expired or will not expire before the analysis can be performed.
- The information concerning transportation mode and manner will be reported on the form. Samples must be transported on ice or under refrigeration, and the inside temperature of the cooler recorded upon opening.

- The pH of each sample as well as the sample appearance will be recorded if required by the analytical method. Also, preservative adjustments, filtration, and sample splitting must also occur as required prior to distribution. Sample adjustments will be fully documented.

During analysis of the samples, it is recommended that the laboratory agent maintain the integrity of the samples as follows:

- During the sample analysis period, the samples will remain refrigerated.
- If at any point during the analysis process, the results are considered technically inaccurate, the analysis must be performed again if holding times have not been exceeded.

Documentation activities should be completed with permanent ink in a legible manner with mistakes crossed out with a single line.

6.9.2 Laboratory Analyses

Analytical procedures for constituents listed in Table 3.1 of the VSWMR and Appendix IV of the CCR Rule will be performed in accordance with USEPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846,* as updated. Analytical methods for the remaining constituents and parameters required for the monitoring programs will be performed pursuant to procedures in USEPA *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846,* as updated or if an SW-846 Method is not available, other USEPA-approved methods (*e.g.*, published drinking water methods, clean water act method, Standard Methods). The modified Detection Monitoring Program and modified Assessment Monitoring Program constituents, along with recommended test methods and PQLs, are listed in Tables 3 and 4. Laboratory analytical results for groundwater compliance samples will be reported on a total sample basis.

Alternate methods may be used if they have the same or lower PQL. Methods with higher PQLs will be considered if the concentration of the parameter is such that an alternate test method with a higher PQL will provide the same result.

6.9.3 Limits of Quantitation (LOQs)

Laboratory-specific LOQs will be used as the reporting limits for quantified detections of required monitoring constituents. Laboratory LOQs should be reported with the sample results.

6.9.4 Limits of Detection (LODs)

Laboratory-specific LODs will be used as the reporting limits for estimated detections of required monitoring constituents. Constituents detected at concentrations above the LOD but below the LOQ will be reported as estimated with a qualifying “J” flag on the laboratory certificates of analysis. It is noted that estimated detections

are not considered statistically significant and cannot trigger the Corrective Action Program. Laboratory LODs should be reported with the sample results.

6.9.5 Method Blanks

Laboratory method blanks are used during the analytical process to detect any laboratory-introduced contamination that may occur during analysis. A minimum of one method blank should be analyzed by the laboratory per sample batch.

6.9.6 Matrix Spike and Matrix Spike Duplicate Samples

A matrix spike/matrix spike duplicate sample will be run with every sample batch. The relative percent difference between the spike and the spike duplicate sample should be less than 20 percent. Higher values may indicate matrix interference.

6.10 Data Validation

The laboratory is responsible for verifying that the reported analytical results are correct. The QA/QC data provided by the laboratory will be reviewed to ensure that the analytical results meet the project's data quality objectives. The review process should be performed in general accordance with the procedures outlined in the following USEPA guidance documents:

- National Functional Guidelines for Inorganic Superfund Methods Data Review, January 2017 (USEPA, 2017); and
- Multi-Agency Radiological Laboratory Analytical Protocols Manual. (USEPA, 2004).

7.0 DATA EVALUATION

Statistical analysis of the data will be completed as discussed in the following subsections. These criteria represent a conservative approach to groundwater analysis and incorporate appropriate statistical and other evaluation methodologies.

7.1 Groundwater Data Evaluation

This section outlines the inter-well statistical evaluation methodologies that may be used to detect a release from the LAP and the UAP by comparing downgradient well results to statistically calculated background concentrations.

During background sample collection, it will be necessary to examine the data for outliers, anomalies, and trends that might be an indication of a sampling or analytical error. Outliers and anomalies are inconsistently large or small values that can occur due to sampling, laboratory, transportation, or transcription errors, or even by chance alone. Significant trends indicate a source of systematic error, or an actual contamination occurrence, that must be evaluated and corrected before valid inter-well statistical evaluations can be implemented. The inclusion of such values in the historical database used for temporal water quality evaluations or in the Station's background database for inter-well statistical evaluations could cause misinterpretation of the data set, and result in high false positive (*i.e.*, an indication of a release when none exists) and/or false negative (*i.e.*, falsely concluding there is no release in the presence of an actual release) conclusions.

To prevent the inclusion of anomalous data in the inter-well database, background monitoring results will be evaluated during background development for any new wells constructed, once those well(s) have at least four measurements for a given constituent using time vs. concentration graphs. Parameter concentrations that appear anomalous (*i.e.*, that are 5 times or greater than the previous results) may be verified during the next sample collection event or after a reasonable period of time to ensure sample independence (*e.g.*, 3 months). If the anomalous result is not verified, the outlier may be removed from the database to maintain the accuracy of the evaluation method. Any detected systematic trends or verified outliers in the background database will be evaluated and reported to the DEQ in a timely manner.

7.1.1 Correcting for Linear Trends

If a data series exhibits a linear trend, the sample will exhibit temporal dependence when tested via the sample autocorrelation function (see Section 14.2.3 of the Unified Guidance; EPA, 2009), the rank von Neumann ratio (see Section 14.2.4 of the Unified Guidance; EPA, 2009), or similar procedure. These data can be de-trended, much like the data in the previous example were de-seasonalized. Typically, the easiest way to de-trend observations with a linear trend is to compute a linear regression on the data (see Section 17.3.1 of the Unified Guidance; EPA, 2009) and then use the regression *residuals* instead of the original measurements in subsequent statistical analysis.

7.2 Statistical Methodology

In accordance with CCR Final Rule §257.93(f)(6) as adopted in the VSWMR, Dominion Energy, as owner and operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification will include a narrative description of the statistical method selected to evaluate the groundwater monitoring data. As adopted in the VSWMR, this certification is subject to the recordkeeping requirements specified in §257.105(h), the notification requirements specified in §257.106(h), and the internet requirements specified in §257.107(h).

The statistical test used to evaluate the groundwater monitoring data will be selected based on the size of the dataset, the data distribution, and statistical level of significance requirements as allowed by the VSWMR and the CCR Final Rule and associated state and Federal guidance documents. Dominion Energy will ensure that an adequate number of independent samples for the chosen statistical method are collected within the compliance period such that the level of significance for individual well comparison will be no less than 0.01 and no less than 0.05 for multiple comparisons for any statistical test. Possible statistical test methods are:

- A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method will include estimating and testing the contrasts between each compliance well's mean and the background mean levels for each constituent;
- An analysis of variance (ANOVA) based on ranks followed by multiple comparisons procedures to identify significant evidence of contamination. The method will include estimating and testing the contrasts between each compliance well's median and the background median levels for each constituent;
- A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data, and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit;
- A control chart approach that gives control limits for each constituent; or
- Another statistical test method that meets the performance standards specified by the DEQ. A justification for the alternate test method will be submitted for approval by the DEQ.

The statistical analysis chosen to evaluate the groundwater data will meet the following performance standards and will be consistent with the EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009):

- The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of monitoring parameters or constituents. If the distribution is shown by Dominion Energy to be inappropriate

for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.

- If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a GPS, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experiment-wise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, predictions intervals, or control charts.
- If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and the environment. The parameters shall be determined after considering the number of samples in the background database, the data distribution, and the range of the concentration for each constituent of concern.
- If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be protective of human health and the environment. These parameters shall be determined after considering the number of samples in the background database, the data distribution, and the range of the concentrations for each constituent of concern.
- The statistical method shall account for data below the LOD with one or more statistical procedures that shall be at least as effective as any other approach in this section for evaluating groundwater data. Any PQL that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the Station.
- If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

7.2.1 Reporting of Low and Zero Values

Chemical constituents that are not present above the detection limit of the analytical procedure are reported as NOT DETECTED (ND), or less than the LOD, rather than as zero or not present, and the laboratory's LOD is provided on the analytical report. There are a several methods for dealing with data that include values below detection and the selected method should be consistent with the EPA's Unified Guidance (USEPA, 2009).

7.2.2 Normality Testing

The original data must be tested for normality using an appropriate method consistent with EPA's Unified Guidance (USEPA, 2009). The following generalized guidelines should be considered for decisions in normality testing:

- If the original data show that the data are not normally distributed, then the data must be natural log-transformed and tested for normality using the above methods.
- If the original or the natural log-transformed data confirm that the data are normally distributed, then a normal distribution test must be applied.
- If neither the original nor the natural log-transformed data fit a normal distribution, then a distribution-free test must be applied.

7.2.3 Missing Data Values

Missing data values may result in an incomplete measure of environmental variability and an increased likelihood of falsely detecting contamination. If data are missing, there is a danger that the full extent of contamination may not be characterized. Therefore, resampling will occur within 30 days to replace the missing data unless an alternative schedule is otherwise approved by DEQ.

7.2.4 Outliers

An outlier is a value that is much different from most other values in a data set for a given groundwater chemical constituent. The reasons for outliers may include:

- Sampling errors or field contamination;
- Analytical errors or laboratory contamination;
- Recording or transcription errors;
- Faulty sample preparation or preservation, or shelf-life exceedance; or
- Extreme, but accurately detected environmental conditions (*e.g.*, spills, migration from the Station).

Formal testing for outliers should be done only if an observation seems particularly high (by orders of magnitude) compared to the rest of the data set. If a sample value is suspect, one should run the outlier test described below, from USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance* (USEPA, 2009).

7.3 Verification Procedure

Once groundwater analysis results have been collected, checked for QA/QC consistency, and determined to be above the appropriate statistical level, the results must be verified in accordance with the objectives of the VSWMR for groundwater monitoring. Verification re-sampling is an integral part of the statistical methodology described by USEPA's *Addendum to Interim Final Guidance Document - Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities* (July 1992). Without verification re-sampling, much larger statistical limits would be required to achieve site-wide false positive rates of 5% or less. Furthermore, the resulting false negative rate would be greatly

increased. Verification sampling should generally be performed for each constituent when it is initially determined to be present above its statistical limit. Consistent with the VSWMR, verification samples if collected must be obtained within the 30-day statistically significant increase determination period defined in 9VAC20-81-250.A.4.h.(2).

7.4 Comparison to Groundwater Protection Standards

As discussed herein, the Station has two types of groundwater protection standards. The federal GWPS that are established pursuant to the CCR Rule based on USEPA MCLs, impoundment- and aquifer-specific background concentrations and CCR Rule established risk-based alternative concentrations for cobalt, lithium, and molybdenum. The CCR Rule does not require a federal GWPS for boron.

Once the Virginia Solid Waste Permit is issued, Dominion Energy will submit proposed Virginia GPS to the DEQ for approval. These Virginia GPS will be established pursuant to the VSWMR and permit provisions based on USEPA MCLs and impoundment- and aquifer-specific background concentrations. At this time, DEQ is not allowing the use of an alternate risk-based concentration for cobalt, lead, lithium, molybdenum, or boron. If the solid waste permit is revised to allow for the use of alternate risk-based concentrations for these or other constituents, Dominion Energy may submit a proposal for Virginia GPS updates to the DEQ at that time.

Following the establishment of federal GWPS under the CCR Rule Assessment Monitoring Program and separately for the Virginia GPS under the modified Assessment Monitoring Program outlined herein, quantified detections of the modified Assessment Monitoring Program constituents will be statistically compared to the established federal GWPS and DEQ-approved Virginia GPS using one of the methods discussed below.

7.4.1 Background-Based GWPS / GPS

If the federal GWPS / Virginia GPS for a constituent is derived from the impoundment- and aquifer-specific background concentration, then the groundwater monitoring data must be compared directly to the federal GWPS / Virginia GPS using a value-to-value comparison.

7.4.2 MCL- or Alternate Concentration-Based GWPS / GPS

If the established federal GWPS is derived from a MCL (or an alternate concentration), or the Virginia GPS is derived from a MCL, then the groundwater monitoring data may be compared to the federal GWPS / Virginia GPS statistically and/or using a value-to-value procedure.

7.4.3 GWPS / GPS Comparison Process

Based on the criteria presented herein, groundwater monitoring data will initially be compared to the established federal GWPS / Virginia GPS via a value-to-value comparison. If a federal GWPS / Virginia GPS is exceeded

during the value-to-value comparison for any parameter, a verification sample may be collected. The results from the verification sample will be compared to the federal GWPS / Virginia GPS via a value-to-value comparison.

If the comparison indicates a potential federal GWPS / Virginia GPS exceedance, the source of the federal GWPS / Virginia GPS will be determined. If the federal GWPS or Virginia GPS is derived from a MCL or alternate concentration limit (federal GWPS only), two additional independent groundwater samples for the suspect constituent(s) may be collected to facilitate a statistical comparison to the federal GWPS / Virginia GPS. It is noted that verification sampling and/or additional sampling required to perform a statistical evaluation must occur within the same compliance monitoring period that the original samples were collected. The compliance monitoring period begins on the day of sampling and expires 6 months later, or the date of the next compliance sampling event, whichever occurs first.

To perform a statistical comparison, a minimum of four samples must be collected within the compliance monitoring period. Once data have been received for the four samples, then the lower confidence interval can be calculated and compared to the federal GWPS / Virginia GPS. The lower limit should be calculated initially by using a 95% confidence level. If the lower limit exceeds the federal GWPS / Virginia GPS, the DEQ may be contacted regarding the use of a confidence level greater than 95%.

8.0 HYDROGEOLOGIC ASSESSMENT

After each sampling event, groundwater surface elevations will be evaluated to determine whether the requirements for locating the monitoring wells continue to be satisfied and the rate and direction of groundwater flow will be determined. Groundwater elevations in monitoring wells must be measured within a period of time short enough to avoid temporal variations in groundwater flow which could preclude accurate determination of groundwater flow rate and direction.

The rate and direction of groundwater flow will be determined each time groundwater is sampled by comparing the groundwater surface elevations among the monitoring wells, and at least annually, constructing a groundwater surface contour map. The groundwater flow rate shall be determined using the following equation:

$$V_{gw} = K\, i \left({}^{1}/_{n_e}\right)$$

Where:

V_{gw} = Groundwater velocity

K = Hydraulic conductivity

i = Hydraulic gradient

n_e = Effective porosity

If the evaluation shows that the groundwater monitoring system does not satisfy the requirements of the VSWMR, the monitoring system will be modified to comply with those regulations after obtaining approval from the DEQ. The operator will request the appropriate permit amendment action related to any revisions of the monitoring well network deemed necessary due to a change in groundwater flow pattern or functionality of any monitoring well. Proposed revisions will be submitted to the DEQ within 30 days of determining that the system does not satisfy the requirements of the VSWMR; the modifications may include a change in the number, location, or depth of the monitoring wells.

9.0 REFERENCES

Dames and Moore. 1983. *Water Quality Impact Evaluation from Proposed Ash Tailing Impoundment at VEPCO's Chesterfield Power Station, Farrar Island, Virginia*. Bethesda, Maryland. July 15.

Dischinger, Jr., J.B. 1987. *Late Mesozoic and Cenozoic Stratigraphic and Structural Framework near Hopewell, Virginia*. U.S. Geological Survey Bulletin 1567.

Environmental Resource Management (ERM). 2001. *Supplemental Investigation of Groundwater Conditions at the Bellwood Extrusion Plant, Chesterfield County*, Virginia. September.

Environmental Service and Technology Corporation. 1993. *Oil Discharge Contingency Plan, Groundwater Characterization Study, Virginia Power, Chesterfield Power Station*. May 1.

Golder Associates Inc. 2010. *Hydrogeologic and Geotechnical Report for the Dominion Chesterfield Power Station Fossil Fuel Combustion Products Management Facility, Chesterfield County, Virginia. July.*

Golder Associates Inc. 2012. *Facility Background Concentration Report for Groundwater Analytes, Chesterfield Power Station Fossil Fuel Combustion Products Management Facility*. May.

Haley & Aldrich, Inc. 2019*. Assessment of Corrective Measures Report, Lower and Upper Ash Ponds, Chesterfield Power Station*. May

Hamilton, P.A., and Larson, J.D. 1988. *Hydrogeology and Analysis of the Ground-Water Flow System in the Coastal Plain of Southeastern Virginia*. Virginia State Waste Control Board: US Geological Survey.

Kearl, P.M., Korte, N.E., and T.A. Cronk. 1992. Suggested modifications to groundwater sampling procedures based on observations from the colloidal borescope: *Groundwater Monitoring Review*, v.12, No. 2, pp.155-161.

Laczniak, R.J., and A.A. Meng III. 1988. *Ground-Water Resources of the York-James Peninsula of Virginia*. US Geological Survey, Water-Resources Investigation Report No. 88-4059.

McFarland, E.R., and T.S. Bruce. 2006. *The Virginia Coastal Plain Hydrogeologic Framework*, Professional Paper No. 1731. U.S. Department of Interior, U.S. Geological Survey

Mixon, R.B., C.R. Berquist, Jr., W.L. Newell, G.H. Johnson, D.S. Powars, J.S. Schindler, and R.K. Radar. 1989. *Geologic Map and Generalized Cross Sections of the Coastal Plain and Adjacent Parts of the Piedmont, Virginia.* United States Department of the Interior, United States Geological Survey. Miscellaneous Investigation Series. MAP I-2033. 1:250,000 scale.

O'Brien and Gere, 2010. *Dam Safety Assessment of CCW Impoundments, Chesterfield Power Station*. September 29. p. 55.

Robin, M.L. and Gillham, R.W. 1987. Field evaluation of well purging procedures: *Groundwater Monitoring Review*, v.7, No. 4, pp.85-93.

Sanders, Laura L. 1998. *A Manual of Field Hydrogeology*, 1st Ed., Prentice Hall, 1998. p. 196.

URS Corporation. 2012. *Revised Groundwater Quality and Risk Assessment Report, Chesterfield Power Station – Old Ash Pond, VPDES Permit No. VA0004146, 500 Coxendale Road, Chesterfield County, Virginia*. Richmond, Virginia. March 22.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2006. Soil Survey Geographic (SSURGO) Database for Chesterfield County, Virginia. USDA, Fort Worth, Texas Online Linkage: URL:http://SoilDataMart.nrcs.usda.gov/

U.S. Environmental Protection Agency (USEPA). 1986. RCRA Ground-Water Monitoring Technical Enforcement Document. Office of Solid Waste and Emergency Response (OSWER). OSWER-9950.1. September.

USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. Office of Resource Conservation and Recovery – Program Implementation and Information Division. March.

USEPA. 2014. *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities.* [RIN-2050-AE81; FRL-9149-4]. Prepublication Copy. Unofficial Version. December.

USEPA. 2015. Federal Register. Volume 80. No. 74. 21302-21501. Friday, April 17, 2015. Part II. Environmental Protection Agency. *40 CFR Parts 257 and 261. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule.* [EPA-HQ-RCRA–2009–0640; FRL–9919–44–OSWER]. RIN–2050–AE81. April.

USEPA. 2016. Federal Register. Volume 81. No. 151. 51802-51808. Friday, August 5, 2016. Environmental Protection Agency. *40 CFR Part 257. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Extension of Compliance Deadlines for Certain Inactive Surface Impoundments; Response to Partial Vactur.* [EPA-HQ-OLEM–2016–0274; FRL–9949–44–OLEM]. August.

USEPA. 2018. Federal Register. Volume 83. No. 146. 36435-36456. Monday, July 30, 2018. Environmental Protection Agency. *40 CFR Part 257. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One).* [EPA-HQ-OLEM–2017–0286; FRL–9981–18–OLEM]. July.

USEPA. 2020. Federal Register. Volume 85. No. 168. 53516-53566. Friday, August 28, 2020. Environmental Protection Agency. *40 CFR Part 257. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; A Holistic Approach to Closure Part A: Deadline to Initiate Closure.* [EPA-HQ-OLEM–2019–0172 and EPA-HQ-OLEM-2018-0524; FRL–10013–20–OLEM]. August.

Virginia Division of Mineral Resources (VDMR). 1993. *Geologic Map of Virginia*. Virginia Division of Mineral Resources, scale 1:500,000.

Virginia Waste Management Board (VWMB). 2019. Virginia Solid Waste Management Regulations – (9VAC20-81 *et seq*.). February 4, 2019, effective March 6, 2019.

Tables

Table 1
Summary of Existing Well Construction Information
Chesterfield Power Station Lower and Upper Ash Ponds
Chesterfield, Virginia

Boring Identification	Well Identification	Compliance Monitoring Network	Coordinates*		Ground Surface Elevation (feet)	Top of Casing Elevation (feet)	Well Surface Protection Type	Boring Depth (feet below grade)	Well Screen (feet below grade)	Screen Length (feet)	Screened Unit	Drilling Method	Installation Date	Engineering Firm	Drilling Firm	Well Borehole Diameter (inches)
			Northing (feet)	Easting (feet)												
MW-1	MW-1	UAP	3,659,452.91	11,811,819.04	9.73	11.58	Floodplain Wellhead	80	20.0-30.0	10	Columbia	HSA/Mud-Rotary	6/21/2016	Haley and Aldrich, Inc.	Fishburne	6
MW-1D	MW-1D	UAP	3,659,449.96	11,811,809.97	9.8	11.38	Floodplain Wellhead	55.3	45.3-55.3	10	Potomac	HSA	8/22/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-1DD	MW-1DD	UAP	3,659,451.76	11,811,833.19	9.46	11.1	Floodplain Wellhead	181	171.0-181.0	10	Basement Bedrock	Mud-Rotary	9/26/2016	Golder Associates Inc.	Water Well Solut. LLC	6 5/8
MW-2	MW-2	UAP	3,659,888.60	11,812,365.73	9.07	10.80	Floodplain Wellhead	68	25.0-35.0	10	Columbia	HSA	6/20/2016	Haley and Aldrich, Inc.	Fishburne	6
MW-2I	MW-2I	UAP	3,659,899.22	11,812,373.76	9.13	10.49	Floodplain Wellhead	68	79.0-89.0	10	Potomac	Sonic	3/2/2019	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-B31	MW-B31	UAP	3,660,340.77	11,812,582.82	11.82	12.81	Floodplain Wellhead	24.5	19.5-24.5	5	Columbia	Unknown	Unknown	Unknown	Unknown	Unknown
MW-3S	MW-3S	UAP	3,660,738.85	11,812,882.62	15.27	17.05	Floodplain Wellhead	30	19.0-29.0	10	Columbia	HSA	8/18/2016	Golder Associates Inc.	GZ & CAI	8 1/4
MW-3D	MW-3D	UAP	3,660,744.77	11,812,886.53	15.12	16.92	Floodplain Wellhead	90	79.5-89.5	10	Triassic	HSA	8/17/2016	Golder Associates Inc.	GZ & CAI	8 1/4
MW-4	MW-4	UAP	3,661,189.06	11,813,224.92	16.63	18.45	Floodplain Wellhead	35	23.6-33.6	10	Columbia/Potomac	HSA	8/18/2016	Golder Associates Inc.	GZ & CAI	8 1/4
MW-5	MW-5	UAP	3,661,405.67	11,813,401.53	20.30	22.11	Floodplain Wellhead	60	27.0-37.0	10	Columbia	Sonic	6/22/2016	Haley and Aldrich, Inc.	Cascade	6 7/8
MW-6	MW-6	UAP	3,661,834.37	11,813,189.15	36.78	39.24	Stickup	62	49.0-59.0	10	Potomac	HSA	8/27/2016	Golder Associates Inc.	Parratt Wolffe, Inc.	8 1/4
MW-6D	MW-6D	UAP	3,661,820.42	11,813,197.33	37.8	40.17	Stickup	92	70.0-90.0	20	Triassic	HSA	8/27/2016	Golder Associates Inc.	Parratt Wolffe, Inc.	8 1/4
MW-6DD	MW-6DD	UAP	3,661,789.31	11,813,221.56	40.03	42.69	Stickup	240	220.0-230.0	10	Triassic	Mud-Rotary	9/15/2016	Golder Associates Inc.	Water Well Solut. LLC	6 5/8
MW-7	MW-7	UAP	3,661,718.44	11,812,729.28	41	43.45	Stickup	53	42.5-52.5	10	Potomac	HSA	9/12/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-8	Decommissioned	UAP	3,661,566.62	11,812,252.31	41.31	43.62	Stickup	53	42.5-52.5	10	Columbia	HSA	9/13/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-8R	MW-8R	UAP	3,661,572.56	11,812,278.37	41.21	44.10	Stickup	53	41.0-51.0	10	Columbia	HSA	1/5/2017	Golder Associates Inc.	GEOlogic Exploration	8 1/4
MW-9	Decommissioned	UAP	3,661,408.62	11,811,813.33	41.7	44.25	Stickup	55	43.0-53.0	10	Columbia	HSA	9/12/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-9R	MW-9R	UAP	3,661,400.01	11,811,790.81	41.78	44.64	Stickup	54	43.0-53.0	10	Columbia	HSA	1/19/2017	Golder Associates Inc.	GEOlogic Exploration	8 1/4
MW-10	MW-10	UAP	3,661,177.84	11,811,227.10	41.07	43.6	Stickup	53	42.0-52.0	10	Columbia/Potomac	HSA	9/17/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-11	MW-11	UAP	3,661,020.14	11,810,778.85	40.94	43.87	Stickup	53	42.5-52.5	10	Columbia	HSA	9/12/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-11I	MW-11I	UAP	3,661,011.54	11,810,757.49	41.13	44.29	Stickup	99	89.0-99.0	10	Potomac	Sonic	2/26/2019	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-12	MW-12	UAP	3,660,850.86	11,810,294.33	41.31	44.06	Stickup	52	42.5-52.5	10	Columbia	HSA	8/25/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-13	MW-13	UAP	3,660,477.31	11,809,299.07	10.95	12.68	Floodplain Wellhead	25	14.0-24.0	10	Columbia	HSA	7/12/2016	Golder Associates Inc.	Ground Zero	8 1/4
MW-14	MW-14	UAP	3,660,027.47	11,809,396.53	19.45	21.19	Floodplain Wellhead	45.2	35.2-45.2	10	Potomac	HSA	8/5/2016	Golder Associates Inc.	GZ & CAI	8 1/4
MW-15	MW-15	UAP	3,659,595.36	11,809,774.96	22.76	24.39	Floodplain Wellhead	40	30.0-40.0	10	Columbia	HSA	6/22/2016	Haley and Aldrich, Inc.	Fishburne	6
MW-16	MW-16	UAP	3,659,489.24	11,810,179.79	20.1	23.17	Stickup	34.4	24.4-34.4	10	Columbia	HSA	7/13/2016	Golder Associates Inc.	Ground Zero	8 1/4
MW-16D	MW-16D	UAP	3,659,491.31	11,810,173.48	20.35	23.09	Stickup	69.8	59.8-69.8	10	Potomac	HSA	7/13/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-16DD	MW-16DD	UAP	3,659,495.58	11,810,159.40	21.01	23.64	Stickup	175	150.0-160.0	10	Triassic/Bedrock	Mud-Rotary	9/28/2016	Golder Associates Inc.	Water Well Solut. LLC	6 5/8
MW-B32	MW-B32	UAP	3,659,332.19	11,810,654.15	12.63	13.58	Floodplain Wellhead	33	29.0-33.0	4	Columbia/Potomac	Unknown	Unknown	Unknown	Unknown	Unknown
MW-17S	MW-17S	UAP	3,659,391.73	11,811,284.32	11.14	13.01	Floodplain Wellhead	30.5	20.0-30.0	10	Columbia	Sonic	6/20/2016	Haley and Aldrich, Inc.	Cascade	6
MW-29U	MW-29U	UAP	3,661,275.70	11,807,107.29	5.25	7.13	Floodplain Wellhead	40	8.0-18.0	10	Columbia	HSA	7/7/2016	Golder Associates Inc.	Ground Zero	8 1/4
MW-30U	MW-30U	UAP	3,661,266.44	11,807,111.93	5.14	6.94	Floodplain Wellhead	54	44.0-54.0	10	Potomac	HSA	8/23/2016	Golder Associates Inc.	GZ & PW	8 1/4
MW-31U	MW-31U	UAP	3,661,235.21	11,807,125.11	4.55	6.29	Floodplain Wellhead	200	120.0-140.0	20	Basement Bedrock	Mud-Rotary	9/21/2016	Golder Associates Inc.	Water Well Solut. LLC	6 5/8
MW-35S	MW-35S	LAP	3,663,435.66	11,806,316.70	55.16	57.81	Stickup	64	54-64	10	Columbia	HSA	9/29/2016	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-35D	MW-35D	LAP	3,663,443.97	11,806,317.22	55.03	57.75	Stickup	99	89-99	10	Potomac	HSA	9/28/2016	Haley and Aldrich, Inc.	GEOlogic Exploration	6
OW-35B	OW-35B	LAP	3,663,425.53	11,806,315.70	55.32	58.24	Stickup	175	165-175	10		Sonic	12/1/2016	Haley and Aldrich, Inc.	Cascade	6
MW-35B	MW-35B	LAP	3,663,414.67	11,806,314.41	55.09	58.18	Stickup	175	165-175	10	Basement Bedrock	Sonic	1/26/2017	Haley and Aldrich, Inc.	Cascade	6
MW-20	MW-20	LAP	3,663,340.91	11,808,794.84	19.16	21.3	Stickup	35	25.0-35.0	10	Columbia	HSA	8/2/2016	Golder Associates Inc.	GZ & CAI	8 1/4
MW-20I	MW-20I	LAP	3,663,308.94	11,808,883.48	10.50	12.37	Floodplain Wellhead	49	39.0-49.0	10	Potomac	Sonic	3/1/2019	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-21	MW-21	LAP	3,663,048.82	11,809,166.60	10.06	11.91	Floodplain Wellhead	81	15.0-25.0	10	Columbia	HSA	6/30/2016	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-21I	MW-21I	LAP	3,663,045.57	11,809,178.61	10.43	12.14	Floodplain Wellhead	55	45.0-55.0	10	Potomac	Sonic	2/28/2019	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-22	MW-22	LAP	3,662,650.43	11,809,438.06	10.43	12.33	Floodplain Wellhead	35	23.0-33.0	10	Columbia	HSA	7/8/2016	Golder Associates Inc.	GZ & CAI	8 1/4
MW-23	MW-23	LAP	3,661,610.03	11,809,607.63	6.50	8.37	Floodplain Wellhead	41	30.0-40.0	10	Columbia	HSA	6/29/2016	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-24	MW-24	LAP	3,660,510.02	11,808,151.46	16.15	18.66	Stickup	35	25.0-35.0	10	Columbia	Mud-Rotary	9/19/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	6 5/8
MW-25	MW-25	LAP	3,661,281.36	11,807,565.35	10.78	12.64	Floodplain Wellhead	57	45.0-55.0	10	Columbia/Potomac	HSA	9/14/2016	Golder Associates Inc.	Parratt Wolffe, Inc.	8 1/4
MW-26	MW-26	LAP	3,661,811.49	11,807,505.17	7.85	9.71	Floodplain Wellhead	30	13.0-23.0	10	Columbia	HSA	8/24/2016	Golder Associates Inc.	Parratt Wolffe, Inc.	8 1/4
MW-27	MW-27	LAP	3,662,287.10	11,807,604.24	15.44	17.15	Floodplain Wellhead	30	19.0-29.0	10	Columbia	HSA	8/25/2016	Golder Associates Inc.	Parratt Wolffe, Inc.	8 1/4
MW-28	MW-28	LAP	3,663,025.11	11,808,370.03	19.67	22.01	Stickup	35	24.0-34.0	10	Columbia	HSA	8/3/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-B50	MW-B50	LAP	3,662,817.77	11,807,891.10	22.97	25.83	Stickup	30	20.0-30.0	10	Columbia	HSA	10/19/2001	Resource International, LTD.	Fishburne	Unknown
MW-32	MW-32	LAP	3,662,108.03	11,809,523.64	6.62	8.37	Floodplain Wellhead	31	20.0-30.0	10	Columbia	HSA	6/29/2016	Haley and Aldrich, Inc.	GEOlogic Exploration	6
MW-33	MW-33	LAP	3,661,029.44	11,809,704.77	11.09	12.73	Floodplain Wellhead	35.2	25.2-35.2	10	Columbia	HSA	7/11/2016	Golder Associates Inc.	Ground Zero	8 1/4
MW-34	MW-34	LAP	3,660,827.15	11,807,767.32	8.10	9.70	Floodplain Wellhead	30	19-29	10	Columbia	HSA	9/12/2016	Golder Associates Inc.	Connelly & Assoc. Inc.	8 1/4
MW-B40A	MW-B40A	LAP	3,660,535.63	11,808,691.69	15.17	18.49	Stickup	15	5.0-15.0	10	Columbia	HSA	10/19/2001	Resource International, LTD.	Fishburne	Unknown
BF-4	BF-4	LAP	3,663,154.64	11,808,243.98	32.75	36.06	Stickup	39	34.0-39.0	5	Columbia	Sonic	2/27/2019	Haley and Aldrich, Inc.	GEOlogic Exploration	6

Notes: UAP = Upper Ash Pond
LAP = Lower Ash Pond
Coordinate system is Virginia State Plane South Zone North American Datum 1983 (NAD 83)
Vertical Datum is North American Vertical Datum 1988 (NAVD 88) and referenced to mean sea level.

Table 2
Summary of Existing Well Construction Information
Chesterfield Power Station Lower and Upper Ash Ponds
Chesterfield, Virginia

Well Location	Water Bearing Unit	Test Type	Location	Analyst	Analysis Type	Analysis Method	Screened Interval	Date	Result (ft/sec)	Result (cm/sec)
MW-35B	Bedrock	Falling Head Slug	Lower Ash Pond	Golder	confined	H	165.0-175.0	1/12/2017	8.65E-09	2.64E-07
B-19	Columbia	Falling Head Slug	Lower Ash Pond	Dames & Moore	unconfined	Unknown	5.0-15.0	1983	2.84E-01	1.00E-04
B-19*	Columbia	Falling Head Slug	Lower Ash Pond	URS	unconfined	B&R	10.0-20.0	9/12/2006	2.25E-06	6.85E-05
B-19*	Columbia	Rising Head Slug	Lower Ash Pond	URS	unconfined	B&R	10.0-20.0	9/12/2006	1.25E-06	3.81E-05
B-21	Columbia	Falling Head Slug	Lower Ash Pond	Dames & Moore	unconfined	Unknown	5.0-15.0	1983	1.42E+00	5.00E-04
B-41A	Columbia	Falling Head Slug	Lower Ash Pond	URS	unconfined	B&R	41.0-51.0	9/12/2006	2.89E-06	8.82E-05
B-41A	Columbia	Rising Head Slug	Lower Ash Pond	URS	unconfined	B&R	41.0-51.0	9/12/2006	1.00E-08	3.06E-07
B-42A	Columbia	Falling Head Slug	Lower Ash Pond	URS	unconfined	B&R	26.0-31.0	9/12/2006	1.29E-05	3.94E-04
B-42A	Columbia	Rising Head Slug	Lower Ash Pond	URS	unconfined	B&R	26.0-31.0	9/12/2006	6.81E-06	2.08E-04
DM-11	Columbia	Falling Head Slug	Off-Site (upgradient)	Dames & Moore	unconfined	Unknown	10.0-20.0	1983	5.00E+02	1.76E-01
DM-2	Columbia	Falling Head Slug	Off-Site (upgradient)	Dames & Moore	unconfined	Unknown	14.7-24.7	1983	5.00E+02	1.76E-01
DM-3	Columbia	Falling Head Slug	Off-Site (upgradient)	Dames & Moore	confined	Unknown	73.7-83.7	1983	2.84E-01	1.00E-04
DM-5	Columbia	Falling Head Slug	Upper Ash Pond	Dames & Moore	unconfined	Unknown	15.0-25.0	1983	2.83E+02	1.00E-01
DM-7	Columbia	Falling Head Slug	Upper Ash Pond	Dames & Moore	confined	Unknown	49.0-54.0	1983	5.67E+00	2.00E-03
MW-1	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	KGS	20.0-30.0	9/29/2016	3.22E-04	9.81E-03
MW-1	Columbia	Rising Head Slug	Upper Ash Pond	Golder	unconfined	KGS	20.0-30.0	9/29/2016	8.73E-05	2.66E-03
MW-5	Columbia	Test 1	Upper Ash Pond	Haley and Aldrich	unconfined	Unknown	27.0-37.0	Unknown	3.28E-05	1.00E-03
MW-5	Columbia	Test 2	Upper Ash Pond	Haley and Aldrich	unconfined	Unknown	27.0-37.0	Unknown	3.28E-05	1.00E-03
MW-15	Columbia	Falling Head Slug	Upper Ash Pond	Golder	confined	KGS with Skin	30.0-40.0	9/30/2016	7.48E-05	2.28E-03
MW-15	Columbia	Rising Head Slug	Upper Ash Pond	Golder	confined	KGS	30.0-40.0	9/30/2016	8.26E-05	2.52E-03
MW-16	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	KGS	24.4-34.4	9/29/2016	8.37E-06	2.55E-04
MW-16	Columbia	Rising Head Slug	Upper Ash Pond	Golder	unconfined	KGS	24.4-34.4	9/29/2016	8.56E-06	2.61E-04
MW-17S	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	KGS	20.0-30.0	9/29/2016	7.99E-05	2.44E-03
MW-17S	Columbia	Rising Head Slug	Upper Ash Pond	Golder	unconfined	KGS	20.0-30.0	9/29/2016	9.77E-05	2.98E-03
MW-17S	Columbia	Test 1	Upper Ash Pond	Haley and Aldrich	unconfined	Unknown	20.0-30.0	Unknown	3.28E-05	1.00E-03
MW-17S	Columbia	Test 2	Upper Ash Pond	Haley and Aldrich	unconfined	Unknown	20.0-30.0	Unknown	3.28E-05	1.00E-03
MW-17I	Columbia	Test 1	Upper Ash Pond	Haley and Aldrich	unconfined	Unknown	46.0-56.0	Unknown	2.62E-05	8.00E-04
MW-17I	Columbia	Test 2	Upper Ash Pond	Haley and Aldrich	unconfined	Unknown	46.0-56.0	Unknown	1.97E-05	6.00E-04
MW-2	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	KGS	25.0-35.0	9/29/2016	5.04E-04	1.54E-02
MW-2	Columbia	Falling Head Slug	Oil Storage Tanks	ENSAT	unconfined	B&R	50.0-65.0	2/25/1993	7.78E-01	2.74E-04
MW-2	Columbia	Rising Head Slug	Upper Ash Pond	Golder	unconfined	KGS	25.0-35.0	9/29/2016	2.69E-04	8.20E-03
MW-20	Columbia	Falling Head Slug	Lower Ash Pond	Golder	confined	KGS	25.0-35.0	9/29/2016	8.53E-04	2.60E-02
MW-20	Columbia	Rising Head Slug	Lower Ash Pond	Golder	confined	KGS	25.0-35.0	9/29/2016	7.48E-04	2.28E-02
MW-21	Columbia	Falling Head Slug	Lower Ash Pond	Golder	unconfined	KGS	15.0-25.0	9/28/2016	9.77E-05	2.98E-03
MW-21	Columbia	Rising Head Slug	Lower Ash Pond	Golder	unconfined	KGS	15.0-25.0	9/28/2016	4.86E-04	1.48E-02
MW-21	Columbia	Test 1	Lower Ash Pond	Haley and Aldrich	unconfined	KGS	15.0-25.0	Unknown	1.64E-04	5.00E-03
MW-21	Columbia	Test 2	Lower Ash Pond	Haley and Aldrich	unconfined	KGS	15.0-25.0	Unknown	1.97E-04	6.00E-03
MW-22	Columbia	Rising Head Slug	Lower Ash Pond	Golder	unconfined	KGS	23.0-33.0	9/28/2016	9.82E-05	2.99E-03
MW-23	Columbia	Falling Head Slug	Lower Ash Pond	Golder	confined	KGS	30.0-40.0	9/26/2016	1.78E-05	5.43E-04
MW-23	Columbia	Rising Head Slug	Lower Ash Pond	Golder	confined	KGS	30.0-40.0	9/26/2016	2.60E-05	7.92E-04
MW-26	Columbia	Falling Head Slug	Lower Ash Pond	Golder	confined	H	13.0-23.0	9/29/2016	6.36E-05	1.94E-03
MW-26	Columbia	Rising Head Slug	Lower Ash Pond	Golder	confined	H	13.0-23.0	9/29/2016	6.12E-05	1.87E-03
MW-27	Columbia	Falling Head Slug	Lower Ash Pond	Golder	confined	KGS	19.0-29.0	9/29/2016	4.50E-04	1.37E-02
MW-27	Columbia	Rising Head Slug	Lower Ash Pond	Golder	confined	H	19.0-29.0	9/29/2016	4.37E-04	1.33E-02
MW-28	Columbia	Falling Head Slug	Lower Ash Pond	Golder	confined	KGS with Skin	24.0-34.0	9/29/2016	1.25E-04	3.81E-03
MW-28	Columbia	Rising Head Slug	Lower Ash Pond	Golder	confined	H	24.0-34.0	9/29/2016	1.01E-04	3.08E-03
MW-29U	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	H	8.0-18.0	9/29/2016	1.82E-06	5.55E-05
MW-3	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	H	19.0-29.0	9/29/2016	5.02E-04	1.53E-02
MW-3	Columbia	Rising Head Slug	Upper Ash Pond	Golder	unconfined	KGS	19.0-29.0	9/29/2016	5.84E-04	1.78E-02
MW-32	Columbia	Falling Head Slug	Lower Ash Pond	Golder	confined	H	20.0-30.0	9/29/2016	4.43E-06	1.35E-04
MW-32	Columbia	Rising Head Slug	Lower Ash Pond	Golder	confined	H	20.0-30.0	9/29/2016	2.92E-06	8.90E-05
MW-32I	Columbia	Test 1	Lower Ash Pond	Haley and Aldrich	confined	Unknown	41.0-51.0	Unknown	3.28E-04	1.00E-02
MW-32I	Columbia	Test 2	Lower Ash Pond	Haley and Aldrich	confined	Unknown	41.0-51.0	Unknown	6.56E-05	2.00E-03
MW-33	Columbia	Falling Head Slug	Lower Ash Pond	Golder	confined	KGS	25.2-35.2	9/26/2016	3.42E-05	1.04E-03
MW-33	Columbia	Rising Head Slug	Lower Ash Pond	Golder	confined	KGS	25.2-35.2	9/26/2016	3.50E-05	1.07E-03
MW-35S	Columbia	Falling Head Slug	Lower Ash Pond	Golder	unconfined	KGS	54.0-64.0	1/12/2017	1.06E-04	3.23E-03
MW-35S	Columbia	Rising Head Slug	Lower Ash Pond	Golder	unconfined	KGS	54.0-64.0	1/12/2017	9.58E-05	2.92E-03
MW-5	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	KGS with Skin	27.0-37.0	9/29/2016	1.27E-04	3.87E-03
MW-5	Columbia	Rising Head Slug	Upper Ash Pond	Golder	unconfined	KGS	27.0-37.0	9/29/2016	1.08E-04	3.29E-03
MW-8	Columbia	Falling Head Slug	Upper Ash Pond	Golder	unconfined	B&R	42.5-52.5	9/30/2016	3.48E-06	1.06E-04
MW-8	Columbia	Rising Head Slug	Upper Ash Pond	Golder	unconfined	KGS	42.5-52.5	9/30/2016	1.75E-06	5.33E-05
MW-25	Columbia/Potomac	Falling Head Slug	Lower Ash Pond	Golder	confined	KGS	45.0-55.0	9/29/2016	1.45E-04	4.42E-03
MW-25	Columbia/Potomac	Rising Head Slug	Lower Ash Pond	Golder	confined	KGS	45.0-55.0	9/29/2016	8.56E-05	2.61E-03
MW-4	Columbia/Potomac	Falling Head Slug	Upper Ash Pond	Golder	confined	KGS	23.6-33.6	9/29/2016	5.95E-03	1.81E-01
MW-4	Columbia/Potomac	Rising Head Slug	Upper Ash Pond	Golder	confined	KGS	23.6-33.6	9/29/2016	7.28E-03	2.22E-01
DM-6	Potomac	Falling Head Slug	Upper Ash Pond	Dames & Moore	confined	Unknown	82.5-92.5	1983	5.67E-01	2.00E-04
MW-16D	Potomac	Falling Head Slug	Upper Ash Pond	Golder	confined	KGS	59.8-69.8	9/29/2016	6.21E-05	1.89E-03
MW-16D	Potomac	Rising Head Slug	Upper Ash Pond	Golder	confined	KGS	59.8-69.8	9/29/2016	6.56E-05	2.00E-03
MW-17D	Potomac	Test 1	Upper Ash Pond	Haley and Aldrich	confined	Unknown	79.0-89.0	Unknown	1.64E-05	5.00E-04
MW-17D	Potomac	Test 2	Upper Ash Pond	Haley and Aldrich	confined	Unknown	79.0-89.0	Unknown	9.84E-06	3.00E-04
MW-1D	Potomac	Falling Head Slug	Upper Ash Pond	Golder	confined	H	45.3-55.3	9/29/2016	4.35E-04	1.33E-02
MW-1D	Potomac	Rising Head Slug	Upper Ash Pond	Golder	confined	H	45.3-55.3	9/29/2016	3.94E-04	1.20E-02
MW-35D	Potomac	Falling Head Slug	Upper Ash Pond	Golder	confined	KGS	89.0-99.0	1/12/2017	1.35E-05	4.11E-04
MW-35D	Potomac	Rising Head Slug	Upper Ash Pond	Golder	confined	KGS	89.0-99.0	1/12/2017	1.57E-05	4.79E-04
MW-6	Potomac	Rising Head Slug	Upper Ash Pond	Golder	unconfined	H	49.0-59.0	9/28/2016	3.99E-04	1.22E-02
MW-7	Potomac	Falling Head Slug	Upper Ash Pond	Golder	confined	KGS	42.5-52.5	9/16/2016	3.25E-06	9.91E-05
MW-7	Potomac	Rising Head Slug	Upper Ash Pond	Golder	confined	KGS with Skin	42.5-52.5	9/16/2016	4.17E-06	1.27E-04

Note:
KGS = Hyder et al. (1994)
H = Hvorslev (1951)
B&R = Bouwer and Rice, 1976
* = B-19 replacement boring (2002)
Columbia/Potomac wells pooled with Potomac wells for evaluation

Parameter Estimate	Columbia	Potomac	Bedrock
Geometric Mean (cm/s):	1.45E-03	2.18E-03	2.64E-07
Maximum (cm/s):	1.76E-01	2.22E-01	2.64E-07
Minimum (cm/s):	3.06E-07	9.91E-05	2.64E-07

Table 3
Summary of Modified Detection Monitoring Program Constituents and Parameters
Chesterfield Power Station Lower and Upper Ash Ponds
Chesterfield, Virginia

PARAMETER	CLASS	CAS RN	TYPICAL METHOD	TYPICAL LOQ/PQL (ug/L)
CCR Appendix III to Part 257				
Boron	metal	7440-42-8	6010C/6020B	50
Calcium	metal	7440-70-2	6010C/6020B	5,000
Chloride	anion	16887-00-6	9056A	1,000
Fluoride	anion	16984-48-8	9056A	100
pH	field parameter	NA	SM4500-H+/9040C	NA
Sulfate	anion	18785-72-3	9056A	1,000
Total Dissolved Solids (TDS)	dissolved cations and anions	Total	SM2540C	50,000
Virginia Solid Waste Management Regulation Table 3.1 Column A Constituents				
Antimony	metal	Total	6010C/6020B	5
Arsenic	metal	Total	6010C/6020B	1
Barium	metal	Total	6010C/6020B	5
Beryllium	metal	Total	6010C/6020B	1
Cadmium	metal	Total	6010C/6020B	1
Chromium	metal	Total	6010C/6020B	5
Cobalt	metal	Total	6010C/6020B	1
Copper	metal	Total	6010C/6020B	5
Lead	metal	Total	6010C/6020B	1
Nickel	metal	Total	6010C/6020B	5
Selenium	metal	Total	6010C/6020B	5
Silver	metal	Total	6010C/6020B	5
Thallium	metal	Total	6010C/6020B	1
Vanadium	metal	Total	6010C/6020B	5
Zinc	metal	Total	6010C/6020B	20

Notes:

- Class: General type of compound
- CAS RN: Chemical Abstracts Service Registry Number. Where 'Total' is entered, all species that contain the element are included.
- Method: Analytical Method from EPA SW-846 Methods for Evaluating Solid Waste. Samples will be analyzed using the version of each method that is current at the time of sampling.
- LOQ: Limit of Quantitation.
- PQL: Practical Quantitation Limit.
- Acceptable alternatives to the analytical methods listed above include current SW-846 Methods with LOQ/PQLs equal to or lower than the one specified and other laboratory methods as approved by the Virginia Department of Environmental Quality.

Table 4
Summary of Modified Assessment Monitoring Program Constituents and Parameters
Chesterfield Power Station Lower and Upper Ash Ponds
Chesterfield, Virginia

PARAMETER	CLASS	CAS RN	TYPICAL METHOD	TYPICAL LOQ/PQL (ug/L)
CCR Appendix III to Part 257				
Boron	metal	7440-42-8	6010C/6020B	50
Calcium	metal	7440-70-2	6010C/6020B	5,000
Chloride	anion	16887-00-6	9056A	1,000
Fluoride	anion	16984-48-8	9056A	100
pH	field parameter	NA	SM4500-H+/9040C	NA
Sulfate	anion	18785-72-3	9056A	1,000
Total Dissolved Solids (TDS)	dissolved cations and anions	Total	SM2540C	50,000
CCR Appendix IV to Part 257				
Antimony	metal	Total	6010C/6020B	5
Arsenic	metal	Total	6010C/6020B	1
Barium	metal	Total	6010C/6020B	5
Beryllium	metal	Total	6010C/6020B	1
Cadmium	metal	Total	6010C/6020B	1
Chromium	metal	Total	6010C/6020B	5
Cobalt	metal	Total	6010C/6020B	1
Fluoride	metal	Total	9056A	300
Lead	metal	Total	6010C/6020B	1
Lithium	metal	Total	6010C/6020B	50
Mercury	metal	Total	7470	2
Molybdenum	metal	Total	6010C/6020B	10
Selenium	metal	Total	6010C/6020B	10
Thallium	metal	Total	6010C/6020B	1
Radium 226 and 228 combined	radionuclide	(226) - 13982-63-3 (228) - 15262-20-1	9315/9320 or other EPA-approved methods	1.00 pCi/L
Pertinent Virginia Solid Waste Management Regulation Table 3.1 Column B Constituents				
Copper	metal	Total	6010C/6020B	5
Nickel	metal	Total	6010C/6020B	10
Silver	metal	Total	6010C/6020B	5
Tin	metal	Total	6010C/6020B	10
Vanadium	metal	Total	6010C/6020B	5
Zinc	metal	Total	6010C/6020B	20
Other Analytes				
Hexavalent Chromium	metal	18540-29-9	7196A	5

Notes:

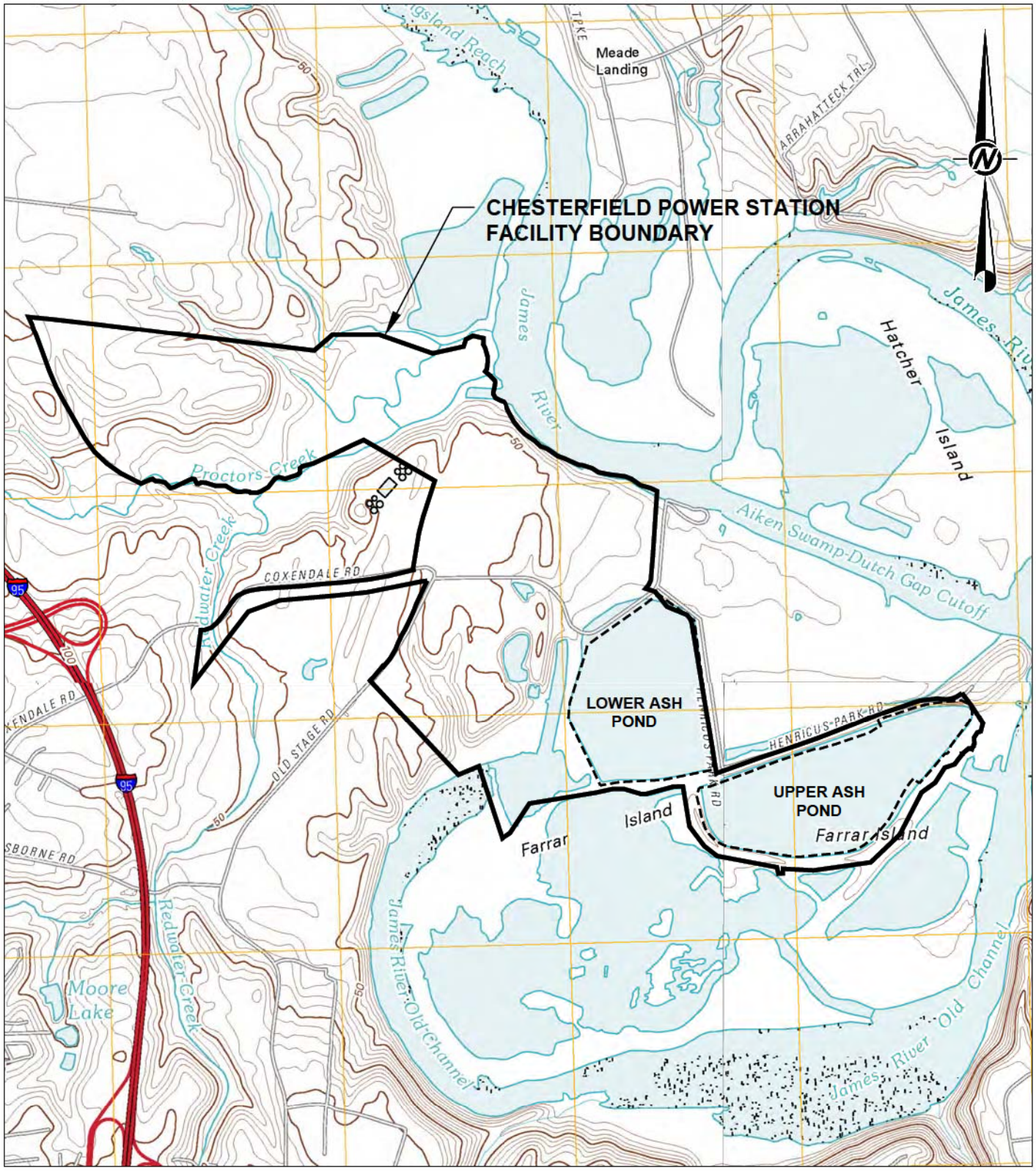
- Class: General type of compound
- CAS RN: Chemical Abstracts Service Registry Number. Where 'Total' is entered, all species that contain the element are included.
- Method: Analytical Method from EPA SW-846 Methods for Evaluating Solid Waste. Samples will be analyzed using the version of each method that is current at the time of sampling.
- LOQ: Limit of Quantitation
- PQL: Practical Quantitation Limit
- ug/L: micrograms per liter
- NA: Not Available
- pCi/L: picocuries per liter
- Acceptable alternatives to the analytical methods listed above include current SW-846 Methods with LOQ/PQLs equal to or lower than the one specified and other laboratory methods as approved by the Virginia Department of Environmental Quality.

Table 5
Summary of Sample Container Information and Hold Times
Chesterfield Power Station Lower and Upper Ash Ponds
Chesterfield, Virginia

Parameter	Container & Volume	Preservative	Maximum Holding Time
pH	Flow-through cell or plastic, 500 mL	None	15 minutes (field analysis)
Specific Conductance	Flow-through cell or plastic, 500 mL	None	15 minutes (field analysis)
Temperature	Flow-through cell or plastic, 500 mL	None	15 minutes (field analysis)
Mercury (total)	Plastic; 250 mL	HNO_3 to pH<2	28 days
Metals (total) except mercury	Plastic, 250 mL	HNO_3 to pH<2	6 months
Total Dissolved Solids (TDS)	Plastic, 200 mL	None	7 days
Fluoride, Chloride, Sulfate	Plastic, 250 mL	None	28 days
Hexavalent Chromium	Plastic, 500 mL	None	24 Hours
Radium 226/228	Plastic, 1/2 gallon (2 L)	Preserved upon receipt at laboratory	6 months

Notes:
mL= milliliter
L= Liter
HNO_3 = Nitric Acid
HCL = Hydrochloric Acid
H_2SO_4 = Sulfuric Acid

Drawings



SOURCE NOTE

Site Location Map consists of 7.5-minute USGS topographic quadrangles named Dutch Gap, Drewry's Bluff, Chester and Hopewell, all dated 2010.

2000 0 2000

SCALE FEET

CLIENT
DOMINION ENERGY

PROJECT
CHESTERFIELD POWER STATION

CONSULTANT
GOLDER

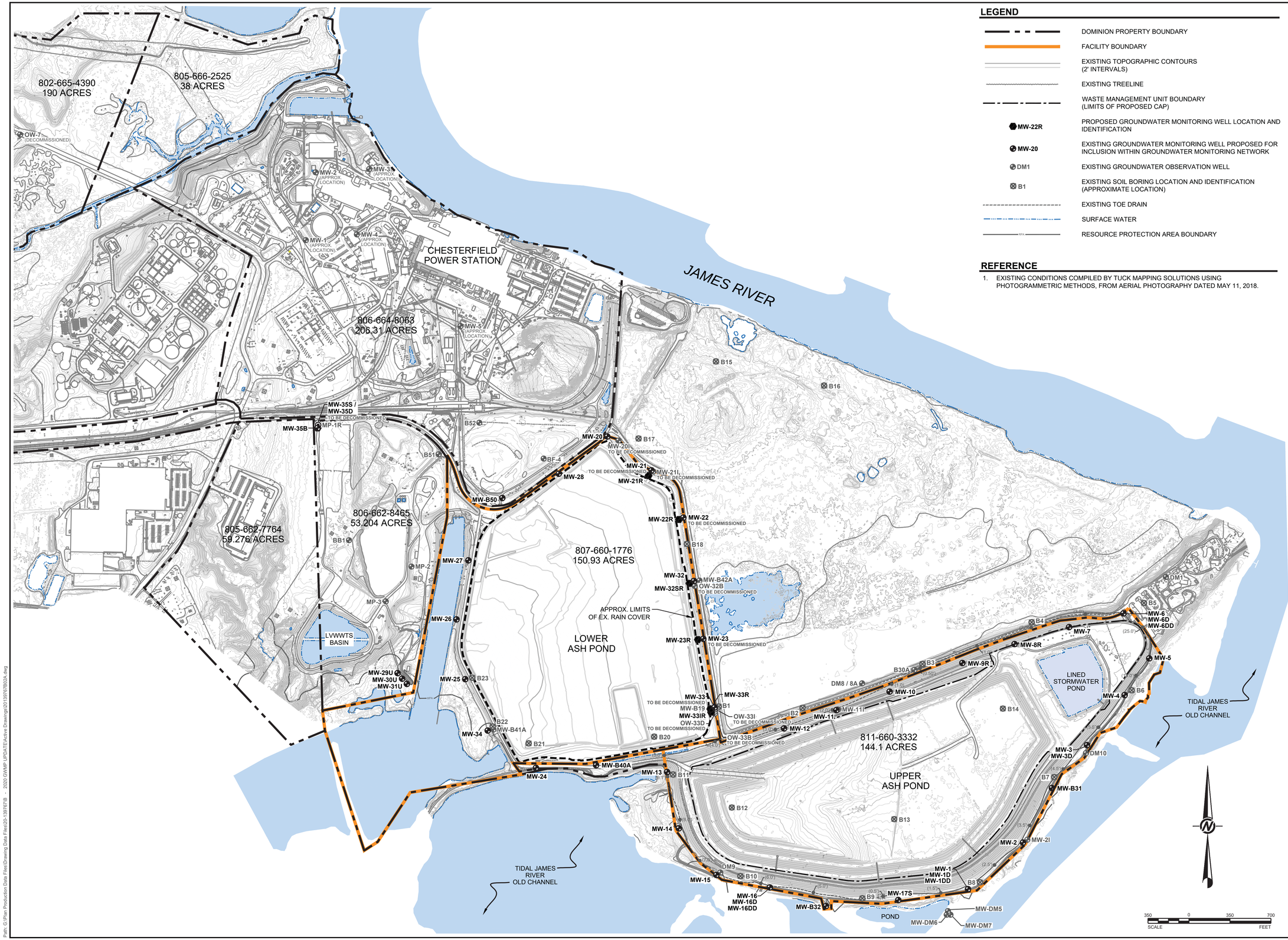
YYYY-MM-DD	2020-06-15
DESIGNED	-
PREPARED	BPG
REVIEWED	PKT
APPROVED	MGW

TITLE
SITE LOCATION MAP

PROJECT NO. 20-139767 | REV. 1 | DRAWING 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\8 - 2020 GWMP UPDATE\Active Drawings\20139767B01.dwg



LEGEND

- DOMINION PROPERTY BOUNDARY
- FACILITY BOUNDARY
- EXISTING TOPOGRAPHIC CONTOURS (2' INTERVALS)
- EXISTING TREELINE
- WASTE MANAGEMENT UNIT BOUNDARY (LIMITS OF PROPOSED CAP)
- MW-22R — PROPOSED GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION
- MW-20 — EXISTING GROUNDWATER MONITORING WELL PROPOSED FOR INCLUSION WITHIN GROUNDWATER MONITORING NETWORK
- DM1 — EXISTING GROUNDWATER OBSERVATION WELL
- B1 — EXISTING SOIL BORING LOCATION AND IDENTIFICATION (APPROXIMATE LOCATION)
- EXISTING TOE DRAIN
- SURFACE WATER
- RPA — RESOURCE PROTECTION AREA BOUNDARY

REFERENCE

1. EXISTING CONDITIONS COMPILED BY TUCK MAPPING SOLUTIONS USING PHOTOGRAMMETRIC METHODS, FROM AERIAL PHOTOGRAPHY DATED MAY 11, 2018.

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
4	06/15/20	NEW WELL LOCATIONS	MGW	BPG	MGW	MGW
3	05/26/16	WELL LOCATION REVISIONS	MGW	BPG	MGW	MGW
2	05/16/16	MONITORING NETWORK REVISIONS	MGW	BPG	MGW	MGW
1	03/17/16	RESPONSE TO COMMENTS	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
LOWER AND UPPER ASH POND
GROUNDWATER MONITORING PLAN

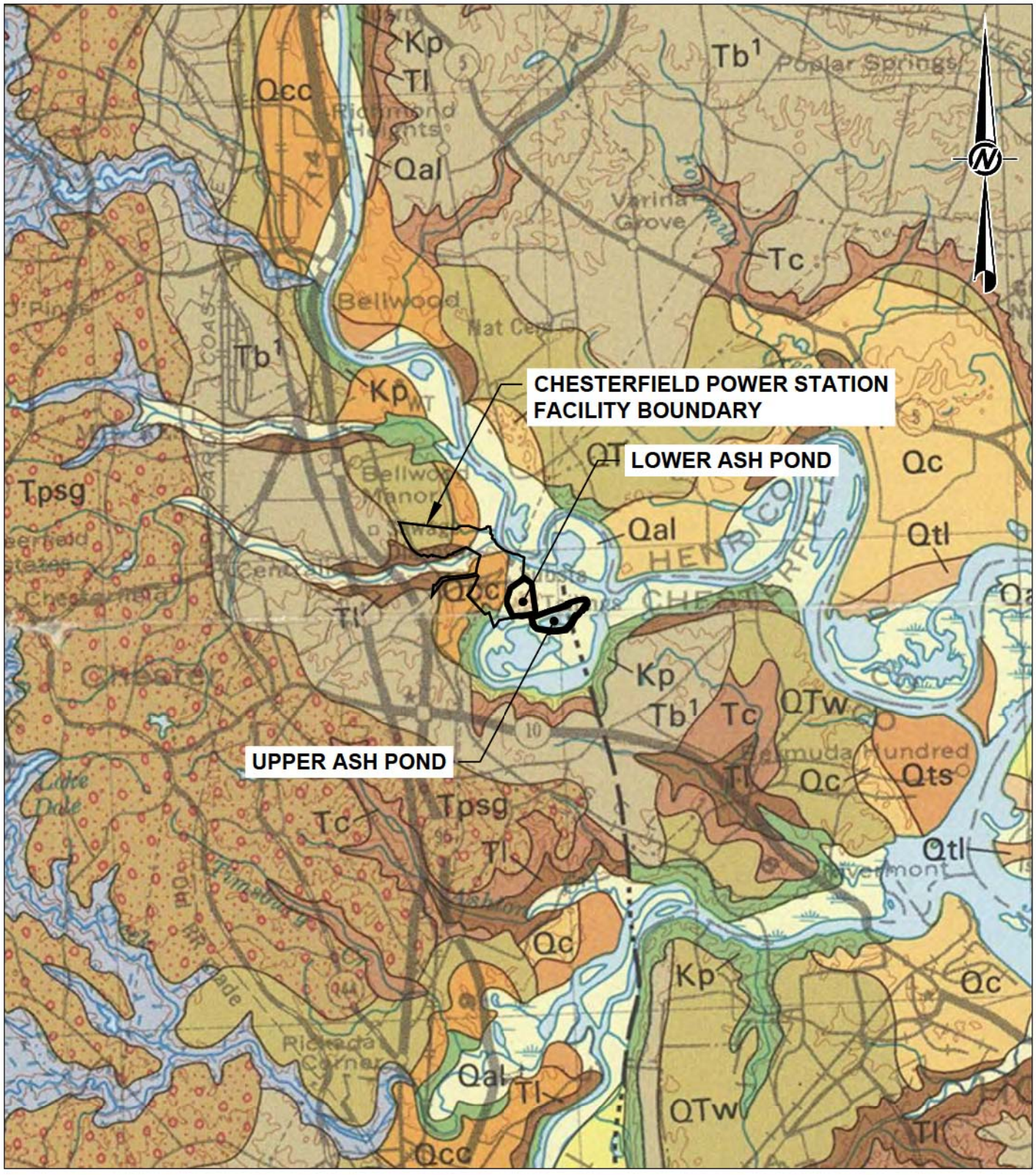
PROJECT NO.
20-139767

REV.
4

DRAWING
2

0 1 in
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\B ... 2020 GWMP UPDATE\Active Drawings\20139767B02A.dwg



SOURCE NOTE

Geologic Map, 1989, by R.B. Mixon, C.R. Berquist, Jr., W.L. Newell, and G.H. Johnson

10000 0 10000

SCALE FEET

CLIENT
DOMINION ENERGY

PROJECT
CHESTERFIELD POWER STATION

CONSULTANT
GOLDER

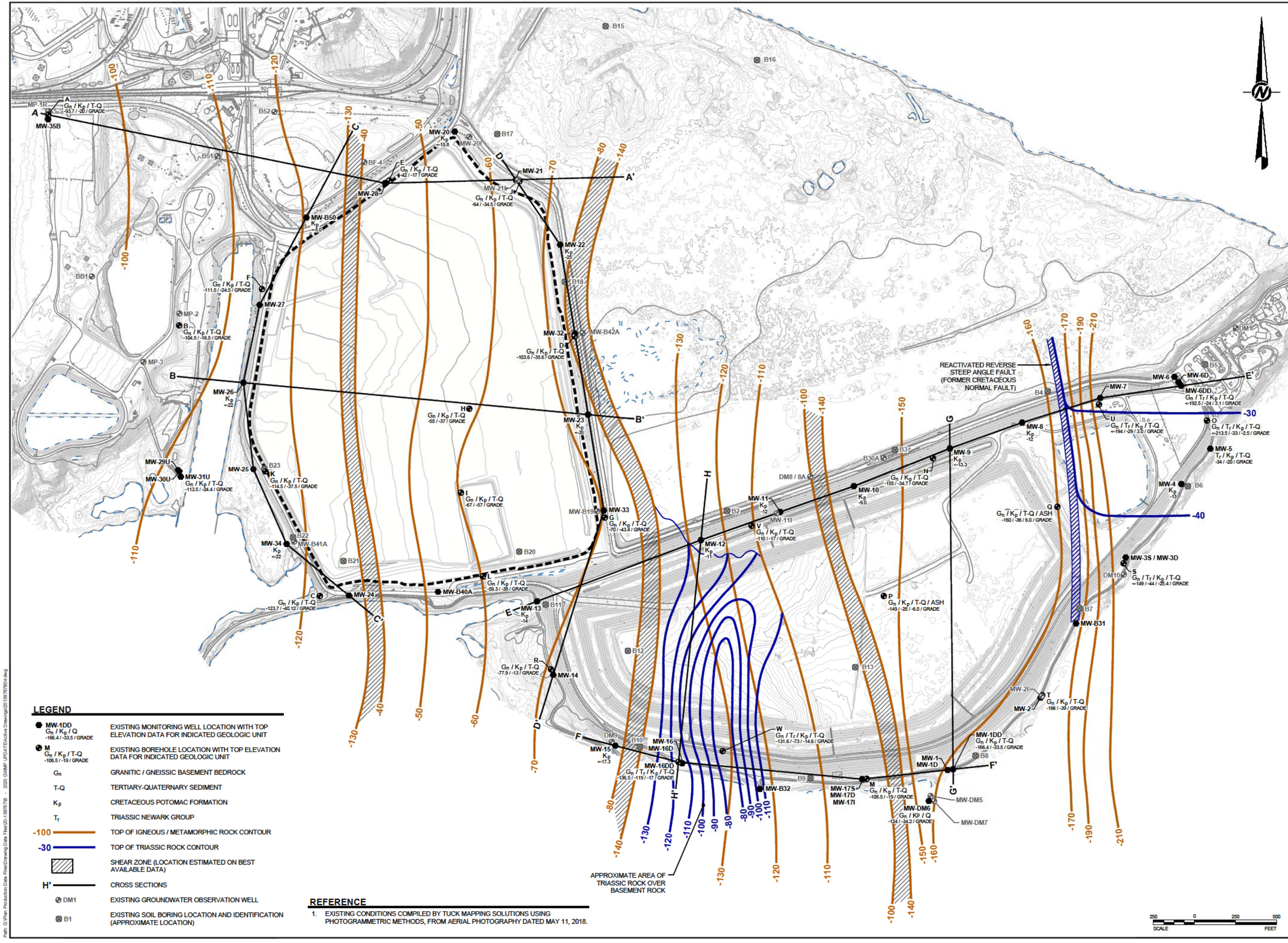
YYYY-MM-DD	2020-06-15
DESIGNED	-
PREPARED	BPG
REVIEWED	PKT
APPROVED	MGW

TITLE
GEOLOGIC MAP

PROJECT NO. 20-139767 | REV. 1 | DRAWING 3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\B - 2020 GWMP UPDATE\Active Drawings\20139767B03.dwg



LEGEND

MW-1DD Gn / Kp / Q -166.4 / -33.5 / GRADE	EXISTING MONITORING WELL LOCATION WITH TOP ELEVATION DATA FOR INDICATED GEOLOGIC UNIT
M Gn / Kp / T-Q -106.5 / -19 / GRADE	EXISTING BOREHOLE LOCATION WITH TOP ELEVATION DATA FOR INDICATED GEOLOGIC UNIT
G_n	GRANITIC / GNEISSIC BASEMENT BEDROCK
T-Q	TERTIARY-QUATERNARY SEDIMENT
K_p	CRETACEOUS POTOMAC FORMATION
T_r	TRIASSIC NEWARK GROUP
-100	TOP OF IGNEOUS / METAMORPHIC ROCK CONTOUR
-30	TOP OF TRIASSIC ROCK CONTOUR
	SHEAR ZONE (LOCATION ESTIMATED ON BEST AVAILABLE DATA)
H'	CROSS SECTIONS
DM1	EXISTING GROUNDWATER OBSERVATION WELL
B1	EXISTING SOIL BORING LOCATION AND IDENTIFICATION (APPROXIMATE LOCATION)

REFERENCE

1. EXISTING CONDITIONS COMPILED BY TUCK MAPPING SOLUTIONS USING PHOTOGRAMMETRIC METHODS, FROM AERIAL PHOTOGRAPHY DATED MAY 11, 2018.

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	NEW WELL LOCATIONS	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER

GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
STRUCTURAL CONTOUR MAP FOR BASEMENT BEDROCK

PROJECT NO.
20-139767

REV.
1

DRAWING
4

SCALE
250 0 250 500
FEET

1in

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ARCH D

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\8 - 2020 GWMP UPDATE\Active Drawings\20139767804.dwg

LEGEND

MW-1DD G_n / K_p / Q -166.4 / -33.5 / GRADE	EXISTING MONITORING WELL LOCATION WITH TOP ELEVATION DATA FOR INDICATED GEOLOGIC UNIT
M G_n / K_p / T-Q -106.5 / -19 / GRADE	EXISTING BOREHOLE LOCATION WITH TOP ELEVATION DATA FOR INDICATED GEOLOGIC UNIT
G_n	GRANITIC / GNEISSIC BASEMENT BEDROCK
T-Q	TERTIARY-QUATERNARY SEDIMENT
K_p	CRETACEOUS POTOMAC FORMATION
T_r	TRIASSIC NEWARK GROUP
-50	TOP OF CRETACEOUS POTOMAC FORMATION CONTOUR
	SHEAR ZONE (LOCATION ESTIMATED ON BEST AVAILABLE DATA)
H'	CROSS SECTIONS
DM1	EXISTING GROUNDWATER OBSERVATION WELL
B1	EXISTING SOIL BORING LOCATION AND IDENTIFICATION (APPROXIMATE LOCATION)

REFERENCE

1. EXISTING CONDITIONS COMPILED BY TUCK MAPPING SOLUTIONS USING PHOTOGRAMMETRIC METHODS, FROM AERIAL PHOTOGRAPHY DATED MAY 11, 2018.

SCALE 250 0 250 500 FEET

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	NEW WELL LOCATIONS	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com
GOLDER

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
STRUCTURAL CONTOUR MAP FOR TOP OF CRETACEOUS POTOMAC FORMATION

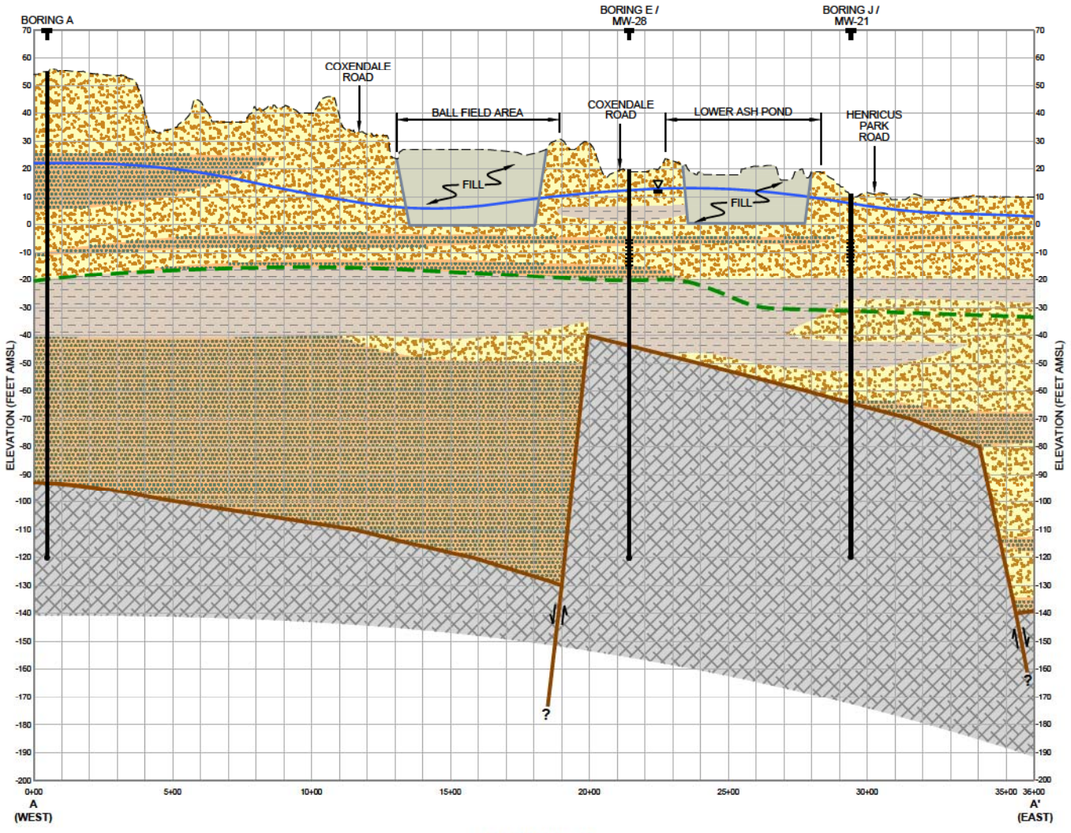
PROJECT NO.
20-139767

REV.
1

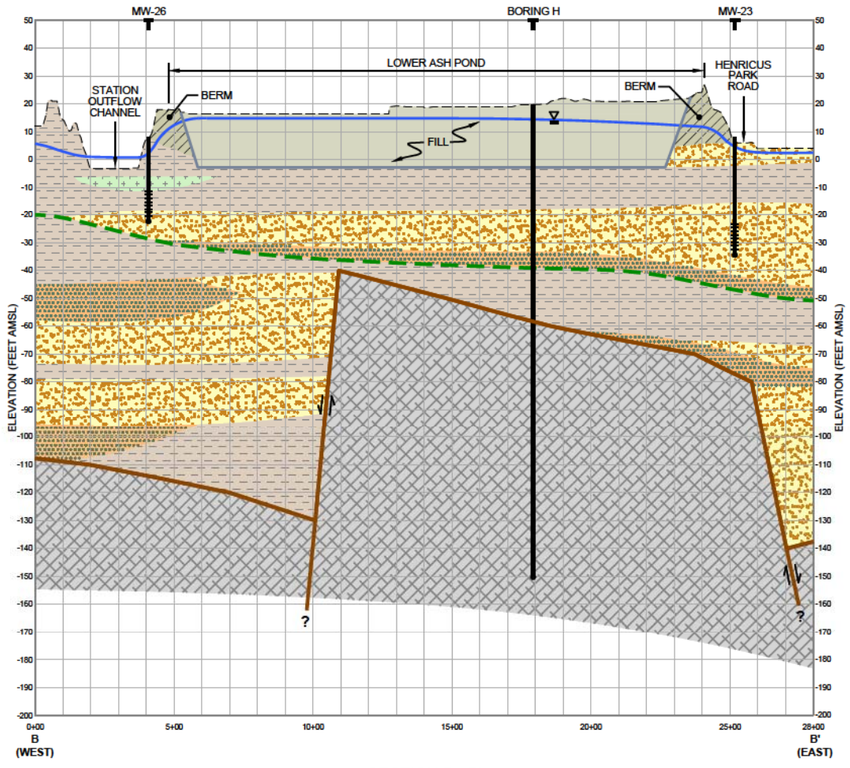
DRAWING
5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D
0 1in

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\8 - 2020 GWMP UPDATE\Active Drawings\20-139767R05.dwg



SECTION A - A'



SECTION B - B'

LEGEND

- EXISTING GROUND
- WATER TABLE
- TOP CRETACEOUS POTOMAC FORMATION
- TOP OF IGNEOUS / METAMORPHIC ROCK
- TOP OF TRIASSIC ROCK
- BOTTOM OF FILL
- SCREENED INTERVAL
- CLAY + SANDY CLAY + CLAYEY SILT
- SAND + GRAVEL
- SAND + SILT
- ORGANIC SILT + CLAY
- TRIASSIC CONGLOMERATE SILT STONE, SAND STONE, AND MUD STONE
- BEDROCK
- FILL MATERIAL
- ASH POND BERM FILL

SCALE 50 25 0 25 FEET

SCALE 250 0 250 500 FEET

REV.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

GOLDER

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
CROSS SECTIONS A-A' AND B-B'

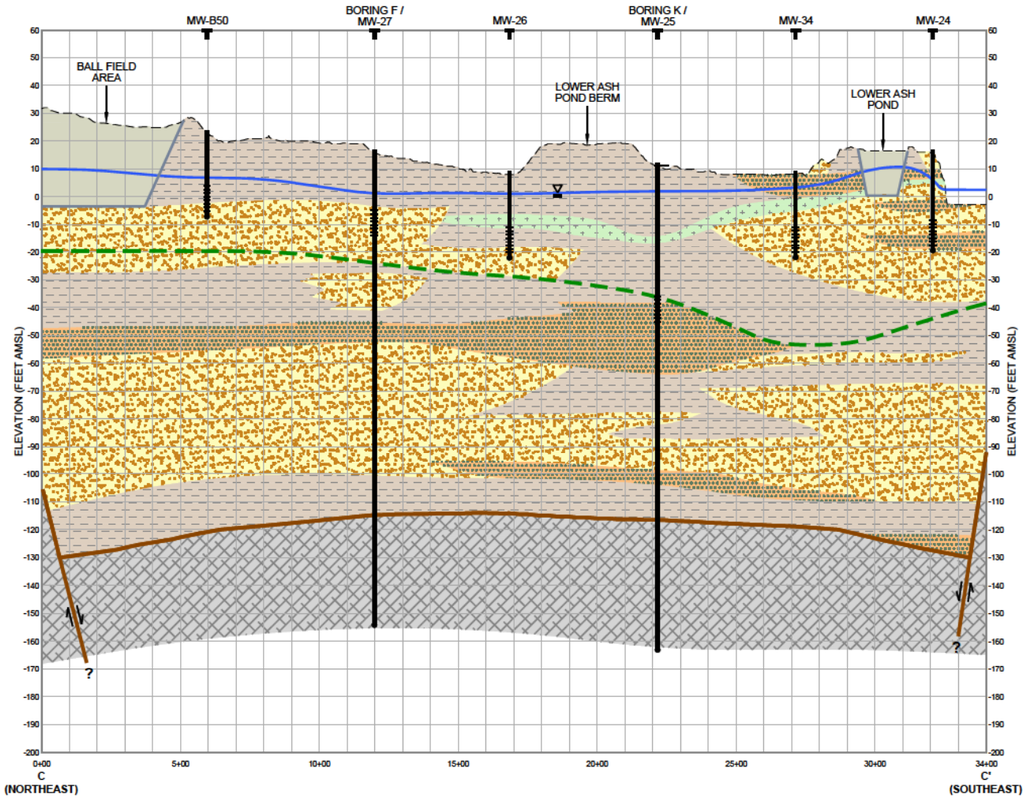
PROJECT NO.
20-139767

REV.
1

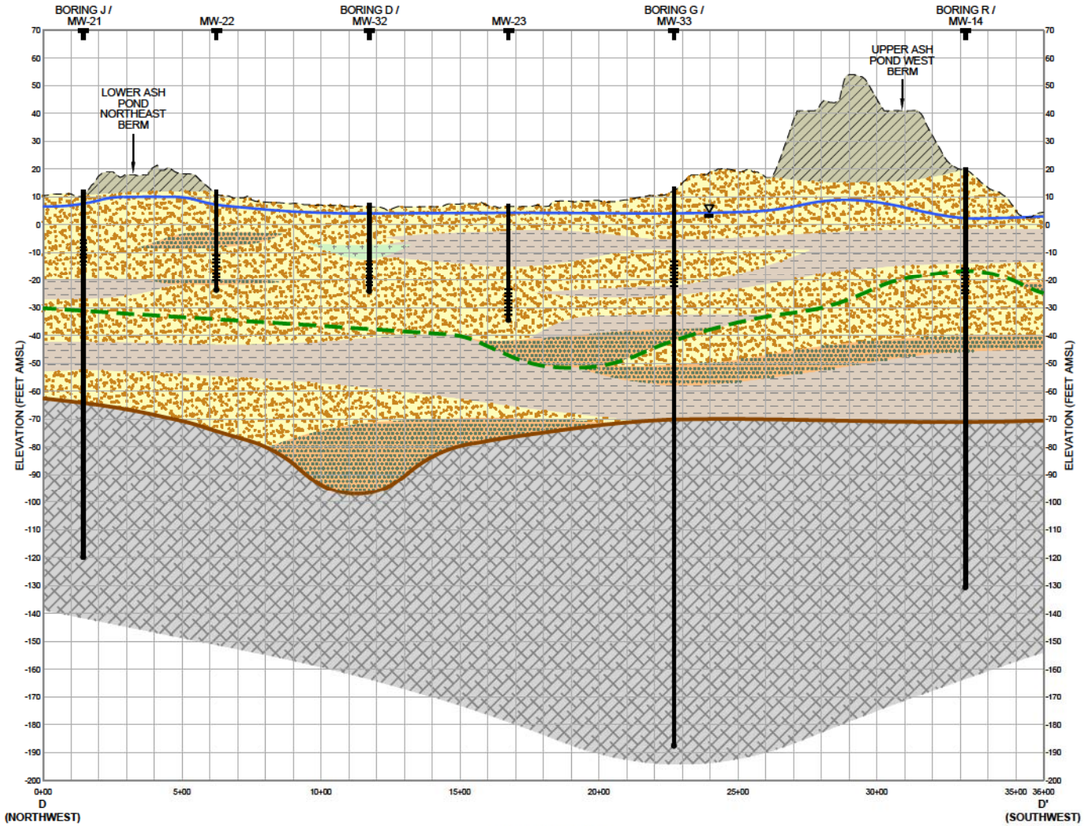
DRAWING
6

0 1in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ARCH D

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\8 - 2020 GWMP UPDATE\Active Drawings\20139767B06-10.dwg



SECTION C - C'



SECTION D - D'

LEGEND

- EXISTING GROUND
- WATER TABLE
- TOP CRETACEOUS POTOMAC FORMATION
- TOP OF IGNEOUS / METAMORPHIC ROCK
- TOP OF TRIASSIC ROCK
- BOTTOM OF FILL
- SCREENED INTERVAL
- CLAY + SANDY CLAY + CLAYEY SILT
- SAND + GRAVEL
- SAND + SILT
- ORGANIC SILT + CLAY
- TRIASSIC CONGLOMERATE SILT STONE, SAND STONE, AND MUD STONE
- BEDROCK
- FILL MATERIAL
- ASH POND BERM FILL

SCALE: 50 25 0 25 FEET

SCALE: 250 0 250 500 FEET

REV.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER

GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
CROSS SECTIONS C-C' AND D-D'

PROJECT NO.
20-139767

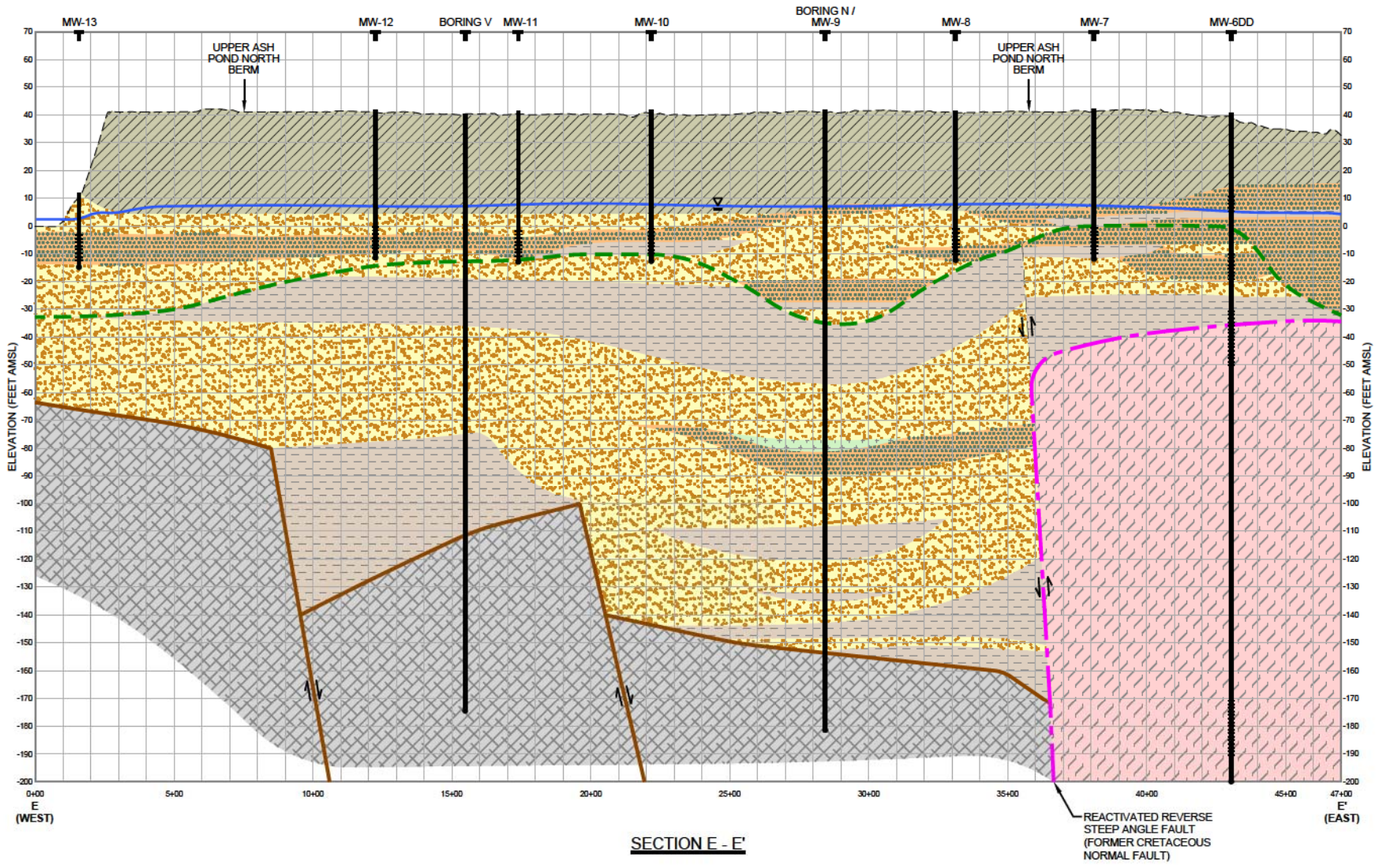
REV.
1

DRAWING
7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

1 in 0

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767B - 2020 GWMP UPDATE\Active Drawings\20139767B06-10.dwg



SECTION E - E'

LEGEND

- EXISTING GROUND
- WATER TABLE
- TOP CRETACEOUS POTOMAC FORMATION
- TOP OF IGNEOUS / METAMORPHIC ROCK
- TOP OF TRIASSIC ROCK
- BOTTOM OF FILL
- SCREENED INTERVAL
- CLAY + SANDY CLAY + CLAYEY SILT
- SAND + GRAVEL
- SAND + SILT
- ORGANIC SILT + CLAY
- TRIASSIC CONGLOMERATE SILT STONE, SAND STONE, AND MUD STONE
- BEDROCK
- FILL MATERIAL
- ASH POND BERM FILL

SCALE 50 25 0 25 FEET

SCALE 250 0 250 500 FEET

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER

GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
CROSS SECTION E-E'

PROJECT NO.
20-139767

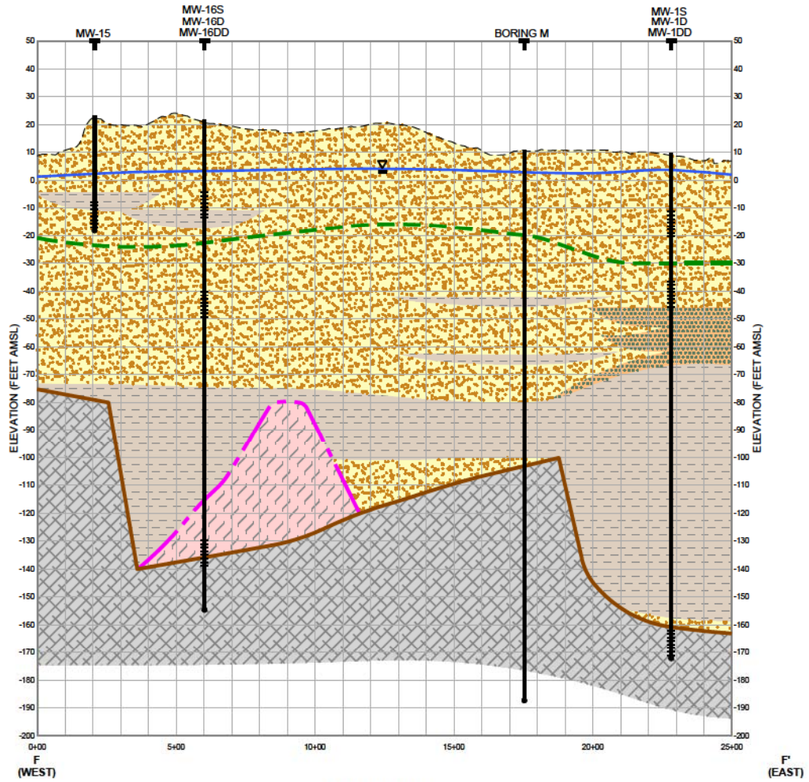
REV.
1

DRAWING
8

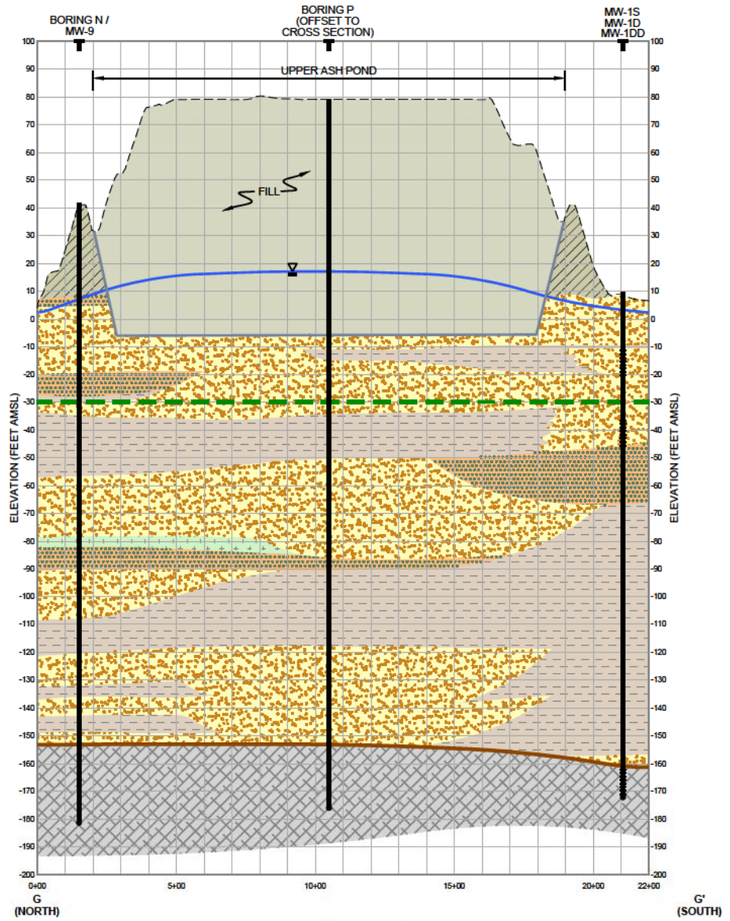
1 in

© THIS MEA SUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ARCH D

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\8 - 2020 GWMP UPDATES\Active Drawings\20139767B004-10.dwg



SECTION F - F'



SECTION G - G'

LEGEND

- EXISTING GROUND
- WATER TABLE
- TOP CRETACEOUS POTOMAC FORMATION
- TOP OF IGNEOUS / METAMORPHIC ROCK
- TOP OF TRIASSIC ROCK
- BOTTOM OF FILL
- SCREENED INTERVAL
- CLAY + SANDY CLAY + CLAYEY SILT
- SAND + GRAVEL
- SAND + SILT
- ORGANIC SILT + CLAY
- TRIASSIC CONGLOMERATE SILT STONE, SAND STONE, AND MUD STONE
- BEDROCK
- FILL MATERIAL
- ASH POND BERM FILL

SCALE 50 25 0 25 FEET

SCALE 250 0 250 500 FEET

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
CROSS SECTIONS F-F' AND G-G'

PROJECT NO.
20-139767

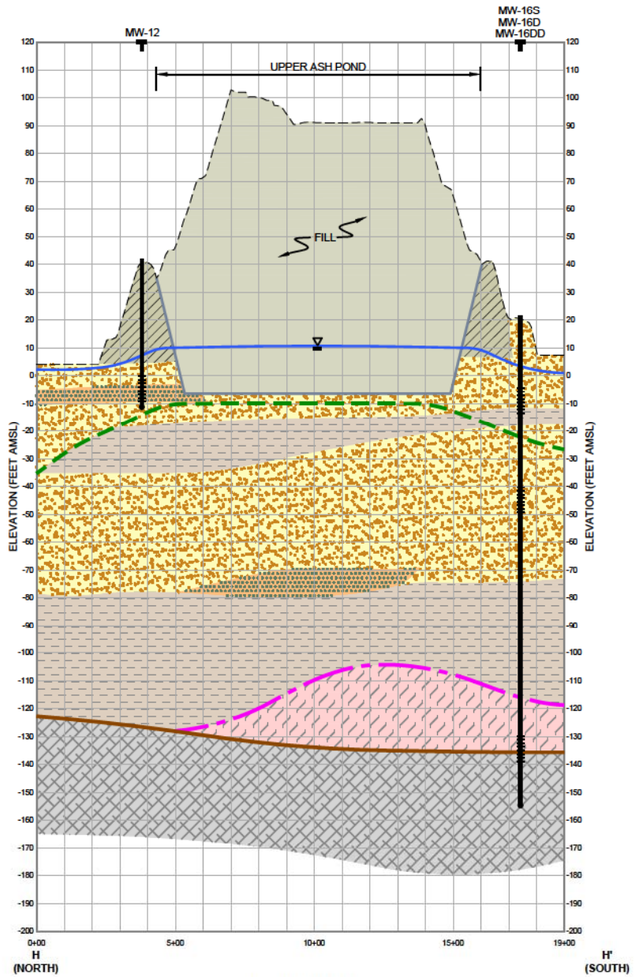
REV.
1

DRAWING
9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ARCH D

1 in 0

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\8 - 2020 GWMP UPDATES\Active Drawings\20139767B008-10.dwg



SECTION H - H'

LEGEND

- EXISTING GROUND
- WATER TABLE
- TOP CRETACEOUS POTOMAC FORMATION
- TOP OF IGNEOUS / METAMORPHIC ROCK
- TOP OF TRIASSIC ROCK
- BOTTOM OF FILL
- SCREENED INTERVAL
- CLAY + SANDY CLAY + CLAYEY SILT
- SAND + GRAVEL
- SAND + SILT
- ORGANIC SILT + CLAY
- TRIASSIC CONGLOMERATE SILT STONE, SAND STONE, AND MUD STONE
- BEDROCK
- FILL MATERIAL
- ASH POND BERM FILL

SCALE 50 25 0 25 FEET

SCALE 250 0 250 500 FEET

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

SEAL

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
CROSS SECTION H-H'

PROJECT NO.
20-139767

REV.
1

DRAWING
10

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ARCH D

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767B - 2020 GWMP UPDATE\Active Drawings\20139767B06-10.dwg

JAMES RIVER

MW-35S (7.22)
MW-20 (3.62)
MW-20I
BF-4
MW-28 (3.16)
MW-21 (4.99)
MW-21I
MW-B50 (3.23)
MW-22 (4.99)
MW-27 (1.92)
APPROX. LIMITS OF EX. RAIN COVER
MW-32 (3.84)
MW-26 (2.13)
$i\ gw_2 = 793'$
LOWER ASH POND
MW-23 (3.42)
$i\ gw_1 = 62'$
MW-29U (2.68)
MW-25 (2.37)
MW-33 (3.43)
MW-11I
MW-11 (5.77)
MW-12 (4.55)
MW-34 (2.52)
MW-B40A (11.99)
MW-24 (5.90)
MW-13 (1.41)
UPPER ASH POND
$i\ gw_4 = 255'$
MW-B31 (5.58)
$i\ gw_3 = 241'$
TIDAL JAMES RIVER OLD CHANNEL
MW-2 (3.13)
MW-2I
MW-15 (0.97)
MW-16 (2.62)
MW-B32 (1.90)
MW-17S (3.06)
MW-1 (2.96)
POND
OW-6S (6.88)
MW-8R (6.96)
MW-9R (6.39)
LINED STORMWATER POND
MW-5 (6.46)
MW-3 (6.13)

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- FACILITY BOUNDARY
- 250 — EXISTING TOPOGRAPHIC CONTOURS (2' INTERVALS)
- WETLANDS
- RPA — RESOURCE PROTECTION AREA BOUNDARY
- 10 — POTENTIOMETRIC SURFACE CONTOUR
- APPROXIMATE GROUNDWATER FLOW LINE
- i gw = 255' — GROUNDWATER FLOW PATH LENGHT (FEET)
- MW-2 — EXISTING GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION
- OW-6S — OBSERVATION WELL WITH STATIC WATER LEVEL ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- (3.13) — STATIC GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)

NOTES

1. EXISTING CONDITIONS COMPILED BY TUCK MAPPING SOLUTIONS USING PHOTOGRAMMETRIC METHODS, FROM AERIAL PHOTOGRAPHY DATED MAY 11, 2018.
2. APPROXIMATE LIMITS OF EXISTING RAIN COVER BASED ON DRAWING TITLED, "RECORD LAYOUT DRAWING PLAN," BY CHESAPEAKE CONTAINMENT SYSTEMS, INC., DATED NOVEMBER 6, 2019. EXISTING TOPOGRAPHY WITHIN LIMITS OF RAIN COVER BASED ON SURVEY PERFORMED BY McKIM & CREED, DATED NOVEMBER 6, 2019.
3. GROUNDWATER CONTOURS BASED ON LINEAR INTERPOLATION BETWEEN AND EXTRAPOLATION FROM KNOWN DATUM, TOPOGRAPHIC CONTOURS, AND KNOWN FIELD CONDITIONS. THEREFORE, GROUNDWATER CONTOURS MAY NOT REFLECT ACTUAL GROUNDWATER CONDITIONS.
4. GROUNDWATER CONTOUR LINES SHOW THE WATER TABLE SHAPE AND ELEVATION. THESE CONTOURS ARE INFERRED LINES FOLLOWING THE GROUNDWATER SURFACE AT A CONSTANT ELEVATION ABOVE SEA LEVEL. THE GROUNDWATER FLOW DIRECTION IS GENERALLY PERPENDICULAR TO THE GROUNDWATER SURFACE CONTOURS, SIMILAR TO THE RELATIONSHIP BETWEEN SURFACE WATER FLOW AND TOPOGRAPHIC CONTOURS.

600 0 600
SCALE FEET

YYYY-MM-DD 2020-06-15
DESIGNED PKT
PREPARED BPG
REVIEWED MGW
APPROVED MGW

CLIENT DOMINION ENERGY

CONSULTANT GOLDER

PROJECT CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE GROUNDWATER POTENTIOMETRIC SURFACE MAP
COLUMBIA AQUIFER
MAY 4, 2020

PROJECT NO. 20-139767

REV. 0

DRAWING 11

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\B - 2020 GWMP UPDATE\Active Drawings\20139767B11.dwg

JAMES RIVER

MW-35D (2.98)

MW-30U (3.10)*

MW-25 (2.37)

APPROX. LIMITS OF EX. RAIN COVER

LOWER ASH POND

MW-11I

MW-10 (6.09)

MW-7 (8.13)

MW-6 (5.59)

LINED STORMWATER POND

MW-4 (6.92)

UPPER ASH POND

t gw = 2,172'

MW-14 (2.23)

MW-16D (1.60)

OW-17I (2.72)

MW-1D (2.55)

MW-2I

TIDAL JAMES RIVER OLD CHANNEL

TIDAL JAMES RIVER OLD CHANNEL

POND

2.0 3.0 4.0 5.0 6.0 7.0 8.0

LEGEND

	APPROXIMATE PROPERTY BOUNDARY
	FACILITY BOUNDARY
250	EXISTING TOPOGRAPHIC CONTOURS (2' INTERVALS)
	WETLANDS
RPA	RESOURCE PROTECTION AREA BOUNDARY
5.0	POTENTIOMETRIC SURFACE CONTOUR
	APPROXIMATE GROUNDWATER FLOW LINE
t gw = 2,172'	GROUNDWATER FLOW PATH LENGHT (FEET)
MW-6	EXISTING GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION
OW-17I	OBSERVATION WELL WITH STATIC WATER LEVEL ELEVATION (FEET ABOVE MEAN SEA LEVEL)
(5.59)	STATIC GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)

NOTES

1. EXISTING CONDITIONS COMPILED BY TUCK MAPPING SOLUTIONS USING PHOTOGRAMMETRIC METHODS, FROM AERIAL PHOTOGRAPHY DATED MAY 11, 2018.
2. APPROXIMATE LIMITS OF EXISTING RAIN COVER BASED ON DRAWING TITLED, "RECORD LAYOUT DRAWING PLAN," BY CHESAPEAKE CONTAINMENT SYSTEMS, INC., DATED NOVEMBER 6, 2019. EXISTING TOPOGRAPHY WITHIN LIMITS OF RAIN COVER BASED ON SURVEY PERFORMED BY McKIM & CREED, DATED NOVEMBER 6, 2019.
3. GROUNDWATER CONTOURS BASED ON LINEAR INTERPOLATION BETWEEN AND EXTRAPOLATION FROM KNOWN DATUM, TOPOGRAPHIC CONTOURS, AND KNOWN FIELD CONDITIONS. THEREFORE, GROUNDWATER CONTOURS MAY NOT REFLECT ACTUAL GROUNDWATER CONDITIONS.
4. GROUNDWATER CONTOUR LINES SHOW THE WATER TABLE SHAPE AND ELEVATION. THESE CONTOURS ARE INFERRED LINES FOLLOWING THE GROUNDWATER SURFACE AT A CONSTANT ELEVATION ABOVE SEA LEVEL. THE GROUNDWATER FLOW DIRECTION IS GENERALLY PERPENDICULAR TO THE GROUNDWATER SURFACE CONTOURS, SIMILAR TO THE RELATIONSHIP BETWEEN SURFACE WATER FLOW AND TOPOGRAPHIC CONTOURS.
5. GROUNDWATER ELEVATION FOR MW-30U NOT USED FOR INTERPOLATION OF CONTOURS.

600 0 600
SCALE FEET

YYYY-MM-DD 2020-06-15
DESIGNED PKT
PREPARED BPG
REVIEWED MGW
APPROVED MGW

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
GROUNDWATER POTENTIOMETRIC SURFACE MAP
POTOMAC AQUIFER
MAY 4, 2020

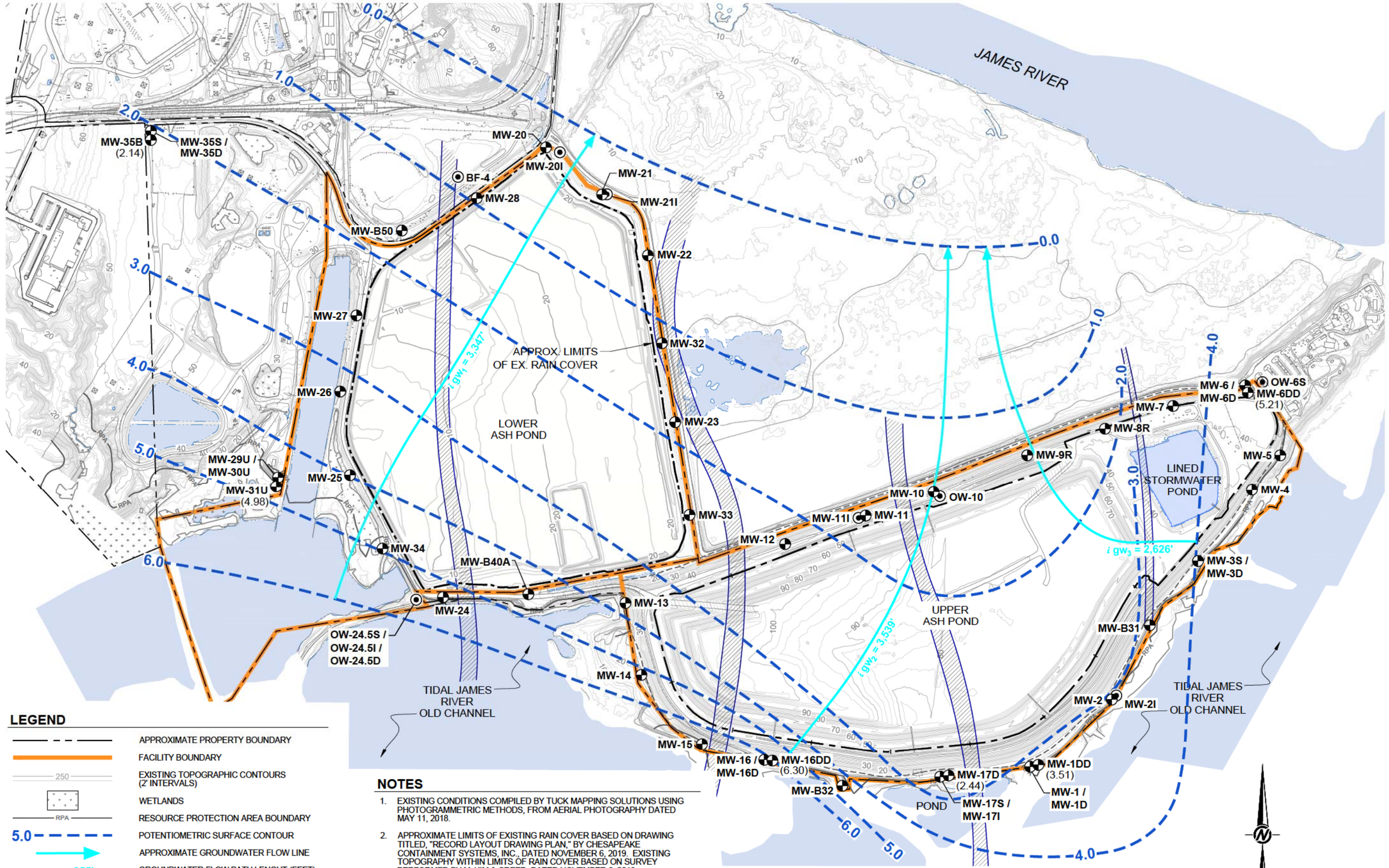
PROJECT NO.
20-139767

REV.
0

DRAWING
12

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\B - 2020 GWMP UPDATE\Active Drawings\20139767B12.dwg



LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- FACILITY BOUNDARY
- 250 — EXISTING TOPOGRAPHIC CONTOURS (2' INTERVALS)
- WETLANDS
- RPA — RESOURCE PROTECTION AREA BOUNDARY
- 5.0 — POTENTIOMETRIC SURFACE CONTOUR
- APPROXIMATE GROUNDWATER FLOW LINE
- *i* gw = 255' — GROUNDWATER FLOW PATH LENGHT (FEET)
- MW-6DD — EXISTING GROUNDWATER MONITORING WELL LOCATION AND IDENTIFICATION
- OW-6S — OBSERVATION WELL WITH STATIC WATER LEVEL ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- (5.21) — STATIC GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- SHEAR ZONE (LOCATION ESTIMATED ON BEST AVAILABLE DATA)

NOTES

1. EXISTING CONDITIONS COMPILED BY TUCK MAPPING SOLUTIONS USING PHOTOGRAMMETRIC METHODS, FROM AERIAL PHOTOGRAPHY DATED MAY 11, 2018.
2. APPROXIMATE LIMITS OF EXISTING RAIN COVER BASED ON DRAWING TITLED, "RECORD LAYOUT DRAWING PLAN," BY CHESAPEAKE CONTAINMENT SYSTEMS, INC., DATED NOVEMBER 6, 2019. EXISTING TOPOGRAPHY WITHIN LIMITS OF RAIN COVER BASED ON SURVEY PERFORMED BY McKIM & CREED, DATED NOVEMBER 6, 2019.
3. GROUNDWATER CONTOURS BASED ON LINEAR INTERPOLATION BETWEEN AND EXTRAPOLATION FROM KNOWN DATUM, TOPOGRAPHIC CONTOURS, AND KNOWN FIELD CONDITIONS. THEREFORE, GROUNDWATER CONTOURS MAY NOT REFLECT ACTUAL GROUNDWATER CONDITIONS.
4. GROUNDWATER CONTOUR LINES SHOW THE WATER TABLE SHAPE AND ELEVATION. THESE CONTOURS ARE INFERRED LINES FOLLOWING THE GROUNDWATER SURFACE AT A CONSTANT ELEVATION ABOVE SEA LEVEL. THE GROUNDWATER FLOW DIRECTION IS GENERALLY PERPENDICULAR TO THE GROUNDWATER SURFACE CONTOURS, SIMILAR TO THE RELATIONSHIP BETWEEN SURFACE WATER FLOW AND TOPOGRAPHIC CONTOURS.

CLIENT
DOMINION ENERGY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-06-15
DESIGNED	PKT
PREPARED	BPG
REVIEWED	MGW
APPROVED	MGW

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

TITLE
GROUNDWATER SURFACE MAP
BEDROCK AQUIFER
MAY 4, 2020

PROJECT NO.
20-139767

REV.
0

DRAWING
13

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Path: G:\Plan Production Data Files\Drawing Data Files\20-139767\B - 2020 GWMP UPDATE\Active Drawings\20139767B13.dwg

Appendix A

Monitoring Well Construction Logs Available Geophysical Logs

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

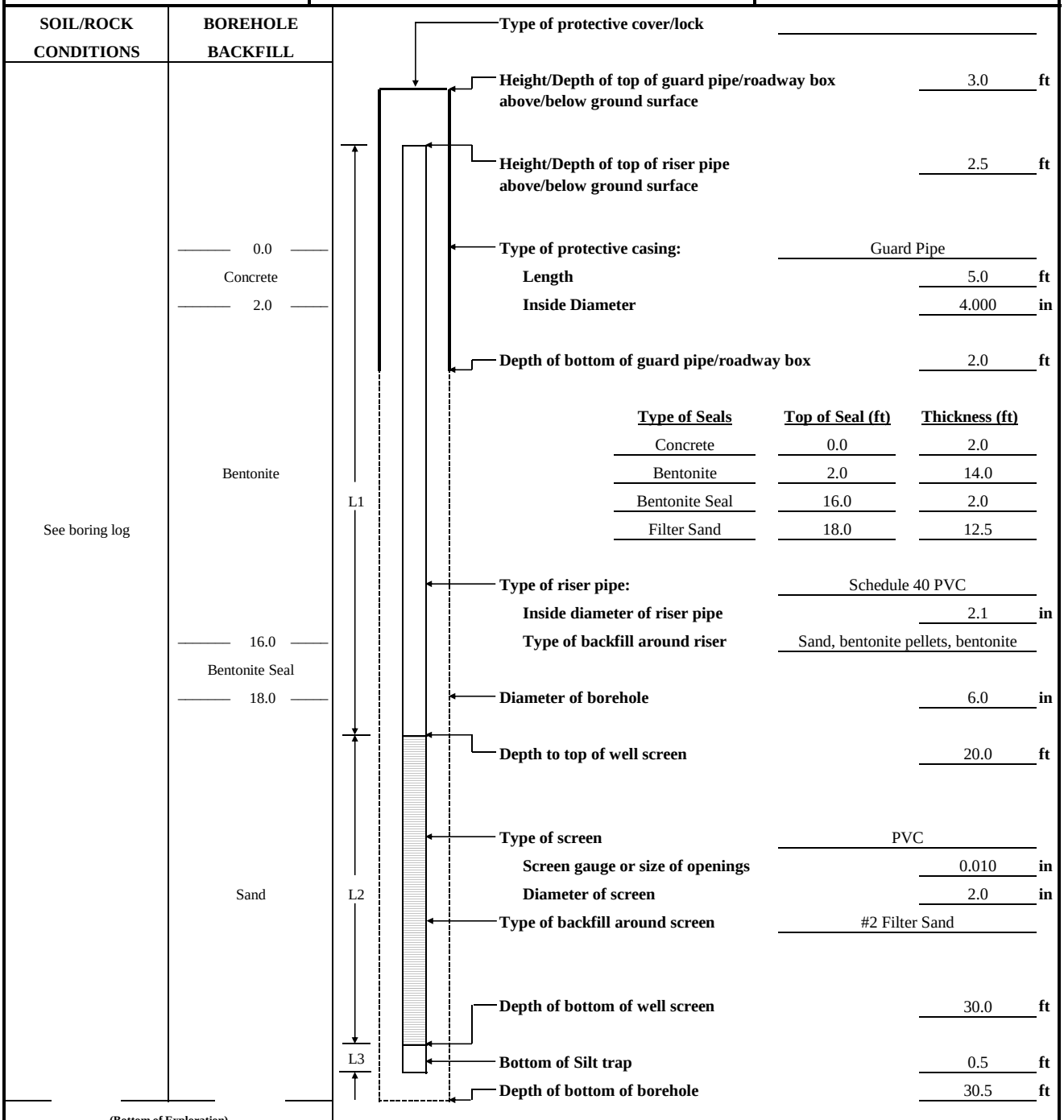
Well No. MW-1
Boring No. MW-1

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	J. Yonts
CONTRACTOR	Fishburne Drilling	**DATE INSTALLED**	6/20/2016
DRILLER	J. Raasio		

Ground El. - ft
El. Datum -

Location See plan

☑ **Guard Pipe**
☐ **Roadway Box**



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	14.0
Bentonite Seal	16.0	2.0
Filter Sand	18.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 20.0 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 30.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 30.5 ft

20 ft	+	10 ft	+	0.5 ft	=	30.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

Form 2007

TEST BORING REPORT

Boring No. MW-1

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Fishburne Drilling Inc.

File No. 42735-001
Sheet No. 1 of 3
Start June 21, 2016
Finish June 21, 2016
Driller J. Raasio
H&A Rep. J. Yonts
Elevation 9.7
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel
Type	HSA	S	-
Inside Diameter (in.)	2.5	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures:
Rig Make & Model: Track mounted CME 55
Bit Type: Cutting Head/Roller Bit
Drill Mud: Bentonite
Casing: HSA Spun to 80.0 ft
Hoist/Hammer: Automatic Hammer
PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	7 8 8 20	S1 18	0.0 2.0	9.5 0.3 8.7 1.0	GP	-TOPSOIL- White and black GRAVEL (GP), mps 1.0 in., no odor, dry										
					SM	Medium dense brown and tan silty SAND (SM), trace rounded gravel, mps 1.0 in., no odor, moist	5	5	--	10	50	30				
	4 6 9 7	S2 20	3.0 5.0		SM	Similar to S1, below 1.0 ft, except moist, less gravel	--	5	--	10	55	30				
5																
	1 1 1 2	S3 17	8.0 10.0		ML/ SM	Loose sandy SILT (ML) grading to silty SAND (SM), trace well rounded gravel, mps 1.1 in., no odor, wet	5	5	--	10	40	40				
10				-3.3												
	3 9 18 15	S4 24	13.0 15.0	13.0	SM	Medium dense brown to red-brown silty SAND with gravel (SM), subrounded gravel, mps 1.1 in., no odor, wet	10	20	10	5	25	30				
15				-8.3		-FILL-										
	18 27 52 50/3"	S5 24	18.0 19.8	18.0	SM	Very dense orange, tan, and white silty SAND with gravel (SM), mps 1.0 in., no odor, wet, gravel subrounded to rounded	5	10	10	25	20	30				
20						Note: Augering to 23.0 ft indicates cobbles/gravel present.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
Refer to groundwater level table					

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 80.0
Rock Cored (ft) -
Samples 17S

Boring No. MW-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-1
File No. 42735-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	50/1"	S6 2	23.0 23.1	-13.3 23.0	SW-SM	Very dense well-graded SAND with silt (SW-SM), mps 0.8 in., wet	5	5	20	30	30	10				
25						Note: Augering to 28.0 ft indicates coarse material.											
	50/2"	S7 0	28.0 28.2			Very dense, no recovery										
30						Note: Augering indicates cobbles/gravel, coarse material to approximately 31 ft. Change in soil below 31.0 ft. Approximately 2 ft running sands in augers.											
	5 22 60 50/3"	S8 24	33.0 34.8		SW-SM	Very dense well-graded SAND with silt and gravel (SW-SM) grading to to brown, tan, and white silty SAND with gravel (SM), mps 1.2 in., wet, no odor	10	20	20	30	10	10				
35						Note: Augering to 38.0 ft indicates coarse material (gravel/cobbles).										
				-28.3												
	12 50/3"	S9 8	38.0 38.8	38.0	SP	Very dense brown, orange, and white poorly-graded SAND (SP), wet, no odor, rounded sand	--	--	15	60	15	10				
40																
	21 50/3"	S10 10	43.0 43.8		SM	Very dense gray-green silty SAND (SM), no odor, wet	--	--	20	30	20	30				
45																
	14 42 50/2"	S11 13	48.0 49.2		SM	Very dense gray-green silty SAND (SM), wet	--	--	30	30	15	15				
50						Note: Augers filled with approximately 6.0 to 8.0 ft of running sand and gravel after drilling to 53.0 ft. Washed out to attempt to remove material. Filled again with approximately 7.0 to 9.0 ft of running sand and gravel. Started using drilling mud below 53.0 ft. Switched to roller bit.											
				-43.3												
	8 13 20 21	S12 24	53.0 55.0	53.0	SP	Dense gray poorly-graded SAND (SP), no odor, wet, rounded sand and gravel, mostly quartz, trace fines	--	15	30	30	20	5				
55																

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-1

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-1
File No. 42735-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	50/2"	S13 0	58.0 58.2			No recovery, possibly on coarse gravel										
60																
	50/1"	S14 1	63.0 63.1			Recovered one piece of gravel approximately 1 in., well rounded										
65				-58.3												
	19 18 20 27	S15 16	68.0 70.0	68.0	SW-SM	Dense gray and white well-graded SAND with silt and gravel (SW-SM), no odor, wet, well rounded gravel	15	15	20	20	15	15				
				-59.3 69.0	CL	Hard gray to dark gray lean CLAY (CL), moist	--	--	--	--	10	90				
				-60.0 69.7	SW-SM	Dense gray and white well-graded SAND with silt and gravel (SW-SM), no odor, wet	10	20	20	20	15	15				
70																
				-63.3												
	34 48 26 13	S16 13	73.0 75.0	73.0	CL	Hard dark gray lean CLAY (CL), no odor, moist	--	--	--	--	5	95				
75																
				-68.3												
	12 12 20 27	S17 15	78.0 80.0	78.0	SP	Medium dense gray and white poorly-graded SAND (SP), no odor, wet	--	5	10	60	20	5				
80				-70.3 80.0		BOTTOM OF EXPLORATION 80.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-1

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

RECORD OF BOREHOLE MW-1D

SHEET 1 of 3

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 55.30 ft
DRILL METHOD: 4.25-inch HSA

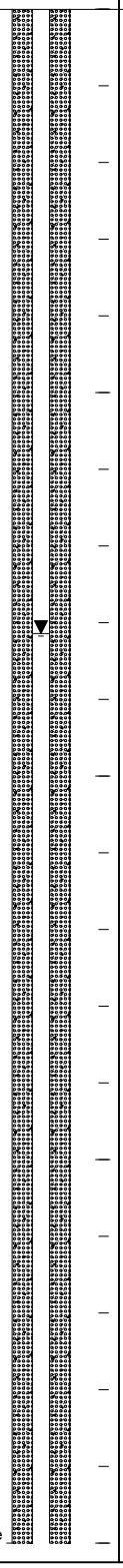
DRILL RIG: CME-55
DATE STARTED: 8/22/16
DATE COMPLETED: 8/22/16

NORTHING: 3,659,449.96
EASTING: 11,811,809.97
GS ELEVATION: 9.80 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	10	0.00 - 13.00 Sand, medium to fine-grained sand, trace silt, brown, light brown, no odor, dry, compact	SP								
							1	2 IN SS	6 -11 -10 -9	21	1.60 / 2.00
5	5										
							2	2 IN SS	1 -2 -1 -2	3	0.10 / 2.00
10	0				-3.20 / 13.00						
		13.00 - 19.00 Sand, fine to coarse-grained sand, trace silt, orange brown to brown, no odor, saturated, loose.	SW				3	2 IN SS	10 -3 -3 -3	6	0.90 / 2.00
15	-5										
					-9.20 / 19.00		4	2 IN SS	12 -25 -43 -47	>50	1.60 / 2.00
20	-10	19.00 - 28.00 Clayey sand, fine to medium-grained sand, trace coarse sand, gray to tan, no odor, wet, very dense.	SC								

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0 TO 45.3'
Material: PVC
Diameter: 2 inches
Joint Type: threaded

WELL COMPLETION
Pad: 3.0' by 3.0'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.5' to 40.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 40.0' to 43.0'
Type: Bentonite Chip

FILTER PACK
Interval: 43.0' TO 55.3'
Type: No. 2 DSI

WELL SCREEN
Interval: 45.3' TO 55.3'
Material: PVC
Diameter: 2 inches
Slot Size: 0.010-inch
End Cap: PVC

Well Notes:
Floodplain housing installed

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-1D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 55.30 ft
DRILL METHOD: 4.25-inch HSA

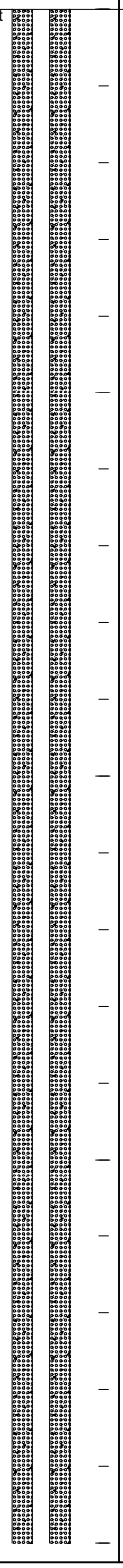
DRILL RIG: CME-55
DATE STARTED: 8/22/16
DATE COMPLETED: 8/22/16

NORTHING: 3,659,449.96
EASTING: 11,811,809.97
GS ELEVATION: 9.80 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20		19.00 - 28.00 Clayey sand, fine to medium-grained sand, trace coarse sand, gray to tan, no odor, wet, very dense. *(Continued)*	SC								
							5	2 IN SS	9 -14 -23 -28	37	0.90 / 2.00
25	-15				-18.20						
		28.00 - 33.00 Sand, fine to coarse-grained sand, trace fine to coarse gravel, some clay, gray to gray brown, no odor, saturated, very dense.	SP		28.00		6	2 IN SS	14 -50	50	0.50 / 0.75
30	-20										
					-23.20						
		33.00 - 38.00 Sand, fine to coarse-grained sand, trace fine gravel, trace clay, gray to gray brown, no odor, saturated, compact.			33.00		7	2 IN SS	7 -3 -22 -40	25	0.80 / 2.00
35	-25		SP								
					-28.20						
		38.00 - 43.00 Clayey sand, fine to medium-grained sand, some silt, trace fine gravel, gray brown to tan, no odor, moist, very dense.	SC		38.00		8	2 IN SS	22 -33 -50	>50	1.20 / 1.50
40	-30										

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0 TO 45.3'
Material: PVC
Diameter: 2 inches
Joint Type: threaded

WELL COMPLETION
Pad: 3.0' by 3.0'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.5' to 40.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 40.0' to 43.0'
Type: Bentonite Chip

FILTER PACK
Interval: 43.0' TO 55.3'
Type: No. 2 DSI

WELL SCREEN
Interval: 45.3' TO 55.3'
Material: PVC
Diameter: 2 inches
Slot Size: 0.010-inch
End Cap: PVC

Well Notes:
Floodplain housing installed

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-1D

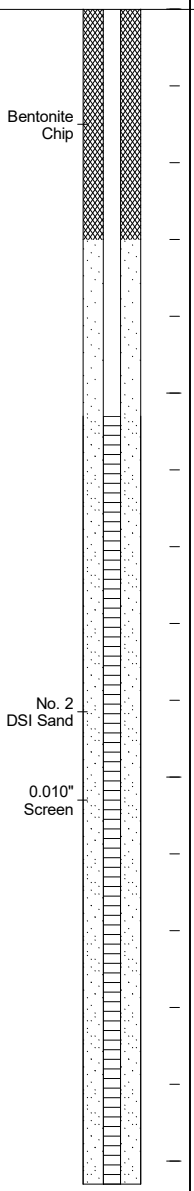
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 55.30 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 8/22/16
DATE COMPLETED: 8/22/16

NORTHING: 3,659,449.96
EASTING: 11,811,809.97
GS ELEVATION: 9.80 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		38.00 - 43.00 Clayey sand, fine to medium-grained sand, some silt, trace fine gravel, gray brown to tan, no odor, moist, very dense. *(Continued)*	SC		-33.20						
		43.00 - 53.00 Sand, fine to medium-grained sand, some clay and silt, gray, no odor, moist to wet, very dense.			43.00		9	2 IN SS	7 -26 -49 -50	>50	1.80 / 1.75
45	-35										
			SP				10	2 IN SS	13 -30 -46 -40	>50	1.60 / 2.00
50	-40										
					-43.20						
		53.00 - 55.00 Sand, fine to coarse-grained sand, some silt and clay, gray, no odor, wet, compact.	SP		53.00		11	2 IN SS	5 -7 -20 -37	27	0.70 / 2.00
55	-45				-45.20						
		Boring completed at 55.30 ft			55.00						
60	-50										

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0 TO 45.3'
Material: PVC
Diameter: 2 inches
Joint Type: threaded

WELL COMPLETION
Pad: 3.0' by 3.0'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.5' to 40.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 40.0' to 43.0'
Type: Bentonite Chip

FILTER PACK
Interval: 43.0' TO 55.3'
Type: No. 2 DSI

WELL SCREEN
Interval: 45.3' TO 55.3'
Material: PVC
Diameter: 2 inches
Slot Size: 0.010-inch
End Cap: PVC

Well Notes:
Floodplain housing installed

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-1DD

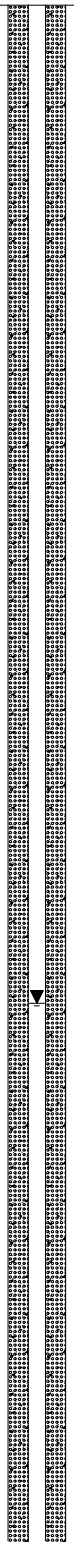
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	5	0.00 - 13.00 Sand, medium to fine-grained sand, trace silt, brown, light brown, no odor, dry, compact	SP							
						1	2 IN SS	6-11-10-9	21	1.60 / 2.00
5	0					2	2 IN SS	1-2-1-2	3	0.10 / 2.00
10					-3.54					
	-5	13.00 - 19.00 Sand, fine to coarse-grained sand, trace silt, orange brown to brown, no odor, saturated, loose.	SW		13.00	3	2 IN SS	10-3-3-3	6	0.90 / 2.00
15					-9.54	4	2 IN SS	12-25-43-47	>50	1.60 / 2.00
	-10	19.00 - 28.00 Clayey sand, fine to medium-grained sand, trace coarse sand, gray to tan, no odor, wet, very dense.	SC		19.00					
20		Log continued on next page								



WELL CASING
Interval: 0 to 171'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0 to 164'
Type: bentonite grout

FILTER PACK SEAL
Interval: 0 to 164'
Type: Bentonite grout

FILTER PACK
Interval: 164' to 181'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 171' to 181'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 6 5/8 mud rotary roller bit
Notes:

WELL NOTES:
Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes.

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		19.00 - 28.00 Clayey sand, fine to medium-grained sand, trace coarse sand, gray to tan, no odor, wet, very dense. *(Continued)*	SC		-18.54	5	2 IN SS	9-14-23-28	37	0.90 / 2.00		
25	-15											
30	-20	28.00 - 33.00 Sand, fine to coarse-grained sand, trace fine to coarse gravel, some clay, gray to gray brown, no odor, saturated, very dense.	SP		-23.54	6	2 IN SS	14-50	50	0.50 / 0.75		**WELL NOTES:** Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes. **SAMPLE NOTES:** Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.
35	-25	33.00 - 38.00 Sand, fine to coarse-grained sand, trace fine gravel, trace clay, gray to gray brown, no odor, saturated, compact.	SP		-28.54	7	2 IN SS	7-3-22-40	25	0.80 / 2.00		
40	-30	38.00 - 43.00 Clayey sand, fine to medium-grained sand, some silt, trace fine gravel, gray brown to tan, no odor, moist, very dense. Log continued on next page	SC			8	2 IN SS	22-33-50	>50	1.20 / 1.50		

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40		38.00 - 43.00 Clayey sand, fine to medium-grained sand, some silt, trace fine gravel, gray brown to tan, no odor, moist, very dense. *(Continued)*	SC		-33.54							
		43.00 - 53.00 Sand, fine to medium-grained sand, some clay and silt, gray, no odor, moist to wet, very dense.	SP		43.00	9	2 IN SS	7-26-49-50	>50	1.80 / 1.75		
	-35											
45												
						10	2 IN SS	13-30-46-40	>50	1.60 / 2.00		**WELL NOTES:** Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes.
	-40											
50												**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.
					-43.54							
		53.00 - 55.00 Sand, fine to coarse-grained sand, some silt and clay, gray, no odor, wet, compact.	SP		53.00	11	2 IN SS	5-7-20-37	27	0.70 / 2.00		
	-45				-45.54							
55		55.00 - 72.00 Sand and gravel.	SP-GW		55.00							
	-50											
60		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
60		55.00 - 72.00 Sand and gravel. *(Continued)*	SP-GW			12	CUT'G			10.00
	-55									
65										
	-60									
70					-62.54					
		72.00 - 73.00 Sand and gravel with some gray clay.	SP-GW		72.00 -63.54					
		73.00 - 75.00 Sand and gravel.	SP-GW		73.00 -65.54					
	-65									
75		75.00 - 83.00 Clay, some sand and gravel, dark gray clay, stringers of clayer sand, white, fine to medium-grained sand.	CH		75.00	13	CUT'G			8.00
	-70									
80		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES: Bentonite Grout

WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes.

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
80		75.00 - 83.00 Clay, some sand and gravel, dark gray clay, stringers of clayer sand, white, fine to medium-grained sand. *(Continued)*	CH		-73.54							
		83.00 - 85.00 Clay, some sand and gravel, dark gray clay, stringers of clayer sand, white, fine to medium-grained sand.	CH		83.00 -75.54	14	CUT'G			8.00		
85	-75	85.00 - 103.00 Sandy Clay, white to light gray, fine to coarse-grained sand with rounded gravel.			85.00							
90	-80		CH									
	-85					15	CUT'G			12.00		
95												
	-90											
100		Log continued on next page										

WELL NOTES:
Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes.

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
100		85.00 - 103.00 Sandy Clay, white to light gray, fine to coarse-grained sand with rounded gravel. *(Continued)*	CH		-93.54	16	CUT'G			6.00		
	-95	103.00 - 110.00 Clay, light green, large clay chips.			103.00							
105			CL									
	-100				-100.54	17	CUT'G			6.00		**WELL NOTES:** Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes. **SAMPLE NOTES:** Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.
110		110.00 - 128.00 Clay, reddish-brown, large clay chips.			110.00							
	-105											
115			CL			18	CUT'G			12.00		
	-110											
120		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
120		110.00 - 128.00 Clay, reddish-brown, large clay chips. *(Continued)*	CL			18	CUT'G			12.00		
	-115											
125					-118.54	19	CUT'G			8.00		
		128.00 - 132.00 Clay, bluish-green and reddish-brown, large clay chips.	CL		128.00							
	-120											
130					-122.54							
		132.00 - 138.00 Clay, bluish-green and reddish-brown with lenses of light green clayey sand.	CL		132.00	20	CUT'G			10.00		
	-125											
135					-128.54							
		138.00 - 156.00 Clay, dark gray, large clay chips.	CL		138.00							
	-130											
140		Log continued on next page										

WELL NOTES:
Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes.

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
140		138.00 - 156.00 Clay, dark gray, large clay chips. *(Continued)*				20	CUT'G			10.00		
	-135					21	CUT'G			7.00		
145			CL									
	-140					22	CUT'G			9.00		
150												
	-145											
155					-146.54	23	CUT'G			8.00		
		156.00 - 166.00 Sandy clay, light green, large clay chips.	CH		156.00							
	-150											
160		Log continued on next page										

WELL NOTES:
Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes.

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
160		156.00 - 166.00 Sandy clay, light green, large clay chips. *(Continued)*	CH		-156.54	23	CUT'G			8.00	Bentonite Grout	
	-155											
165												
		166.00 - 177.50 Clayey sand, light green, clay chips small to absent.	SC		166.00	24	CUT'G			8.00	No. 2 DSI Sand	**WELL NOTES:** Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes. **SAMPLE NOTES:** Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.
	-160											
170												
	-165											
175					-168.04						0.010" Screen	
		177.50 - 181.00 Granite, sand cuttings.	Rock		177.50							
	-170											
180		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-1DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 181.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/23/16
DATE COMPLETED: 9/26/16

NORTHING: 3,659,451.76
EASTING: 11,811,833.19
GS ELEVATION: 9.46 ft
TOC ELEVATION: 11.10 ft

DEPTH W.L.: 13.00 ft
ELEVATION W.L.: -3.54 ft
DATE W.L.: 9/26/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
180		177.50 - 181.00 Granite, sand cuttings. *(Continued)*	Rock		-171.54							
		Boring completed at 181.00 ft										
	-175											
185												
	-180											
190												
	-185											
195												
	-190											
200												

WELL NOTES:
Floodplain Cover installed. Sample descriptions to depth of 55 feet obtained from adjoining boreholes.

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-1D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. MW-2

Boring No. MW-2

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	J. Yonts
CONTRACTOR	Fishburne Drilling	**DATE INSTALLED**	6/20/2016
DRILLER	J. Raasio		

Ground El. - ft
El. Datum -

Location See plan

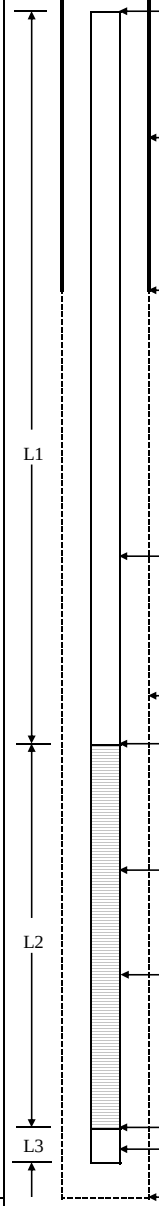
☑ **Guard Pipe**
☐ **Roadway Box**

SOIL/ROCK CONDITIONS

See boring log

BOREHOLE BACKFILL

0.0
Concrete
2.0
Bentonite
21.0
Bentonite Seal
23.0
Sand



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	19.0
Bentonite Seal	21.0	2.0
Filter Sand	23.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 25.00 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 35.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 35.5 ft

(Bottom of Exploration)
(Numbers refer to depth from ground surface in feet)

(Not to Scale)

25 ft	+	10 ft	+	0.5 ft	=	35.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-2

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Fishburne Drilling Inc.

File No. 42735-001
Sheet No. 1 of 3
Start June 20, 2016
Finish June 20, 2016
Driller J. Raasio
H&A Rep. J. Yonts
Elevation 8.9
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: Track mounted CME 55
Inside Diameter (in.)	4.5	1 3/8	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: HSA Spun to 68.0 ft
				Hoist/Hammer: Winch Automatic Hammer
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	7 9 7 9	S1 20	0.0 2.0	8.7 0.3 8.4 0.5	SP ML	-TOPSOIL/GRASS- GRAVEL, mps 1.0 in. no odor Medium dense brown sandy SILT (ML), no odor, moist	--	--	--	10	30	60				
	2 4 3 2	S2 11	3.0 5.0		ML	Similar to S1, except loose, sandier, moist	--	--	--	--	50	50				
5				0.9		-FILL-										
	2/24"	S3 18	8.0 10.0	8.0	SM	Very loose gray-black silty SAND (SM), mps 0.2 in., no odor, wet, trace rounded gravel	--	5	--	20	55	20				
10				-4.1												
	21 13 52 50/1"	S4 19	13.0 15.0	13.0	SM	Very dense brown and white silty SAND with gravel (SM), mps 0.5 in., no odor, wet, rounded gravel	5	10	10	30	20	25				
15																
	4 21 31 40	S5 24	18.0 20.0		SM	Similar to S4, except mps 0.5 in., wet, rounded gravel	5	10	10	30	20	25				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
Refer to groundwater level table					

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	68.0
Rock Cored (ft)	-
Samples	13S

Boring No. MW-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-2
File No. 42735-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
	8 49 50/3"	S6 15	23.0 24.3	-15.1 24.0	SM	Very dense brown to white silty SAND with gravel (SM), mps 0.5 in., no odor, wet	--	5	10	10	40	35				
					SM	Very dense brown and white silty SAND with gravel (SM), mps 0.5 in., no odor, wet, few angular gray gravel pieces (limestone)	20	10	5	5	30	30				
25																
	18 29 29 25	S7 18	28.0 30.0		SM	Dense brown, white, and tan silty SAND with gravel (SM), mps 1.0 in, no odor, wet, rounded gravel	10	15	20	15	20	20				
30						Note: Running sands encountered after augering to 28.0 ft.										
	7 14 28 36	S8 17	33.0 35.0		SM	Dense white, gray, and tan silty SAND with gravel (SM), mps 0.75 in., moist, slighty more plastic than S7, well rounded gravel	10	10	10	20	20	30				
35																
	5 9 12 14	S9 24	38.0 40.0	-29.1 38.0	CL	Very stiff gray to dark gray lean CLAY (CL), moist, trace fine sand	--	--	--	--	10	90				
40																
	44 50/2"	S10 8	43.0 43.7	-34.1 43.0	SW-SM	Very dense tan to white well-graded SAND with silt, mps 0.5 in., no odor, moist	5	10	25	20	30	10				
45																
	5 50/3"	S11 24	48.0 48.8		SW-SM	Similar to S10	5	10	20	25	30	10				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-2

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. MW-2

Boring No. MW-2

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	J. Yonts
CONTRACTOR	Fishburne Drilling	**DATE INSTALLED**	6/20/2016
DRILLER	J. Raasio		

Ground El. - ft
El. Datum -

Location See plan

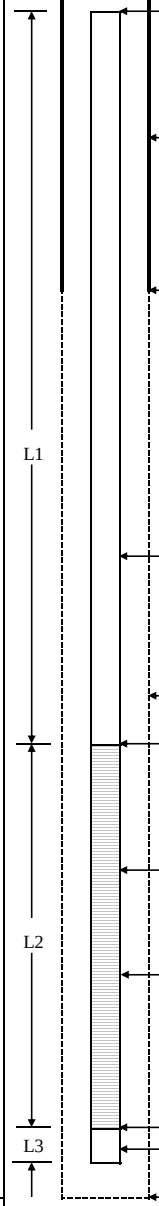
☑ **Guard Pipe**
☐ **Roadway Box**

SOIL/ROCK CONDITIONS

See boring log

BOREHOLE BACKFILL

0.0
Concrete
2.0
Bentonite
21.0
Bentonite Seal
23.0
Sand



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	19.0
Bentonite Seal	21.0	2.0
Filter Sand	23.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 25.00 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 35.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 35.5 ft

(Bottom of Exploration)
(Numbers refer to depth from ground surface in feet)

(Not to Scale)

25 ft	+	10 ft	+	0.5 ft	=	35.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-2

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Fishburne Drilling Inc.

File No. 42735-001
Sheet No. 1 of 3
Start June 20, 2016
Finish June 20, 2016
Driller J. Raasio
H&A Rep. J. Yonts
Elevation 8.9
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: Track mounted CME 55
Inside Diameter (in.)	4.5	1 3/8	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: HSA Spun to 68.0 ft
				Hoist/Hammer: Winch Automatic Hammer
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	7 9 7 9	S1 20	0.0 2.0	8.7 0.3 8.4 0.5	SP ML	-TOPSOIL/GRASS- GRAVEL, mps 1.0 in. no odor Medium dense brown sandy SILT (ML), no odor, moist	--	--	--	10	30	60				
	2 4 3 2	S2 11	3.0 5.0		ML	Similar to S1, except loose, sandier, moist	--	--	--	--	50	50				
5				0.9		-FILL-										
	2/24"	S3 18	8.0 10.0	8.0	SM	Very loose gray-black silty SAND (SM), mps 0.2 in., no odor, wet, trace rounded gravel	--	5	--	20	55	20				
10				-4.1												
	21 13 52 50/1"	S4 19	13.0 15.0	13.0	SM	Very dense brown and white silty SAND with gravel (SM), mps 0.5 in., no odor, wet, rounded gravel	5	10	10	30	20	25				
15																
	4 21 31 40	S5 24	18.0 20.0		SM	Similar to S4, except mps 0.5 in., wet, rounded gravel	5	10	10	30	20	25				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
Refer to groundwater level table					

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	68.0
Rock Cored (ft)	-
Samples	13S

Boring No. MW-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-2
File No. 42735-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																
	8 49 50/3"	S6 15	23.0 24.3	-15.1 24.0	SM	Very dense brown to white silty SAND with gravel (SM), mps 0.5 in., no odor, wet	--	5	10	10	40	35				
					SM	Very dense brown and white silty SAND with gravel (SM), mps 0.5 in., no odor, wet, few angular gray gravel pieces (limestone)	20	10	5	5	30	30				
25																
	18 29 29 25	S7 18	28.0 30.0		SM	Dense brown, white, and tan silty SAND with gravel (SM), mps 1.0 in, no odor, wet, rounded gravel	10	15	20	15	20	20				
30						Note: Running sands encountered after augering to 28.0 ft.										
	7 14 28 36	S8 17	33.0 35.0		SM	Dense white, gray, and tan silty SAND with gravel (SM), mps 0.75 in., moist, slighty more plastic than S7, well rounded gravel	10	10	10	20	20	30				
35																
	5 9 12 14	S9 24	38.0 40.0	-29.1 38.0	CL	Very stiff gray to dark gray lean CLAY (CL), moist, trace fine sand	--	--	--	--	10	90				
40																
	44 50/2"	S10 8	43.0 43.7	-34.1 43.0	SW-SM	Very dense tan to white well-graded SAND with silt, mps 0.5 in., no odor, moist	5	10	25	20	30	10				
45																
	5 50/3"	S11 24	48.0 48.8		SW-SM	Similar to S10	5	10	20	25	30	10				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-2

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-2
File No. 42735-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50																
	5 18 29 28	S12 12	53.0 55.0		SW-SM	Dense gray to white well-graded SAND with silt and gravel (SW-SM), mps 1.5 in., no odor, moist, well rounded gravel, coarsening with depth	15	20	20	20	15	10				
55																
	10 16 23 24	S13 24	58.0 60.0	-50.1	SW-SM	Similar to S12, except dark gray	10	20	25	25	10	10				
				59.0 -50.6 59.5	CL	Dark gray lean CLAY lense from 59.0 to 59.5 ft, less coarse gravel, wet, well rounded gravel										
60						Note: Did not obtain split spoon sample at 63.0 and 68.0 ft due to running sands. Borehole terminated at 68.0 ft.										
65				-59.1 68.0		BOTTOM OF EXPLORATION 68.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-2

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

RECORD OF BOREHOLE MW-3

SHEET 1 of 2

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

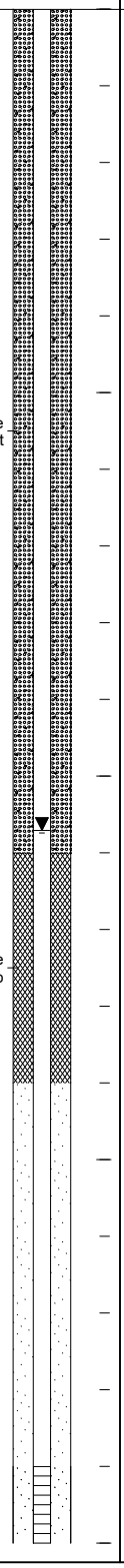
DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 8/18/16
DATE COMPLETED: 8/18/16

NORTHING: 3,660,738.85
EASTING: 11,812,882.62
GS ELEVATION: 15.27 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	15	0.00 - 14.00 Sand, fine to coarse-grained, trace silt and clay, brown, no odor, dry, compact.	SP				1	MACRO CORE	N/A		3.00 / 5.00
5	10						2	MACRO CORE	N/A		3.00 / 5.00
10	5						3	MACRO CORE	N/A		3.80 / 5.00
					1.27 / 14.00						
15	0	14.00 - 18.00 Sand, fine to coarse-grained, trace rounded gravel, trace silt and clay, brown, no odor, wet, dense.	SP				4	MACRO CORE	N/A		3.50 / 5.00
					-2.73 / 18.00						
20		18.00 - 30.00 Sand and gravel, fine to coarse-grained, fine gravel some silt and clay, no odor, brown to orange brown, saturated, very dense.	SP-GW								

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0' to 11'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.5' to 11'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 11' to 14'
Type: Bentonite Chips

FILTER PACK
Interval: 14' to 29'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 19' to 29'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Well Notes:
Floodplain well head

Sample Notes:
Direct push and split spoon sampling

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-3

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 8/18/16
DATE COMPLETED: 8/18/16

NORTHING: 3,660,738.85
EASTING: 11,812,882.62
GS ELEVATION: 15.27 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
20	-5	18.00 - 30.00 Sand and gravel, fine to coarse-grained, fine gravel some silt and clay, no odor, brown to orange brown, saturated, very dense. *(Continued)*					5	2 IN SS	4 -18 -47 -37	>50	0.90 / 2.00	No. 2 DSI Sand	**WELL CASING** Interval: 0' to 11' Material: PVC Diameter: 2" Joint Type: threaded **WELL COMPLETION** Pad: 3' by 3' concrete Protective Casing: 6" PVC **ANNULUS SEAL** Interval: 0.5' to 11' Type: Bentonite grout **FILTER PACK SEAL** Interval: 11' to 14' Type: Bentonite Chips **FILTER PACK** Interval: 14' to 29' Type: No. 2 DSI Sand **WELL SCREEN** Interval: 19' to 29' Material: PVC Diameter: 2" Slot Size: 0.010" End Cap: 2"
25	-10		SP-GW									0.010" Screen	
30	-15				-14.73		6	2 IN SS	16 -24 -23 -24	47	1.20 / 2.00	No. 2 DSI Sand	**Well Notes:** Floodplain well head **Sample Notes:** Direct push and split spoon sampling
		Boring completed at 30.00 ft											
35	-20												
40													

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-3D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 90.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/14/16
DATE COMPLETED: 8/17/16

NORTHING: 3,660,744.77
EASTING: 11,812,886.53
GS ELEVATION: 15.12 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	15	0.00 - 14.00 Sand, fine to coarse-grained, trace silt and clay, brown, no odor, dry, compact.	SP				1	MACRO CORE	N/A		3.00 / 5.00	
5	10						2	MACRO CORE	N/A		3.00 / 5.00	
10	5						3	MACRO CORE	N/A		3.80 / 5.00	
					1.12							
		14.00 - 18.00 Sand, fine to coarse-grained, trace rounded gravel, trace silt and clay, brown, no odor, wet, dense.			14.00							
15	0		SP				4	MACRO CORE	N/A		3.50 / 5.00	
					-2.88							
		18.00 - 33.00 Sand and gravel, fine to coarse-grained sand, fine gravel some silt and clay, no odor, brown to orange brown, saturated, very dense.	SP-GW		18.00							
20		Log continued on next page										

WELL CASING
Interval: 0' to 79.5'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 72'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 72.0' to 75.0'
Type: Bentonite Chips

FILTER PACK
Interval: 75.0' to 89.5'
Type: DSI No. 2 Sand

WELL SCREEN
Interval: 79.5' to 89.5'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Well Notes:
Floodplain wellhead

Sample Notes:
Direct push and Split Spoon Sampling

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-3D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 90.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/14/16
DATE COMPLETED: 8/17/16

NORTHING: 3,660,744.77
EASTING: 11,812,886.53
GS ELEVATION: 15.12 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
20	-5	18.00 - 33.00 Sand and gravel, fine to coarse-grained sand, fine gravel some silt and clay, no odor, brown to orange brown, saturated, very dense. *(Continued)*	SP-GW				5	2 IN SS	4 -18 -47 -37	>50	0.90 / 2.00	
25	-10						6	2 IN SS	16 -24 -23 -24	47	1.20 / 2.00	
30	-15				-17.88		7	2 IN SS	21 -20 -20 -33	40	1.00 / 2.00	
		33.00 - 38.00 Silty sand, fine to medium-grained sand, trace coarse sand and fine gravel, some clay, no odor, gray, wet.	SM		33.00							Bentonite Grout
35	-20				-22.88		8	2 IN SS	6 -10 -12 -13	22	0.90 / 2.00	
		38.00 - 43.00 Silty clay, dark gray, trace fine gravel, no odor, moist, firm.	CL		38.00							
40		Log continued on next page										

WELL CASING
Interval: 0' to 79.5'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 72'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 72.0' to 75.0'
Type: Bentonite Chips

FILTER PACK
Interval: 75.0' to 89.5'
Type: DSI No. 2 Sand

WELL SCREEN
Interval: 79.5' to 89.5'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Well Notes:
Floodplain wellhead

Sample Notes:
Direct push and Split Spoon Sampling

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-3D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 90.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/14/16
DATE COMPLETED: 8/17/16

NORTHING: 3,660,744.77
EASTING: 11,812,886.53
GS ELEVATION: 15.12 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
40	-25	38.00 - 43.00 Silty clay, dark gray, trace fine gravel, no odor, moist, firm. *(Continued)*	CL		-27.88								
		43.00 - 49.00 Clayey silt, green to dark green, no odor, moist, stiff.	ML		43.00		9	2 IN SS	6 -8 -10 -13	18	1.80 / 2.00		
45	-30				-33.88								
		49.00 - 58.00 Clayey silt, some fine to medium-grained sand, light green, no odor, moist, stiff to very stiff.	ML		49.00		10	2 IN SS	6 -10 -12 -16	22	2.00 / 2.00		
50	-35						11	2 IN SS	13 -17 -20 -29	37	2.00 / 2.00		
55	-40				-42.88								
		58.00 - 63.00 Clayey silt, some fine to medium-grained sand, reddish-brown, no odor, moist to dry, very stiff.	ML		58.00		12	2 IN SS	12 -16 -22 -34	38	2.00 / 2.00		
60		Log continued on next page											

WELL CASING
Interval: 0' to 79.5'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 72'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 72.0' to 75.0'
Type: Bentonite Chips

FILTER PACK
Interval: 75.0' to 89.5'
Type: DSI No. 2 Sand

WELL SCREEN
Interval: 79.5' to 89.5'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Well Notes:
Floodplain wellhead

Sample Notes:
Direct push and Split Spoon Sampling

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-3D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 90.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/14/16
DATE COMPLETED: 8/17/16

NORTHING: 3,660,744.77
EASTING: 11,812,886.53
GS ELEVATION: 15.12 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
60	-45	58.00 - 63.00 Clayey silt, some fine to medium-grained sand, reddish-brown, no odor, moist to dry, very stiff. *(Continued)*	ML		-47.88								
		63.00 - 68.00 Clayey silt, some fine to medium-grained sand, reddish-brown to greenish-gray, no odor, dry, very dense.			63.00		13	2 IN SS	17 -30 -40 -50	>50	2.00 / 2.00		
65	-50		ML		-52.88								
		68.00 - 78.00 Clayey silt, some fine-grained sand, reddish-brown, no odor, damp, very stiff.			68.00		14	2 IN SS	13 -17 -21 -30	38	2.00 / 2.00		
70	-55												
			ML				15	2 IN SS	12 -19 -30 -37	49	2.00 / 2.00	Bentonite Chip	
75	-60												
					-62.88								
		78.00 - 79.00 Clayey silt, some fine-grained sand, reddish-brown, no odor, damp, very stiff, small seams of gray clayey silt with fine sand.	ML		78.00 -63.88		16	2 IN SS	18 -19 -28 -36	47	2.00 / 2.00		
		79.00 - 83.00 Clayey silt, some fine-grained sand, reddish-brown, no odor, damp, very stiff.	ML		79.00								
80		Log continued on next page											

WELL CASING
Interval: 0' to 79.5'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3'
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 72'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 72.0' to 75.0'
Type: Bentonite Chips

FILTER PACK
Interval: 75.0' to 89.5'
Type: DSI No. 2 Sand

WELL SCREEN
Interval: 79.5' to 89.5'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Well Notes:
Floodplain wellhead

Sample Notes:
Direct push and Split Spoon Sampling

LOG SCALE: 1 in = 2.5 ft
DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-3D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 90.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/14/16
DATE COMPLETED: 8/17/16

NORTHING: 3,660,744.77
EASTING: 11,812,886.53
GS ELEVATION: 15.12 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
80	-65	79.00 - 83.00 Clayey silt, some fine-grained sand, reddish-brown, no odor, damp, very stiff. *(Continued)*	ML		-67.88							No. 2 DSI Sand	**WELL CASING** Interval: 0' to 79.5' Material: PVC Diameter: 2" Joint Type: threaded **WELL COMPLETION** Pad: 3' by 3' Protective Casing: 6" PVC **ANNULUS SEAL** Interval: 0' to 72' Type: Bentonite grout **FILTER PACK SEAL** Interval: 72.0' to 75.0' Type: Bentonite Chips **FILTER PACK** Interval: 75.0' to 89.5' Type: DSI No. 2 Sand **WELL SCREEN** Interval: 79.5' to 89.5' Material: PVC Diameter: 2" Slot Size: 0.010" End Cap: 2" **Well Notes:** Floodplain wellhead **Sample Notes:** Direct push and Split Spoon Sampling
		83.00 - 84.00 Clayey silt with rock fragments (cobbles) some fine-grained sand, reddish-brown, no odor, damp, very stiff.	ML-GW		83.00 -68.88		17	2 IN SS	16 -22 -30 -50	>50	2.00 / 2.00	0.010" Screen	
85	-70	84.00 - 88.00 Clayey silt, some fine-grained sand, reddish-brown, no odor, damp, very stiff.	ML		84.00 -72.88								
		88.00 - 90.00 Clayey silt, trace fine-grained sand, reddish-brown, no odor, damp to moist, very stiff.	ML		88.00 -74.88		18	2 IN SS	11 -22 -24 -32	46	2.00 / 2.00	No. 2 DSI Sand	
90	-75	Boring completed at 90.00 ft											
95	-80												
100													

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-4

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/14/16
DATE COMPLETED: 8/18/16

NORTHING: 3,661,189.06
EASTING: 11,813,224.92
GS ELEVATION: 16.63 ft
TOC ELEVATION: 18.45 ft

DEPTH W.L.: 11.51 ft
ELEVATION W.L.: 5.12 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL / PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
0		0.00 - 19.80 Sand, fine to coarse-grained sand, trace silt and clay, brown to light brown, no odor, dry compact.										
	15					1	MACRO CORE			3.00 / 5.00		
5												
	10					2	MACRO CORE			2.10 / 5.00		
10			SP								Bentonite Grout	
	5					3	MACRO CORE			3.50 / 5.00		
15												
	0					4	MACRO CORE			5.00 / 5.00		
					-3.17						Bentonite Chip	
20		Log continued on next page	CL									

WELL CASING
Interval: 0' to 23.6'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.5' to 17.6'
Type: bentonite grout

FILTER PACK SEAL
Interval: 17.6' to 20.6'
Type: bentonite chip

FILTER PACK
Interval: 20.6' to 33.6'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 23.6' to 33.6'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: Direct Push, 4.25-inch HSA
Notes:

WELL NOTES:
floodplain wellhead

SAMPLE NOTES:
Direct push and split spoon sampling

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-4

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

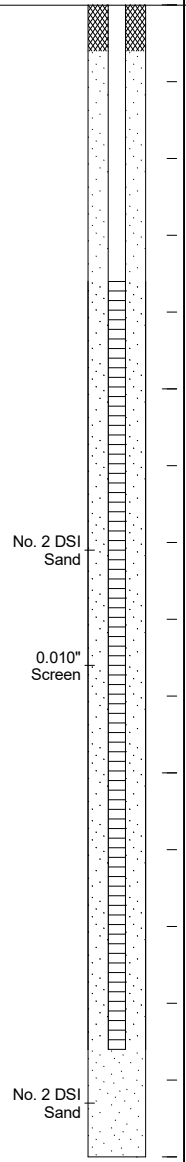
DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/14/16
DATE COMPLETED: 8/18/16

NORTHING: 3,661,189.06
EASTING: 11,813,224.92
GS ELEVATION: 16.63 ft
TOC ELEVATION: 18.45 ft

DEPTH W.L.: 11.51 ft
ELEVATION W.L.: 5.12 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20		19.80 - 28.70 Silty clay, brown to dark gray, moist, stiff. *(Continued)*	CL		19.80					
	-5					5	2 IN SS	4-5-9-13	14	1.50 / 2.00
25										
	-10				-12.07					
		28.70 - 29.80 Sand and fine gravel, fine to coarse-grained sand, some silt, brown, no odor, saturated, compact.	SP-SW		28.70 -13.17	6	2 IN SS	6-9-14-9	23	2.00 / 2.00
30		29.80 - 35.00 Silty clay, greenish gray, no odor, damp to moist, firm.	CL		29.80					
	-15					7	2 IN SS	4-7-8-8	15	2.00 / 2.00
35		Boring completed at 35.00 ft			-18.37					
	-20									
40										

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
floodplain wellhead

SAMPLE NOTES:
Direct push and split spoon sampling

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. MW-5

Boring No. MW-5

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	J. Yonts
CONTRACTOR	Fishburne Drilling	**DATE INSTALLED**	6/22/2016
DRILLER	J. Raasio		

Ground El. - ft
El. Datum -

Location See plan

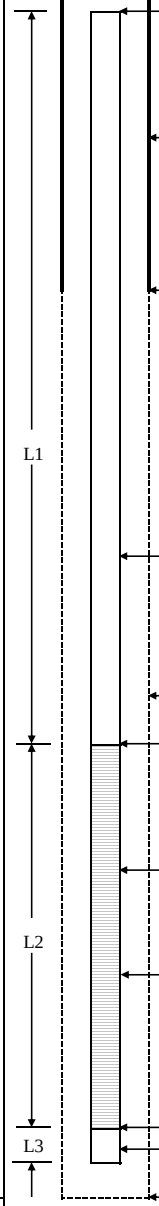
☑ **Guard Pipe**
☐ **Roadway Box**

SOIL/ROCK CONDITIONS

See boring log

BOREHOLE BACKFILL

0.0
Concrete
2.0
Bentonite
23.0
Bentonite Seal
25.0
Sand



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	21.0
Bentonite Seal	23.0	2.0
Filter Sand	25.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 27.00 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 37.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 37.5 ft

(Bottom of Exploration)
(Numbers refer to depth from ground surface in feet)

(Not to Scale)

27 ft	+	10 ft	+	0.5 ft	=	37.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-5

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Cascade Drilling

File No. 42735-001
Sheet No. 1 of 3
Start June 22, 2016
Finish June 22, 2016
Driller C. Ruffer
H&A Rep. H. Hollauer
Elevation 20.2
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	Sonic	-	-	Rig Make & Model: Track mounted TS: 150 CE
Inside Diameter (in.)	6.875	-	-	Bit Type: 6-in. Sonic Core Barrel
Hammer Weight (lb)	-	-	-	Drill Mud: None
Hammer Fall (in.)	-	-	-	Casing: Override
				Hoist/Hammer: None
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0		S1 7	0.0 10.0		SP	Orange-brown poorly-graded SAND (SP), mps 1.0 in., no structure, no odor, dry	-	5	5	5	80	5				
10		S2 10	10.0 20.0	7.2		-FILL-										
				13.0	SP-SM	Medium brown poorly-graded SAND with silt and gravel (SP-SM), mps 1.5 in., no structure, no odor, moist	5	10	15	15	45	10				
15				4.2 16.0	SM	Orange-brown silty SAND with gravel (SM), mps 1.5 in., no structure, no odor, moist, approximately 10 in. layer of dark brown silty from approximately 17.0 to 17.8 ft	5	10	15	15	35	20				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
Refer to groundwater level table					

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 60.0
Rock Cored (ft) -
Samples 6S

Boring No. MW-5

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-5
File No. 42735-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20		S3 8	20.0 30.0													
				-1.8 22.0	SM	Light gray-brown silty SAND (SM), mps 0.5 in., slight depositional structure, no odor, moist	-	5	10	25	40	20				
				-2.8 23.0	ML	Dark brown SILT (ML), mps less than 0.074 mm, depositional layering/structure, no odor, moist	-	-	-	-	-	100				
				-3.3 23.5	SM	Orange-brown silty SAND with gravel (SM), mps 1.5 in., no structure, no odor, moist Note: Gravel increases with depth.	10	10	15	15	35	15				
25																
30		S4 12	30.0 40.0		SM	Orange-brown silty SAND with gravel (SM), mps 2.0 in., no structure, no odor, moist	15	15	10	20	20	20				
35				-15.8 36.0	CL	Dark brown lean CLAY layer (CL)	-	-	-	-	-	100				
				-16.3 36.5												
40		S5 10	40.0 50.0	-19.8 40.0	ML	Dark gray sandy SILT (ML), mps less than 0.43 mm, trace clay, slight layering, no odor, moist	-	-	-	-	30	70				
				-21.8 42.0	ML	Dark gray SILT (ML), mps less than 0.43 mm, slight structure, no odor, moist	-	-	-	-	-	100				
45																

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-5

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-5
File No. 42735-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
				-29.8												
50		S6 12	50.0 60.0	50.0	SM	Medium gray silty SAND with gravel (SM), mps 2.0 in., no structure, no odor, moist	15	15	10	20	20	20				
				-33.8 54.0		Highly weathered/decomposed rock, gray with white granitic composition, able to cut with difficulty										
55																
				-39.8												
60				60.0		BOTTOM OF EXPLORATION 60.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-5

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

RECORD OF BOREHOLE MW-6

SHEET 1 of 4

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 62.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,834.37
EASTING: 11,813,189.15
GS ELEVATION: 36.78 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0		0.00 - 8.00 Silty clay, trace fine-grained sand, micaceous, brown, no odor, firm, w<PL, trace rounded gravel up to 2 inch in diameter, cobbles.	CL		28.78		1	CUT'G	N/A		8.00 / 8.00	
5	35											
10	30	8.00 - 12.00 Silty clay, trace fine-grained sand, micaceous, brown with black mottling, no odor, w<PL, soft.	CL		8.00		2	2 IN SS	2 -6 -7 -7	13	1.60 / 2.00	
							3	2 IN SS	2 -8 -5 -7	13	1.30 / 2.00	
15	25	12.00 - 14.50 Silty clay with fine-grained sand, micaceous, light brown, moist, no odor, w<PL, soft.	CL		24.78 12.00		4	2 IN SS	2 -3 -4 -6	7	2.00 / 2.00	
		14.50 - 17.00 Silty clay, some fine-grained sand, micaceous, light brown, no odor, W<PL, firm	CL		22.28 14.50		5	2 IN SS	2 -5 -7 -9	12	1.60 / 2.00	
20	20	17.00 - 22.00 Silty sand with clay, fine-grained sand, light brown, no odor, dry, loose.	SC		19.78 17.00		6	2 IN SS	2 -4 -5 -6	9	2.00 / 2.00	
							7	2 IN SS	3 -5 -5 -5	10	2.00 / 2.00	

Log continued on next page

WELL CASING
Interval: 0.0' to 49.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" aluminum

ANNULUS SEAL
Interval: 0.0' to 41.0'
Type: bentonite grout

FILTER PACK SEAL
Interval: 41.0' to 44.0'
Type: bentonite chip

FILTER PACK
Interval: 44.0' to 59.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 49.0' to 59.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Sample Notes:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent soil boring MW-6D.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-6

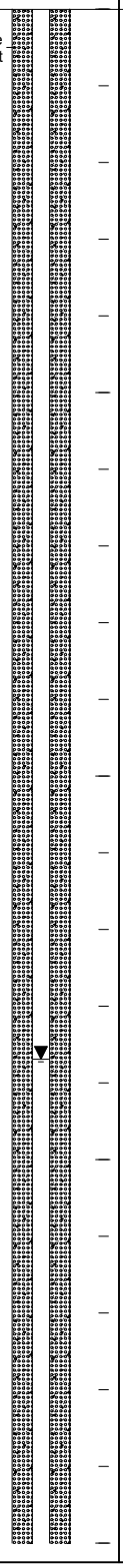
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 62.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,834.37
EASTING: 11,813,189.15
GS ELEVATION: 36.78 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20	15	17.00 - 22.00 Silty sand with clay, fine-grained sand, light brown, no odor, dry, loose. *(Continued)*	SC		14.78		8	2 IN SS	3 -4 -5 -5	9	1.30 2.00
		22.00 - 25.00 Sand, fine to medium-grained sand, some silt and clay, light brown, loose, dry, micaceous.	SP		11.78		9	2 IN SS	3 -3 -3 -3	6	2.00 2.00
25		25.00 - 25.50 Sand, fine to medium-grained sand, some silt and clay, light brown, loose, moist, micaceous.	SP		25.00 11.28		10	2 IN SS	3 -4 -14 -26	18	2.00 2.00
	10	25.50 - 29.50 Sand and gravel, fine to coarse-grained sand, quartzite gravel up to 1 inch in diameter, sub-angular to rounded, moist, compact, light brown.	SP		25.50 7.28		11	2 IN SS	11 -28 -35 -30	>50	2.00 2.00
30		29.50 - 31.50 Sand and gravel, fine to coarse-grained sand, sub-rounded to well rounded gravel up to 1.5 inches in diameter, wet, compact.	SP		29.50 5.28		12	2 IN SS	27 -27 -28 -25	>50	2.00 2.00
	5	31.50 - 33.00 Sand and gravel, medium-grained sand, trace clay, sone fine and coarse-grained sand, some sub to well-rounded gravel up to 0.5 inch in diameter, wet, loose, light brown.	SP		31.50 3.78		13	2 IN SS	11 -20 -13 -18	33	2.00 2.00
		33.00 - 34.40 Sand, poorly sorted fine to coarse-grained sand, sub- to well-rounded 0.5-inch diameter gravel, orange to light brown, wet, loose, some silt and clay nodules.	SP		33.00 2.38		14	2 IN SS	4 -7 -12 -8	19	2.00 2.00
35		34.40 - 35.60 Silty clay, micaceous, brown, W<PL, very stiff.	CL		34.40 1.18		15	2 IN SS	6 -11 -30 -50	41	2.00 2.00
		35.60 - 36.00 Silty sandy clay with gravel, orange sand with gray, brown, and white clay lenses, W>PL, stiff, gravel is sub- to well rounded up to 0.5 inch in diameter.	CL GP		35.60 0.78 36.00						
	0	36.00 - 36.92 Sandy gravel, light gray grading to yellowish-brown, loose, wet.			-0.14 36.92		16	2 IN SS	11 -25 -13 -11	38	0.67 2.00
		36.92 - 45.00 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist. Water perched on top of clay.	CL				17	2 IN SS	2 -5 -9 -10	14	2.00 2.00
40		Log continued on next page									

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0.0' to 49.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" aluminum

ANNULUS SEAL
Interval: 0.0' to 41.0'
Type: bentonite grout

FILTER PACK SEAL
Interval: 41.0' to 44.0'
Type: bentonite chip

FILTER PACK
Interval: 44.0' to 59.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 49.0' to 59.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Sample Notes:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent soil boring MW-6D.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-6

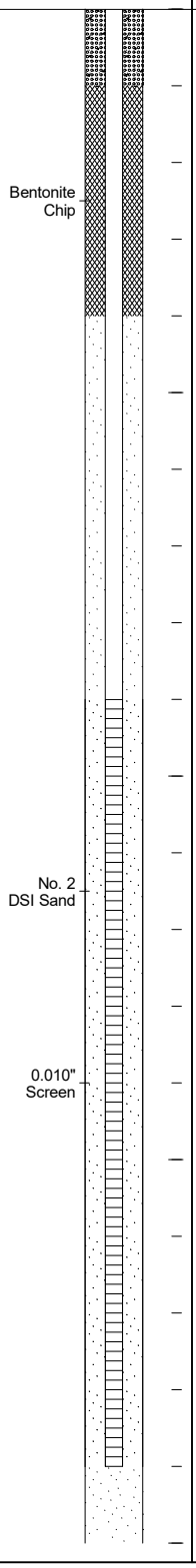
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 62.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,834.37
EASTING: 11,813,189.15
GS ELEVATION: 36.78 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		36.92 - 45.00 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist. Water perched on top of clay. *(Continued)*	CL		-8.22		18	2 IN SS	3 -9 -13 -14	22	2.00 / 2.00
	-5										
45		45.00 - 46.75 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist, trace wood fragments and small pebbles.	CL		45.00 -9.97						
	-10	46.75 - 50.00 Silty fine-grained sand, gray, moist.	SW		46.75 -13.22		19	2 IN SS	4 -9 -12 -15	21	2.00 / 2.00
50		50.00 - 50.50 Silty clay with trace fine-grained sand and mica flakes, dense, dark gray.	CL		50.00 -13.72						
	-15	50.50 - 55.00 Sandy gravel, light gray, small rounded quartz pebbles and rock fragments to coarse-grained sand.	GP		50.50		20	2 IN SS	4 -19 -50/2"	>50	0.92 / 2.00
55		55.00 - 62.00 Sandy gravel with clay stringers, light gray to brown, rounded to subrounded 1 inch diameter broken gravel, saturated.	GP		-18.22 55.00		21	2 IN SS	13 -25 -50/2"	>50	0.92 / 2.00
	-20										
60		Log continued on next page									

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0.0' to 49.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" aluminum

ANNULUS SEAL
Interval: 0.0' to 41.0'
Type: bentonite grout

FILTER PACK SEAL
Interval: 41.0' to 44.0'
Type: bentonite chip

FILTER PACK
Interval: 44.0' to 59.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 49.0' to 59.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Sample Notes:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent soil boring MW-6D.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-6

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 62.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,834.37
EASTING: 11,813,189.15
GS ELEVATION: 36.78 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
60		55.00 - 62.00 Sandy gravel with clay stringers, light gray to brown, rounded to subrounded 1 inch diameter broken gravel, saturated. *(Continued)*	GP				22	2 IN SS	8 -12 -14 -18	26	2.00 / 2.00	No. 2 DSI Sand	
	-25				-25.22								
		Boring completed at 62.00 ft											
65													
	-30												
70													
	-35												
75													
	-40												
80													

WELL CASING
Interval: 0.0' to 49.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" aluminum

ANNULUS SEAL
Interval: 0.0' to 41.0'
Type: bentonite grout

FILTER PACK SEAL
Interval: 41.0' to 44.0'
Type: bentonite chip

FILTER PACK
Interval: 44.0' to 59.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 49.0' to 59.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Sample Notes:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent soil boring MW-6D.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-6D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 92.00 ft
DRILL METHOD: 4.25-inch HSA

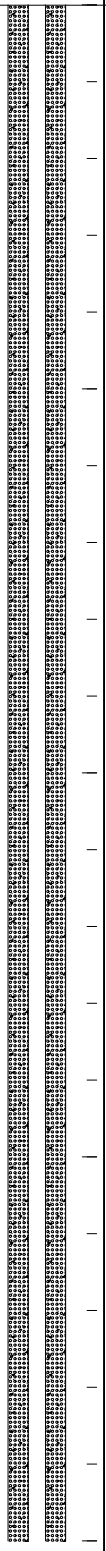
DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,820.42
EASTING: 11,813,197.33
GS ELEVATION: 37.80 ft
TOC ELEVATION: 40.17 ft

DEPTH W.L.: 76.21 ft
ELEVATION W.L.: -38.41 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0		0.00 - 8.00 Silty clay, trace fine-grained sand, micaceous, brown, no odor, firm, w<PL, trace rounded gravel up to 2 inch in diameter, cobbles.	CL		29.80	1	CUT'G			8.00 / 8.00
	35									
5										
	30									
		8.00 - 12.00 Silty clay, trace fine-grained sand, micaceous, brown with black mottling, no odor, w<PL, soft.	CL		8.00 25.80	2	2 IN SS	2-6-7-7	13	1.60 / 2.00
10						3	2 IN SS	2-8-5-7	13	1.30 / 2.00
		12.00 - 14.50 Silty clay with fine-grained sand, micaceous, light brown, moist, no odor, w<PL, soft.	CL		12.00 23.30	4	2 IN SS	2-3-4-6	7	2.00 / 2.00
	25	14.50 - 17.00 Silty clay, some fine-grained sand, micaceous, light brown, no odor, W<PL, firm	CL		14.50 20.80	5	2 IN SS	2-5-7-9	12	1.60 / 2.00
15						6	2 IN SS	2-4-5-6	9	2.00 / 2.00
		17.00 - 22.00 Silty sand with clay, fine-grained sand, light brown, no odor, dry, loose.	SC		17.00	7	2 IN SS	3-5-5-5	10	2.00 / 2.00
	20									
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 70'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4 y 4 aluminum

ANNULUS SEAL
Interval: 0.5' to 61'
Type: bentonite grout

FILTER PACK SEAL
Interval: 61' to 65'
Type: Bentonite chip

FILTER PACK
Interval: 65' to 90'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 70' to 90'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25-inch HSA
Notes:

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse & M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 92.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,820.42
EASTING: 11,813,197.33
GS ELEVATION: 37.80 ft
TOC ELEVATION: 40.17 ft

DEPTH W.L.: 76.21 ft
ELEVATION W.L.: -38.41 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		17.00 - 22.00 Silty sand with clay, fine-grained sand, light brown, no odor, dry, loose. *(Continued)*	SC		15.80	8	2 IN SS	3-4-5-5	9	1.30 / 2.00		
	15	22.00 - 25.00 Sand, fine to medium-grained sand, some silt and clay, light brown, loose, dry, micaceous.	SP		22.00 12.80	9	2 IN SS	3-3-3-3	6	2.00 / 2.00		
25		25.00 - 25.50 Sand, fine to medium-grained sand, some silt and clay, light brown, loose, moist, micaceous.	SP		25.00 12.30	10	2 IN SS	3-4-14-26	18	2.00 / 2.00		
		25.50 - 29.50 Sand and gravel, fine to coarse-grained sand, quartzite gravel up to 1 inch in diameter, sub-angular to rounded, moist, compact, light brown.	SP		25.50 8.30	11	2 IN SS	11-28-35-30	>50	2.00 / 2.00		
	10					12	2 IN SS	27-27-28-25	>50	2.00 / 2.00		**WELL NOTES:** Stick-up casing
30		29.50 - 31.50 Sand and gravel, fine to coarse-grained sand, sub-rounded to well rounded gravel up to 1.5 inches in diameter, wet, compact.	SP		29.50 6.30	13	2 IN SS	11-20-13-18	33	2.00 / 2.00	Bentonite Grout	**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade.
		31.50 - 33.00 Sand and gravel, fine to coarse sand, trace clay, 0.5-inch diameter sub to well-rounded gravel, wet, loose, fines are light brown.	SP-SG		31.50 4.80	14	2 IN SS	4-7-12-8	19	2.00 / 2.00		
	5	33.00 - 34.40 Sand, fine to coarse sand, trace clay, trace 0.5-inch diameter sub to well-rounded gravel, small clay nodules, wet, loose, fines are orange to light brown.	SP		33.00 3.40							
		34.40 - 35.60 Silty clay, micaceous, brown, W<PL, very stiff.	CL		34.40 2.20	15	2 IN SS	6-11-30-50	41	2.00 / 2.00		
35		35.60 - 36.00 Silty clay with sand and gravel, orange sand with gray, brown, and white clay lenses, W>PL, stiff, gravel size up to 0.5-inch diameter, sub to well rounded.	CL GP		35.60 1.80 36.00 0.88							
		36.00 - 36.92 Sandy gravel, light gray grading to yellowish-brown, loose, wet.			36.92	16	2 IN SS	11-25-13-11	38	0.67 / 2.00		
	0	36.92 - 45.00 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist. Water perched on top of clay.	GP			17	2 IN SS	2-5-9-10	14	2.00 / 2.00		
40		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse & M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 92.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,820.42
EASTING: 11,813,197.33
GS ELEVATION: 37.80 ft
TOC ELEVATION: 40.17 ft

DEPTH W.L.: 76.21 ft
ELEVATION W.L.: -38.41 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		36.92 - 45.00 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist. Water perched on top of clay. *(Continued)*	GP			18	2 IN SS	3-9-13-14	22	2.00 / 2.00
	-5									
45		45.00 - 46.75 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist, trace wood fragments and small pebbles.	CL		-7.20 45.00 -8.95					
		46.75 - 50.00 Silty fine sand, gray, moist.	SM		46.75 -12.20	19	2 IN SS	4-9-12-15	21	2.00 / 2.00
50	-10	50.00 - 50.50 Silty clay with trace fine-grained sand and mica flakes, dense, dark gray.	CL		50.00 -12.70	20	2 IN SS	4-19-50	>50	0.92 / 2.00
		50.50 - 60.00 Sandy gravel with coarse sand, up to 1-inch diameter rounded to subrounded quartz gravel, light gray to brown, saturated.	GP		50.50					
55	-15					21	2 IN SS	13-25-50	>50	0.92 / 2.00
	-20									
60		Log continued on next page			-22.20					

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse & M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 92.00 ft
DRILL METHOD: 4.25-inch HSA

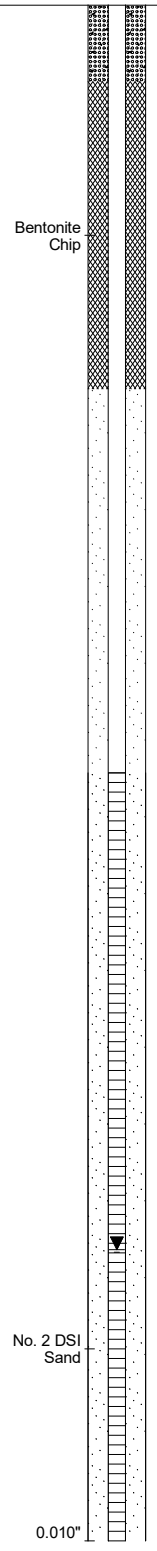
DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,820.42
EASTING: 11,813,197.33
GS ELEVATION: 37.80 ft
TOC ELEVATION: 40.17 ft

DEPTH W.L.: 76.21 ft
ELEVATION W.L.: -38.41 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
60		60.00 - 65.00 Sand, medium to fine with trace clay and mica flakes, gray.	SW		60.00	22	2 IN SS	8-12-14-18	26	2.00 / 2.00
	-25				-27.20					
65		65.00 - 65.30 Silty clay, micaceous, gray, moist.	CL		-27.50					
		65.30 - 67.00 Silty clay, reddish-brown with gray mottling, micaceous, trace fine sand.	CL		65.30 -29.20	23	2 IN SS	14-10-20-20	30	1.25 / 2.00
	-30	67.00 - 80.00 Silty clay with trace fine sand, reddish-brown to dark reddish-brown, micaceous, moist.			67.00					
70						24	2 IN SS	5-8-15-19	23	2.00 / 2.00
	-35		CL							
75						25	2 IN SS	14-18-22-21	40	2.00 / 2.00
	-40									
80		Log continued on next page			-42.20					

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse & M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 92.00 ft
DRILL METHOD: 4.25-inch HSA

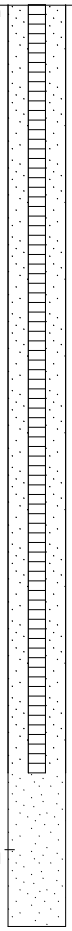
DRILL RIG: CME-850
DATE STARTED: 8/26/16
DATE COMPLETED: 8/27/16

NORTHING: 3,661,820.42
EASTING: 11,813,197.33
GS ELEVATION: 37.80 ft
TOC ELEVATION: 40.17 ft

DEPTH W.L.: 76.21 ft
ELEVATION W.L.: -38.41 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
80		80.00 - 85.00 Silty clay with trace fine sand, brown, micaceous, gray clay stringers (horizontal) at 80 to 82 feet below grade, dry.	CL		80.00	26	2 IN SS	10-15-21-29	36	2.00 / 2.00
	-45				-47.20					
85		85.00 - 89.00 Weathered granitic rock, black and white granite with biotite, feldspar, quartz, muscovite, dry, weathered cobbles.	GP		85.00	27	2 IN SS	50	50	0.42 / 2.00
	-50				-51.20					
		89.00 - 92.00 Silty clay with sand, micaceous, trave weathered rock fragments, dry, reddish-brown, dense.	CL		89.00	28	2 IN SS	10-18-22-27	40	1.08 / 2.00
90					-54.20					
		Boring completed at 92.00 ft								
	-55									
95										
	-60									
100										

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse & M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	40	0.00 - 8.00 Silty clay, trace fine-grained sand, micaceous, brown, no odor, firm, w<PL, trace rounded gravel up to 2 inch in diameter, cobbles.	CL		32.03	1	CUT'G			8.00 / 8.00
		8.00 - 12.00 Silty clay, trace fine-grained sand, micaceous, brown with black mottling, no odor, w<PL, soft.			8.00	2	2 IN SS	2-6-7-7	13	1.60 / 2.00
5	35		CL			3	2 IN SS	2-8-5-7	13	1.30 / 2.00
		12.00 - 14.50 Silty clay with fine-grained sand, micaceous, light brown, moist, no odor, w<PL, soft.			28.03 12.00	4	2 IN SS	2-3-4-6	7	2.00 / 2.00
10	30		CL		25.53					
		14.50 - 17.00 Silty clay, some fine-grained sand, micaceous, light brown, no odor, W<PL, firm			14.50	5	2 IN SS	2-5-7-9	12	1.60 / 2.00
15	25		CL			6	2 IN SS	2-4-5-6	9	2.00 / 2.00
		17.00 - 22.00 Silty sand with clay, fine-grained sand, light brown, no odor, dry, loose.			23.03 17.00	7	2 IN SS	3-5-5-5	10	2.00 / 2.00
20	20		SC							

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 220'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' concrete
Protective Casing: 4" by 4" aluminum

ANNULUS SEAL
Interval:
Type:

FILTER PACK SEAL
Interval: 210' to 0.5'
Type: bentonite grout

FILTER PACK
Interval: 210' to 230'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 220' to 230'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 6 5/8 mud rotary roller bit
Notes:

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20	20	17.00 - 22.00 Silty sand with clay, fine-grained sand, light brown, no odor, dry, loose. *(Continued)*	SC		18.03	8	2 IN SS	3-4-5-5	9	1.30 / 2.00		
		22.00 - 25.00 Sand, fine to medium-grained sand, some silt and clay, light brown, loose, dry, micaceous.	SP		22.00 15.03	9	2 IN SS	3-3-3-3	6	2.00 / 2.00		
25	15	25.00 - 25.50 Sand, fine to medium-grained sand, some silt and clay, light brown, loose, moist, micaceous.	SP		25.00 14.53	10	2 IN SS	3-4-14-26	18	2.00 / 2.00		
		25.50 - 29.50 Sand and gravel, fine to coarse-grained sand, quartzite gravel up to 1 inch in diameter, sub-angular to rounded, moist, compact, light brown.	SP		25.50 10.53	11	2 IN SS	11-28-35-30	>50	2.00 / 2.00		
30	10	29.50 - 31.50 Sand and gravel, fine to coarse-grained sand, sub-rounded to well rounded gravel up to 1.5 inches in diameter, wet, compact.	SP		29.50 8.53	12	2 IN SS	27-27-28-25	>50	2.00 / 2.00		**WELL NOTES:** Stick-up casing
		31.50 - 33.00 Sand and gravel, fine to coarse sand, trace clay, 0.5-inch diameter sub to well-rounded gravel, wet, loose, fines are light brown.	SP-SG		31.50 7.03	13	2 IN SS	11-20-13-18	33	2.00 / 2.00		**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.
		33.00 - 34.40 Sand, fine to coarse sand, trace clay, trace 0.5-inch diameter sub to well-rounded gravel, small clay nodules, wet, loose, fines are orange to light brown.	SP		33.00 5.63	14	2 IN SS	4-7-12-8	19	2.00 / 2.00		
35	5	34.40 - 35.60 Silty clay, micaceous, brown, W<PL, very stiff.	CL		34.40 4.43	15	2 IN SS	6-11-30-50	41	2.00 / 2.00		
		35.60 - 36.00 Silty clay with sand and gravel, orange sand with gray, brown, and white clay lenses, W>PL, stiff, gravel size up to 0.5-inch diameter, sub to well rounded.	CL GP		35.60 4.03 36.00 3.11							
		36.00 - 36.92 Sandy gravel, light gray grading to yellowish-brown, loose, wet.			36.92	16	2 IN SS	11-25-13-11	38	0.67 / 2.00		
40		36.92 - 45.00 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist. Water perched on top of clay.	GP			17	2 IN SS	2-5-9-10	14	2.00 / 2.00		

Log continued on next page

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40	0	36.92 - 45.00 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist. Water perched on top of clay. *(Continued)*	GP		-4.97	18	2 IN SS	3-9-13-14	22	2.00 / 2.00
45	-5	45.00 - 45.75 Silty clay to clay with silt, trace mica flakes, dark gray, dense, moist, trace wood fragments and small pebbles.	CL		45.00 -5.72					
		45.75 - 50.00 Silty fine sand, gray, moist.	SM		45.75 -9.97	19	2 IN SS	4-9-12-15	21	2.00 / 2.00
50	-10	50.00 - 50.50 Silty clay with trace fine-grained sand and mica flakes, dense, dark gray.	CL		50.00 -10.47	20	2 IN SS	4-19-50	>50	0.92 / 2.00
		50.50 - 60.00 Sandy gravel with coarse sand, up to 1-inch diameter rounded to subrounded quartz gravel, light gray to brown, saturated.	GP		50.50	21	2 IN SS	13-25-50	>50	0.92 / 2.00
60		Log continued on next page			-19.97					

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
60	-20	60.00 - 65.00 Sand, medium to fine with trace clay and mica flakes, gray.	SW		60.00	22	2 IN SS	8-12-14-18	26	2.00 / 2.00		
65	-25	65.00 - 65.30 Silty clay, micaceous, gray, moist.	CL		-24.97 -25.27							
		65.30 - 67.00 Silty clay, reddish-brown with gray mottling, micaceous, trace fine sand.	CL		65.30 -26.97	23	2 IN SS	14-10-20-20	30	1.25 / 2.00		
		67.00 - 80.00 Silty clay with trace fine sand, reddish-brown to dark reddish-brown, micaceous, moist.	CL		67.00	24	2 IN SS	5-8-15-19	23	2.00 / 2.00		**WELL NOTES:** Stick-up casing **SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.
70	-30											
75	-35					25	2 IN SS	14-18-22-21	40	2.00 / 2.00		
80					-39.97							

Log continued on next page

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
80	-40	80.00 - 85.00 Silty clay with trace fine sand, brown, micaceous, gray clay stringers (horizontal) at 80 to 82 feet below grade, dry.	CL		80.00	26	2 IN SS	10-15-21-29	36	2.00 / 2.00		
85	-45	85.00 - 89.00 Weathered granitic rock, black and white granite with biotite, feldspar, quartz, muscovite, dry, weathered cobbles.	GP		-44.97 85.00	27	2 IN SS	50	50	0.42 / 2.00		
90	-50	89.00 - 92.00 Silty clay with sand, micaceous, trave weathered rock fragments, dry, reddish-brown, dense.	CL		-48.97 89.00	28	2 IN SS	10-18-22-27	40	1.08 / 2.00		**WELL NOTES:** Stick-up casing **SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.
95	-55	92.00 - 109.00 Sandy clay, coarse rounded sand particles, reddish-brown, small clay chips, small quartz rock fragments, micaceous, moist.	CL		-51.97 92.00	29	CUT'G			3.00		
						30	CUT'G			5.00		
100		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
100	-60	92.00 - 109.00 Sandy clay, coarse rounded sand particles, reddish-brown, small clay chips, small quartz rock fragments, micaceous, moist. *(Continued)*	CL			21	CUT'G			5.00	Bentonite Grout	
105	-65					32	CUT'G			5.00		
					-68.97							
		109.00 - 110.00 Clay, gray clay nodules in cuttings.	CL		109.00 -69.97							**WELL NOTES:** Stick-up casing
110	-70	110.00 - 112.00 Sandy clay, coarse rounded sand particles, reddish-brown, small clay chips, small quartz and grayish-brown weathered rock fragments, micaceous.	CL		110.00 -71.97							**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.
		112.00 - 115.00 Sandy clay, coarse rounded sand particles, reddish-brown, small clay chips, small quartz and hard grayish-brown weathered rock fragments, micaceous, moist.	CL		112.00 -74.97	33	CUT'G			5.00		
115	-75	115.00 - 139.00 Sandy clay, coarse rounded sand particles, small clay chips, brown, trace weathered rock fragments.	CL		115.00	34	CUT'G			5.00		
120		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
120	-80	115.00 - 139.00 Sandy clay, coarse rounded sand particles, small clay chips, brown, trace weathered rock fragments. *(Continued)*	CL			35	CUT'G			5.00		
125	-85					36	CUT'G			5.00		
130	-90					37	CUT'G			5.00		
135	-95					38	CUT'G			5.00		
					-98.97							
140		139.00 - 140.00 Sandy clay, coarse sand, large clay chips	CL		139.00 -99.97							
		Log continued on next page										

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
140	-100	140.00 - 142.00 Clayey gravel (cobbles), gray soft weathered rock fragments with red clay.	GC		140.00 -101.97						
		142.00 - 143.00 Clay, red.	CL		142.00 -102.97	39	CUT'G		5.00		
		143.00 - 144.00 Weathered rock fragments, soft, gray.	GC		143.00 -103.97						
		144.00 - 163.00 Sandy clay with trace soft gray rock fragments, reddish-brown clay.			144.00						
145	-105					40	CUT'G		5.00		
150	-110		CL			41	CUT'G		5.00		
155	-115					42	CUT'G		5.00		
160		Log continued on next page									

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
160	-120	144.00 - 163.00 Sandy clay with trace soft gray rock fragments, reddish-brown clay. *(Continued)*	CL			43	CUT'G			5.00		
					-122.97							
		163.00 - 166.00 Weathered rock fragments, soft, gray, granitic looking rock fragments.	GC		163.00							
165	-125				-125.97	44	CUT'G			5.00		
		166.00 - 193.00 Sandy clay, coarse sand, red to reddish-brown clay, clay chips are small, trace weathered phaneritic rock fragments with quartz, feldpar, and mica minerals and others are aphanitic soft gray fragments.			166.00							
170	-130					45	CUT'G			5.00		
			CL									
175	-135					46	CUT'G			5.00		
180		Log continued on next page										

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
180	-140	166.00 - 193.00 Sandy clay, coarse sand, red to reddish-brown clay, clay chips are small, trace weathered phaneritic rock fragments with quartz, feldpar, and mica minerals and others are aphanitic soft gray fragments. *(Continued)*	CL			47	CUT'G			5.00		
185	-145					48	CUT'G			5.00		
190	-150					49	CUT'G			5.00		
					-152.97							
		193.00 - 194.00 Rock fragments (aphanitic gray rock fragments) with sand and reddish-brown clay.	GC		193.00 -153.97							
		194.00 - 218.00 Sandy clay, micaceous, hard clay small chips, reddish-brown, coarse sand.			194.00							
195	-155		CL			50	CUT'G			5.00		
200		Log continued on next page										

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
200	-160	194.00 - 218.00 Sandy clay, micaceous, hard clay small chips, reddish-brown, coarse sand. *(Continued)*	CL			51	CUT'G			5.00		
205	-165					52	CUT'G			5.00	Bentonite Chip	
210	-170					53	CUT'G			5.00		**WELL NOTES:** Stick-up casing **SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.
215	-175					54	CUT'G			5.00		
					-177.97							
		218.00 - 220.00 Sand, coarse.	SM		218.00							
220					-179.97						No. 2 DSI	
		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
220	-180	220.00 - 224.50 Sandy clay, micaceous, hard clay small chips, reddish-brown, coarse sand.	CL		220.00	55	CUT'G			5.00	Sand	
					-184.47							
225	-185	224.50 - 226.00 Rock fragments (aphanitic gray rock fragments) with sand and reddish-brown clay.	GC		224.50						0.010" Screen	
					-185.97							
		226.00 - 231.00 Sandy clay, micaceous, hard clay small chips, reddish-brown, coarse sand.	CL		226.00	56	CUT'G			5.00		**WELL NOTES:** Stick-up casing
230	-190				-190.97							**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.
		231.00 - 237.00 Sandy clay with gray aphanitic saft rock fragments, micaceous, hard clay small chips, reddish-brown clay, coarse sand.	CL-GC		231.00	57	CUT'G			5.00		
235	-195				-196.97						No. 2 DSI Sand backfill	
		237.00 - 240.00 Sandy clay, micaceous, hard clay small chips, reddish-brown, coarse sand.	CL		237.00	58	CUT'G			5.00		
240		Log continued on next page			-199.97							
		Borehole completed at 240.00 ft										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-6DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 240.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/14/16
DATE COMPLETED: 9/15/16

NORTHING: 3,661,789.31
EASTING: 11,813,221.56
GS ELEVATION: 40.03 ft
TOC ELEVATION: 42.69 ft

DEPTH W.L.: 47.48 ft
ELEVATION W.L.: -7.45 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
240	-200					59	CUT'G			5.00		
245	-205											
250	-210											
255	-215											
260												

WELL NOTES:
Stick-up casing

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade. Split spoon data from adjacent borehole MW-6D. Run geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-7

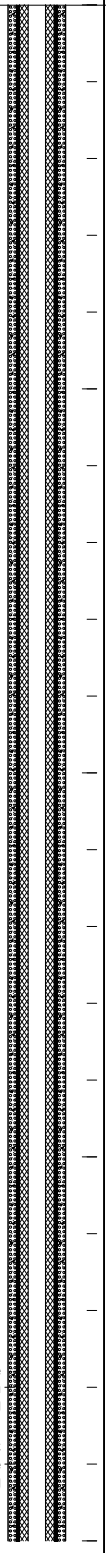
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/9/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,718.44
EASTING: 11,812,729.28
GS ELEVATION: 41.00 ft
TOC ELEVATION: 43.45 ft

DEPTH W.L.: 35.24 ft
ELEVATION W.L.: 5.76 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	40	0.00 - 5.00 Clayey sand with gravel, brown to orange brown, medium sand, gravel is rounded to subrounded, moist. FILL.	SC			1	CUT'G			3.00 / 3.00
						2	2 IN SS	2-3-5-5	8	1.50 / 2.00
5	35				36.00					
		5.00 - 10.00 Clayey sand with gravel, brown to orange brown, medium sand, gravel is rounded to subrounded, moist. FILL.	SC		5.00					
						3	2 IN SS	5-5-5-4	10	1.50 / 2.00
10	30				31.00					
		10.00 - 18.00 Clayey sand, medium to coarse-grained sand, brown, trace rounded gravel, wet. FILL.	SC		10.00	4	2 IN SS	4-4-4-3	8	1.00 / 2.00
15	25									
					23.00					
		18.00 - 23.00 Clayey sand, fine to medium-grained sand, micaceous, moist, loose. FILL.	SC		18.00	5	2 IN SS	3-4-1-3	5	1.50 / 2.00
20		Log continued on next page								



WELL CASING
Interval: 0' to 42.5'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 36.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 36.0' to 38.0'
Type: Bentonite chips

FILTER PACK
Interval: 38.0' to 52.5'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 42.5' to 52.5'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 8.25-inch HSA & 4.25-inch HSA
Notes:

WELL NOTES:
Surface cased borehole.

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-7

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

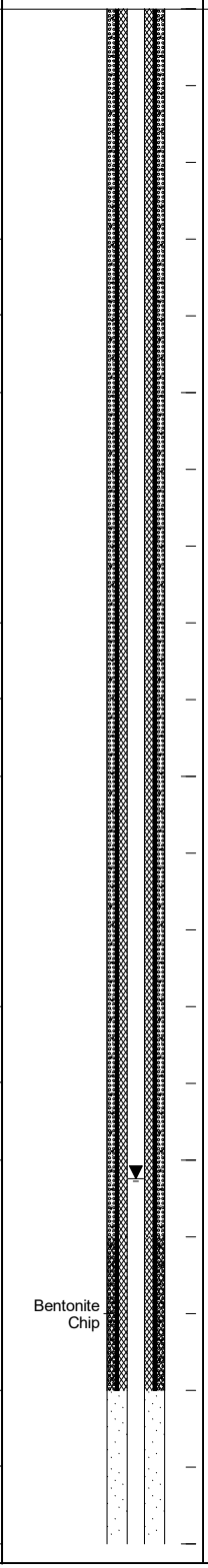
DRILL RIG: CME-55
DATE STARTED: 9/9/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,718.44
EASTING: 11,812,729.28
GS ELEVATION: 41.00 ft
TOC ELEVATION: 43.45 ft

DEPTH W.L.: 35.24 ft
ELEVATION W.L.: 5.76 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20	20	18.00 - 23.00 Clayey sand, fine to medium-grained sand, micaceous, moist, loose. FILL. *(Continued)*	SC		18.00					
		23.00 - 28.00 Clayey sand, fine to medium-grained sand, micaceous, moist, loose, large gravel. FILL.	SC		23.00	6	2 IN SS	5-4-3-3	7	1.00 / 2.00
25	15				13.00					
		28.00 - 33.00 Sand, fine to medium-grained, loose, moist, brown to orange brown, some plastic fines and subrounded gravel. FILL.	SP		28.00	7	2 IN SS	2-2-3-2	5	1.50 / 2.00
30	10				8.00					
		33.00 - 34.00 Sandy clay with gravel and root fragments, wet, dark brown to blackish-brown. FILL.	SC		33.00 7.00	8	2 IN SS	3-9-12-14	21	2.00 / 2.00
35	5	34.00 - 38.50 Sand and gravel, medium to coarse-grained sand, subrounded gravel and cobbles, wet, brown to light brown.	SP		34.00 2.50					
		38.50 - 40.00 Sand and clay, medium to coarse-grained sand, micaceous, wet, compact, tan colored.	SC		38.50 1.00	9	2 IN SS	2-3-4-5	7	2.00 / 2.00
40		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Surface cased borehole.

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-7

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/9/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,718.44
EASTING: 11,812,729.28
GS ELEVATION: 41.00 ft
TOC ELEVATION: 43.45 ft

DEPTH W.L.: 35.24 ft
ELEVATION W.L.: 5.76 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40	0	40.00 - 43.00 Sand and gravel, medium to coarse-grained sand, subrounded gravel and cobbles, wet, brown to light brown.	SC		40.00 -2.00							
45	-5	43.00 - 48.00 Clayey sand, medium-grained sand, trace silt and subangular gravel up to 1.5 inches in diameter, brown, wet.	SC		43.00 -7.00	10	2 IN SS	10-3-12-16	15	2.00/2.00	No. 2 DSI Sand 0.010" Screen	
50	-10	48.00 - 51.00 Silty clay, trace fine-grained sand, dark gray, W<PL, stiff, some fine sand seams up to 0.5-inch thick.	CL-ML		48.00 -10.00	11	2 IN SS	5-6-7-11	13	2.00/2.00		**WELL NOTES:** Surface cased borehole. **SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.
		51.00 - 53.00 Silty sand, fine-grained sand, gray, wet, compact.	SM		51.00 -12.00	12	2 IN SS	7-11-16-17	27	2.00/2.00	No. 2 DSI Sand	
55	-15	Boring completed at 53.00 ft										
60												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-8

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/8/16
DATE COMPLETED: 9/13/16

NORTHING: 3,661,566.62
EASTING: 11,812,252.31
GS ELEVATION: 41.31 ft
TOC ELEVATION: 43.62 ft

DEPTH W.L.: 35.89 ft
ELEVATION W.L.: 5.42 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	40	0.00 - 5.00 Clayey sand with gravel, brown to orange brown, medium sand, gravel is rounded to subrounded, moist. FILL. .	SC		36.31					
5	35	5.00 - 10.00 Clayey sand with gravel, brown to orange brown, medium sand, gravel is rounded to subrounded, moist. FILL.	SC		5.00 31.31	1	CUT'G		28.00	28.00
10	30	10.00 - 18.00 Clayey sand, medium to coarse sand, brown, trace rounded gravel, wet. FILL.	SC		10.00 23.31					
15	25	18.00 - 23.00 Clayey sand, fine to medium sand, micaceous, moist, loose. FILL.	SC		18.00					
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

10-inch PVC surface casing
Bentonite grout in casing

WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0.0' to 41.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 38.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 38.0' to 41.0'
Type: Bentonite chip

FILTER PACK
Interval: 41.0' to 53.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 43.0' to 53.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 8.25-inch HSA & 4.25-inch HSA
Notes:

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-8

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/8/16
DATE COMPLETED: 9/13/16

NORTHING: 3,661,566.62
EASTING: 11,812,252.31
GS ELEVATION: 41.31 ft
TOC ELEVATION: 43.62 ft

DEPTH W.L.: 35.89 ft
ELEVATION W.L.: 5.42 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20		18.00 - 23.00 Clayey sand, fine to medium sand, micaceous, moist, loose. FILL. *(Continued)*	SC		18.31					
	20	23.00 - 28.00 Clayey sand, fine to medium sand, micaceous, moist, loose, large gravel. FILL.	SC		23.00	1	CUT'G			28.00 / 28.00
25					13.31					
	15	28.00 - 33.00 Clayey sand, medium to fine-grained well graded sand, brown, some plastic fines, come cobbles, some root materials, slightly moist, compact. FILL.	SC		28.00	2	2 IN SS	2-3-4-4	7	1.50 / 2.00
30										
	10				8.31					
		33.00 - 38.00 Clayey sand, medium-grained, well-graded sand, brown, moist.	SC		33.00	3	2 IN SS	WOH-WOH-1-1	0	0.50 / 2.00
35										
	5				3.31					
		38.00 - 48.00 Clayey sand, medium to fine-grained, well-graded sand, brown, wet.	SC		38.00	4	2 IN SS	WOH-WOH-WOH-1	0	2.00 / 2.00
40		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-8

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

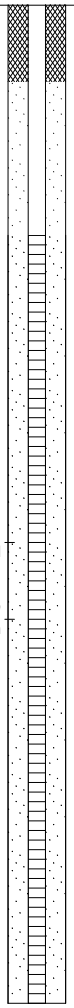
DRILL RIG: CME-55
DATE STARTED: 9/8/16
DATE COMPLETED: 9/13/16

NORTHING: 3,661,566.62
EASTING: 11,812,252.31
GS ELEVATION: 41.31 ft
TOC ELEVATION: 43.62 ft

DEPTH W.L.: 35.89 ft
ELEVATION W.L.: 5.42 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		38.00 - 48.00 Clayey sand, medium to fine-grained, well-graded sand, brown, wet. *(Continued)*								
	0									
			SC			5	2 IN SS	3-2-1-2	3	0.50 / 2.00
45					-6.69					
	-5									
		48.00 - 49.00 Sand, coarse-grained, well graded, tan-brown, wet.	SW		48.00 -7.69	6	2 IN SS	7-11-14-13	25	1.00 / 2.00
		49.00 - 51.00 Gravel and sand, coarse-grained well-graded sand, brown to tan-brown, some reddish-purple clay lens, wet.	GW/SW		49.00 -9.69					
50	-10	51.00 - 53.00 Clayey sand, medium-grained, trace silt and subangular gravel up to 1.5 inches in diameter, brown, wet.	SC		51.00 -11.69	7	2 IN SS	2-1-2-1	3	0.00 / 2.00
		Boring completed at 53.00 ft								
55	-15									
60										

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-8R

SHEET 1 of 3

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: Geoprobe 8040 DT
DATE STARTED: 1/3/17
DATE COMPLETED: 1/5/17

NORTHING: 3,661,572.56
EASTING: 11,812,278.37
GS ELEVATION: 41.21 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	40	0.00 - 5.00 Clayey sand with gravel, brown to orange brown, medium sand, gravel is rounded to subrounded, moist. FILL. .	SC		36.21						
5	35	5.00 - 10.00 Clayey sand with gravel, brown to orange brown, medium sand, gravel is rounded to subrounded, moist. FILL.	SC		5.00 31.21						
10	30	10.00 - 18.00 Clayey sand, medium to coarse sand, brown, trace rounded gravel, wet. FILL.	SC		10.00		1	CUT'G	N/A		28.00 28.00
15	25				23.21						
20		18.00 - 23.00 Clayey sand, fine to medium sand, micaceous, moist, loose. FILL. Log continued on next page	SC		18.00						

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

Bentonite grout in casing

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0.0' to 41.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 36.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 36.0' to 19.0'
Type: Bentonite chip

FILTER PACK
Interval: 36.0' to 51.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 41.0' to 51.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GEOlogic Exploration
DRILLER: Johnny Burr

PREPARED: C. LaCosse
REVIEWED:
DATE:

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-8R

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: Geoprobe 8040 DT
DATE STARTED: 1/3/17
DATE COMPLETED: 1/5/17

NORTHING: 3,661,572.56
EASTING: 11,812,278.37
GS ELEVATION: 41.21 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
20	20	18.00 - 23.00 Clayey sand, fine to medium sand, micaceous, moist, loose. FILL. *(Continued)*	SC		18.21								
25	15	23.00 - 28.00 Clayey sand, fine to medium sand, micaceous, moist, loose, large gravel. FILL.	SC		23.00 13.21		1	CUT'G	N/A		28.00 28.00	Bentonite Chip	
30	10	28.00 - 33.00 Clayey sand, medium to fine-grained well graded sand, brown, some plastic fines, come cobbles, some root materials, slightly moist, compact. FILL.	SC		28.00 8.21		2	2 IN SS	2 -3 -4 -4	7	1.50 2.00		
35	5	33.00 - 38.00 Clayey sand, medium-grained, well-graded sand, brown, moist.	SC		33.00 3.21		3	2 IN SS	WOH -WOH -1 -1	0	0.50 2.00		
40		38.00 - 48.00 Clayey sand, medium to fine-grained, well-graded sand, brown, wet.	SC		38.00		4	2 IN SS	WOH -WOH -WOH -1	0	2.00 2.00		

Log continued on next page

WELL CASING
Interval: 0.0' to 41.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 36.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 36.0' to 19.0'
Type: Bentonite chip

FILTER PACK
Interval: 36.0' to 51.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 41.0' to 51.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft
DRILLING COMPANY: GEOlogic Exploration
DRILLER: Johnny Burr
PREPARED: C. LaCosse
REVIEWED:
DATE:

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-8R

SHEET 3 of 3

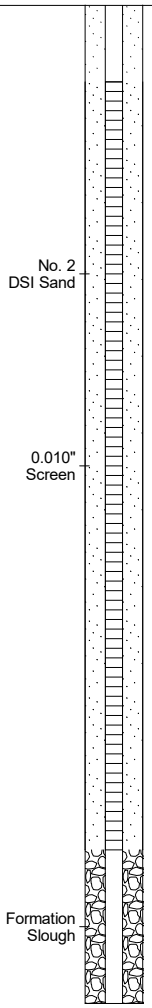
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: Geoprobe 8040 DT
DATE STARTED: 1/3/17
DATE COMPLETED: 1/5/17

NORTHING: 3,661,572.56
EASTING: 11,812,278.37
GS ELEVATION: 41.21 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		38.00 - 48.00 Clayey sand, medium to fine-grained, well-graded sand, brown, wet. *(Continued)*									
	0		SC				5	2 IN SS	3 -2 -1 -2	3	0.50 / 2.00
45					-6.79						
	-5	48.00 - 49.00 Sand, coarse-grained, well graded, tan-brown, wet.	SW		48.00 -7.79		6	2 IN SS	7 -11 -14 -13	25	1.00 / 2.00
		49.00 - 51.00 Gravel and sand, coarse-grained well-graded sand, brown to tan-brown, some reddish-purple clay lens, wet.	GW/SW		49.00 -9.79						
50	-10	51.00 - 53.00 Clayey sand, medium-grained, trace silt and subangular gravel up to 1.5 inches in diameter, brown, wet.	SC		51.00 -11.79		7	2 IN SS	2 -1 -2 -1	3	0.00 / 2.00
		Boring completed at 53.00 ft									
55	-15										
60											

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0.0' to 41.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 36.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 36.0' to 19.0'
Type: Bentonite chip

FILTER PACK
Interval: 36.0' to 51.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 41.0' to 51.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GEOlogic Exploration
DRILLER: Johnny Burr

PREPARED: C. LaCosse
REVIEWED:
DATE:

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-9

SHEET 1 of 3

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 55.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/7/16
DATE COMPLETED: 9/12/16

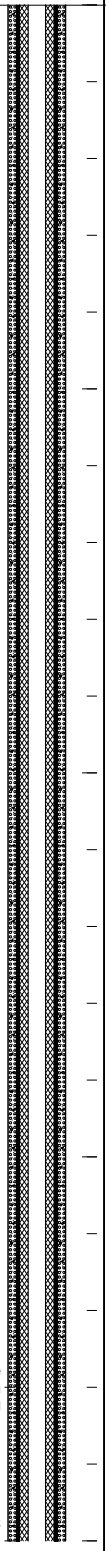
NORTHING: 3,661,408.62
EASTING: 11,811,813.33
GS ELEVATION: 41.70 ft
TOC ELEVATION: 44.25 ft

DEPTH W.L.: 36.55 ft
ELEVATION W.L.: 5.15 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0		0.00 - 4.00 Top soil and root mass, FILL.	OL		37.70	1	2 IN SS	3-2-2-3	4	1.70 / 2.00
5	40	4.00 - 9.00 Silty sand, poorly graded, medium-grained sand, dense, orange brown, no odor, dry. FILL.	SP-SM		4.00 32.70	2	2 IN SS	4-5-5-6	10	1.70 / 2.00
10	35	9.00 - 14.00 Silty sand, poorly graded, medium-grained sand, dense, orange brown, no odor, dry. FILL.	SP-SM		9.00 27.70	3	2 IN SS	4-8-9-11	17	1.70 / 2.00
15	30	14.00 - 19.00 Silty sand with angular gravel, poorly graded, medium-grained sand, dense, gray-brown, no odor, dry. FILL.	SP-SM		14.00 22.70	4	2 IN SS	3-5-6-9	11	1.80 / 2.00
20	25	19.00 - 24.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL.	SM		19.00	5	2 IN SS	3-5-11-14	16	1.80 / 2.00

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0.0' to 43'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 36.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 36.0' to 38.0'
Type: Bentonite chips

FILTER PACK
Interval: 38.0' to 53.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 43.0' to 53.0`
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 8.25-inch HSA & 4.25-inch HSA
Notes:

WELL NOTES:
10-inch casing to 40.0'

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-9

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 55.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

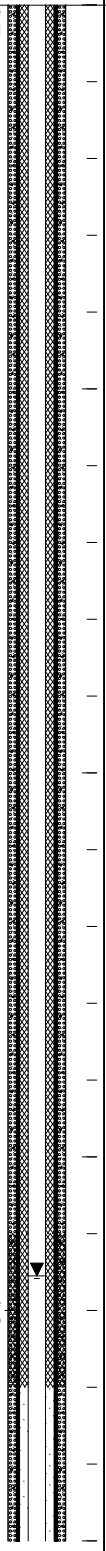
DRILL RIG: CME-55
DATE STARTED: 9/7/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,408.62
EASTING: 11,811,813.33
GS ELEVATION: 41.70 ft
TOC ELEVATION: 44.25 ft

DEPTH W.L.: 36.55 ft
ELEVATION W.L.: 5.15 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20		19.00 - 24.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL. *(Continued)*	SM		24.00	5	2 IN SS	3-5-11-14	16	1.80 / 2.00
	20				17.70					
		24.00 - 29.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL.	SM			6	2 IN SS	8-12-14-16	26	0.30 / 2.00
25										
	15				12.70					
		29.00 - 33.00 Silty sand, medium dense, grayish-brown with decomposed wood fragments, organic odor, moist. FILL.	SM		29.00	7	2 IN SS	9-9-10-10	19	1.70 / 2.00
30										
	10				8.70					
		33.00 - 34.00 Cobbles, FILL.	GP		33.00 7.70					
		34.00 - 39.00 Sandy silt, very soft, grayish-brown grading to orangish-brown, trace roots, no odor, moist.	ML		34.00	8	2 IN SS	2-1-2-1	3	1.80 / 2.00
35										
	5				2.70					
		39.00 - 40.90 Silty sand, decomposed organic material, loose, orangish-brown, very loose.	SM		39.00	9	2 IN SS	1-1-2-5	3	1.70 / 2.00
40		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
10-inch casing to 40.0'

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-9

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 55.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/7/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,408.62
EASTING: 11,811,813.33
GS ELEVATION: 41.70 ft
TOC ELEVATION: 44.25 ft

DEPTH W.L.: 36.55 ft
ELEVATION W.L.: 5.15 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40		39.00 - 40.90 Silty sand, decomposed organic material, loose, orangish-brown, very loose. *(Continued)*	SM		0.80	9	2 IN SS	1-1-2-5	3	1.70 / 2.00		
		40.90 - 53.00 Silty sand, fine-grained sand, some clay, brown to gray, wet, loose.			40.90							
	0											
						10	2 IN SS	8-10-3-5	13	1.00 / 2.00		
45											No. 2 DSI Sand	
	-5		SM									
											0.010" Screen	
						11	2 IN SS	1-1-1-2	2	1.40 / 2.00		**WELL NOTES:** 10-inch casing to 40.0'
50												**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction.
	-10				-11.30							
		53.00 - 55.00 Clayey sand, fine-grained sand, gray, wet, loose.	SC		53.00	12	2 IN SS	3-4-7-5	11	1.10 / 2.00	No. 2 DSI Sand	
55		Boring completed at 55.00 ft			-13.30							
	-15											
60												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-9R

SHEET 1 of 3

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 54.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: Geoprobe 8040 DT
DATE STARTED: 1/18/17
DATE COMPLETED: 1/19/17

NORTHING: 3,661,400.01
EASTING: 11,811,790.81
GS ELEVATION: 41.78 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	40	0.00 - 4.00 Top soil and root mass, FILL.	OL		37.78		1	2 IN SS	3 -2 -2 -3	4	1.70 / 2.00	
5	35	4.00 - 9.00 Silty sand, poorly graded, medium-grained sand, dense, orange brown, no odor, dry. FILL.	SP-SM		4.00 32.78		2	2 IN SS	4 -5 -5 -6	10	1.70 / 2.00	
10	30	9.00 - 14.00 Silty sand, poorly graded, medium-grained sand, dense, orange brown, no odor, dry. FILL.	SP-SM		9.00 27.78		3	2 IN SS	4 -8 -9 -11	17	1.70 / 2.00	Bentonite grout in casing
15	25	14.00 - 19.00 Silty sand with angular gravel, poorly graded, medium-grained sand, dense, gray-brown, no odor, dry. FILL.	SP-SM		14.00 22.78		4	2 IN SS	3 -5 -6 -9	11	1.80 / 2.00	
20		19.00 - 24.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL.	SM		19.00		5	2 IN SS	3 -5 -11 -14	16	1.80 / 2.00	

Log continued on next page

WELL CASING
Interval: 0.0' to 43'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 20.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 20.0' to 38.0'
Type: Bentonite chips

FILTER PACK
Interval: 38.0' to 53.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 43.0' to 53.0`
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft
DRILLING COMPANY: GEOlogic Exploration
DRILLER: Johnny Burr
PREPARED: C. LaCosse
REVIEWED:
DATE:

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-9R

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 54.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: Geoprobe 8040 DT
DATE STARTED: 1/18/17
DATE COMPLETED: 1/19/17

NORTHING: 3,661,400.01
EASTING: 11,811,790.81
GS ELEVATION: 41.78 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
20		19.00 - 24.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL. *(Continued)*	SM				5	2 IN SS	3 -5 -11 -14	16	1.80 / 2.00		
	20				17.78								
		24.00 - 29.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL.	SM		24.00		6	2 IN SS	8 -12 -14 -16	26	0.30 / 2.00		
25													
	15				12.78							Bentonite Chip	
		29.00 - 33.00 Silty sand, medium dense, grayish-brown with decomposed wood fragments, organic odor, moist. FILL.	SM		29.00		7	2 IN SS	9 -9 -10 -10	19	1.70 / 2.00		
30													
	10				8.78								
		33.00 - 34.00 Cobbles, FILL.	GP		33.00 7.78								
		34.00 - 39.00 Sandy silt, very soft, grayish-brown grading to orangish-brown, trace roots, no odor, moist.	ML		34.00		8	2 IN SS	2 -1 -2 -1	3	1.80 / 2.00		
35													
	5				2.78								
		39.00 - 40.90 Silty sand, decomposed organic material, loose, orangish-brown, very loose.	SM		39.00		9	2 IN SS	1 -1 -2 -5	3	1.70 / 2.00		
40		Log continued on next page											

WELL CASING
Interval: 0.0' to 43'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 20.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 20.0' to 38.0'
Type: Bentonite chips

FILTER PACK
Interval: 38.0' to 53.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 43.0' to 53.0`
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft
DRILLING COMPANY: GEOlogic Exploration
DRILLER: Johnny Burr
PREPARED: C. LaCosse
REVIEWED:
DATE:

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-9R

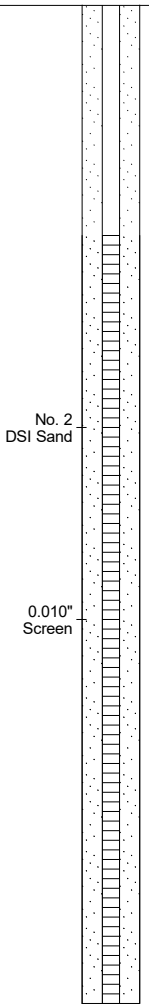
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 54.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: Geoprobe 8040 DT
DATE STARTED: 1/18/17
DATE COMPLETED: 1/19/17

NORTHING: 3,661,400.01
EASTING: 11,811,790.81
GS ELEVATION: 41.78 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		39.00 - 40.90 Silty sand, decomposed organic material, loose, orangish-brown, very loose. *(Continued)*	SM		0.88		9	2 IN SS	1 -1 -2 -5	3	1.70 / 2.00
		40.90 - 53.00 Silty sand, fine-grained sand, some clay, brown to gray, wet, loose.			40.90						
	0										
							10	2 IN SS	8 -10 -3 -5	13	1.00 / 2.00
45											
	-5		SM								
							11	2 IN SS	1 -1 -1 -2	2	1.40 / 2.00
50											
	-10				-11.22						
		53.00 - 55.00 Clayey sand, fine-grained sand, gray, wet, loose.	SC		53.00		12	2 IN SS	3 -4 -7 -5	11	1.10 / 2.00
55					-13.22						
		Boring completed at 54.00 ft			55.00						
	-15										
60											

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0.0' to 43'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 20.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 20.0' to 38.0'
Type: Bentonite chips

FILTER PACK
Interval: 38.0' to 53.0'
Type: No. 2 DSI sand

WELL SCREEN
Interval: 43.0' to 53.0`
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GEOlogic Exploration
DRILLER: Johnny Burr

PREPARED: C. LaCosse
REVIEWED:
DATE:

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-10

SHEET 1 of 3

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 52.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/16/16
DATE COMPLETED: 9/17/16

NORTHING: 3,661,177.84
EASTING: 11,811,227.10
GS ELEVATION: 41.07 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
0	41	0.00 - 4.00 Top soil and root mass, FILL.	OL		37.07								
	40												
		4.00 - 9.00 Silty sand, poorly-graded, medium-grained sand, dense, orange brown, no odor, dry. FILL.	SP-SM		4.00		1	CUT'G	N/A		8.00 / 8.00		
5	35												
					32.07		2	2 IN SS	4 -8 -9 -11	17	1.83 / 2.00		
		9.00 - 14.00 Silty sand, poorly-graded, medium-grained sand, dense, orange brown, no odor, dry. FILL.	SP-SM		9.00								
10	30												
					27.07								
		14.00 - 19.00 Silty sand with angular gravel, poorly-graded, medium-grained sand, dense, gray-brown, no odor, dry. FILL.-	SP-SM		14.00		3	2 IN SS	3 -5 -6 -9	11	1.92 / 2.00		
15	25												
					22.07							Bentonite grout in 10-inch PVC casing 10-inch PVC surface casing cemented in	
		19.00 - 24.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL.	SM		19.00		4	2 IN SS	3 -5 -11 -14	16	1.75 / 2.00		
20	21	Log continued on next page											

WELL CASING
Interval: 0.0' to 42.0'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 35.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 35.0' to 37.0'
Type: Bentonite Chip

FILTER PACK
Interval: 37.0' to 52.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 42.0' to 52.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Sample Notes:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction. Geology descriptions from 0 to 40 feet from adjacent soil boring OW-10.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-10

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 52.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

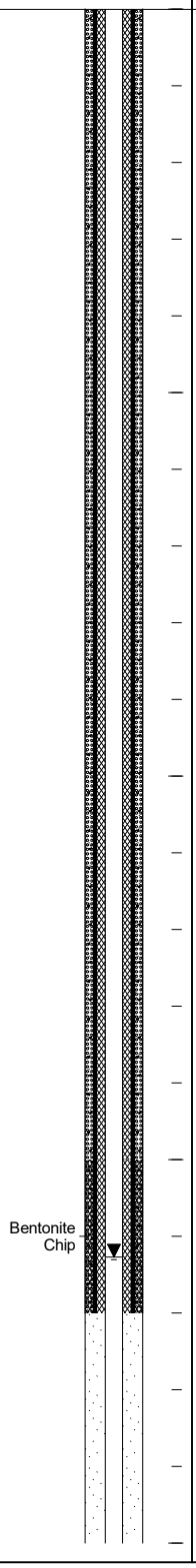
DRILL RIG: CME-55
DATE STARTED: 9/16/16
DATE COMPLETED: 9/17/16

NORTHING: 3,661,177.84
EASTING: 11,811,227.10
GS ELEVATION: 41.07 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20	20	19.00 - 24.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL. *(Continued)*	SM		17.07		4	2 IN SS	3 -5 -11 -14	16	1.75 / 2.00
25	15	24.00 - 29.00 Silty sand, grayish-brown grading to orangish-brown, no odor, moist, dense. FILL.	SM		12.07		5	2 IN SS	8 -12 -14 -16	26	2.00 / 2.00
30	10	29.00 - 43.00 Silty sand, medium dense, grayish-brown with decomposed wood fragments, organic (rotting wood) odor, moist. FILL.	SM		29.00		6	2 IN SS	9 -9 -10 -10	19	1.83 / 2.00
35	5						7	2 IN SS	2 -1 -1 -2	2	1.92 / 2.00
40							8	2 IN SS	1 -1 -2 -5	3	1.83 / 2.00

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0.0' to 42.0'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 35.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 35.0' to 37.0'
Type: Bentonite Chip

FILTER PACK
Interval: 37.0' to 52.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 42.0' to 52.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Sample Notes:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction. Geology descriptions from 0 to 40 feet from adjacent soil boring OW-10.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-10

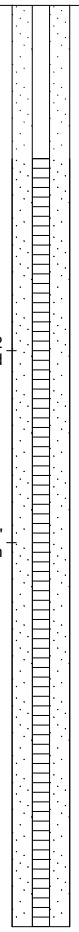
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 52.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/16/16
DATE COMPLETED: 9/17/16

NORTHING: 3,661,177.84
EASTING: 11,811,227.10
GS ELEVATION: 41.07 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		29.00 - 43.00 Silty sand, medium dense, grayish-brown with decomposed wood fragments, organic (rotting wood) odor, moist. FILL. *(Continued)*	SM		-1.93		8	2 IN SS	1 -1 -2 -5	3	1.83 / 2.00
	0										
		43.00 - 45.00 Cobbles, FILL.	GP		43.00 -3.93		9	2 IN SS	4 -6 -3 -6	9	0.00 / 2.00
45		45.00 - 50.00 Silty clay, trace fine-grained sand, gray, with light brown to reddish-brown clayey sand lenses (upto 4" thick), W>PL,soft.	CL		45.00		10	2 IN SS	2 -2 -4 -8	6	2.00 / 2.00
	-5										
50					-8.93						
		50.00 - 52.00 Clayey Sand, fine-grained sand, with gray silty clay lenses (up to 3 inches thick), wet, loose.	SC		50.00 -10.93		11	2 IN SS	5 -4 -10 -12	14	1.70 / 2.00
	-10	Boring completed at 52.00 ft									
55											
	-15										
60											

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0.0' to 42.0'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 35.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 35.0' to 37.0'
Type: Bentonite Chip

FILTER PACK
Interval: 37.0' to 52.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 42.0' to 52.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Sample Notes:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. Borehole advanced and reamed out with HSAs for surface casing and well construction. Geology descriptions from 0 to 40 feet from adjacent soil boring OW-10.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-11

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/18/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,020.14
EASTING: 11,810,778.85
GS ELEVATION: 40.94 ft
TOC ELEVATION: 43.87 ft

DEPTH W.L.: 36.85 ft
ELEVATION W.L.: 4.09 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	40	0.00 - 5.00 Sand, fine to medium-grained sand, some clay and silt, brown to dark brown, no odor, dry, compact. FILL.	SP		35.94	1	MACRO CORE			1.50 / 5.00
5	35	5.00 - 8.00 Sand, fine to medium-grained sand, some clay and silt, brown to dark brown, no odor, dry, compact. FILL.	SP		5.00 32.94	2	MACRO CORE			4.50 / 5.00
		8.00 - 10.00 Clayey sand, fine to medium-grained sand, some silt, brown, drak brown, and gray, no odor, dry, compact. FILL.	SC		8.00 30.94					
10	30	10.00 - 19.50 Sand, fine to medium-grained, some silt and clay, brown to gray brown, no odor, dry, compact. FILL.	SP		10.00	3	MACRO CORE			4.00 / 5.00
15	25					4	MACRO CORE			3.60 / 5.00
					21.44					
20		19.50 - 20.00 Sand, coarse-grained sand. FILL.	SW		19.50 20.94					
		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0.0' to 42.5'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.0' to 35.5'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 35.5 ' to 37.5'
Type: Bentonite Chip

FILTER PACK
Interval: 37.5 to 52.5'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 42.5' to 52.5'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 8.25-inch HSA & 4.25-inch HSA
Notes:

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. 2" diameter macrocore used for direct push. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo, C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-11

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/18/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,020.14
EASTING: 11,810,778.85
GS ELEVATION: 40.94 ft
TOC ELEVATION: 43.87 ft

DEPTH W.L.: 36.85 ft
ELEVATION W.L.: 4.09 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20	20	20.00 - 27.00 Sand, fine to medium-grained sand, some silt and clay, brown to gray brown, no odor, dry, compact. FILL.	SP		20.00	5	MACRO CORE			5.00 / 5.00		
25	15				13.94	6	MACRO CORE			4.70 / 5.00		
		27.00 - 28.00 Sand, coarse-grained sand. FILL.	SW		27.00 12.94							
30	10	28.00 - 38.00 Sand, fine to medium-grained sand, some silt and clay, brown to gray brown, no odor, saturated at 33.8 feet, compact. FILL.	SP		28.00	7	MACRO CORE			4.60 / 5.00		**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade prior to drilling. 2" diameter macrocore used for direct push. Borehole advanced and reamed out with HSAs for surface casing and well construction.
35	5				2.94	8	MACRO CORE			2.10 / 5.00	Bentonite Chip	
		38.00 - 43.00 Silty sand, fine to medium, some clay, dark gray to grayish-brown, moist to saturated, no odor, dense, trace fine gravel.	SP		38.00							
40		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo, C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-11

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 53.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/18/16
DATE COMPLETED: 9/12/16

NORTHING: 3,661,020.14
EASTING: 11,810,778.85
GS ELEVATION: 40.94 ft
TOC ELEVATION: 43.87 ft

DEPTH W.L.: 36.85 ft
ELEVATION W.L.: 4.09 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40	0	38.00 - 43.00 Silty sand, fine to medium, some clay, dark gray to grayish-brown, moist to saturated, no odor, dense, trace fine gravel. *(Continued)*	SP		-2.06							
		43.00 - 53.00 Sand, fine to medium with gravel up to 1 inch in diameter, sub to well rounded, light brown, wet, loose.	SP		43.00	9	2 IN SS	1-8-10-11	18	1.80 / 2.00	No. 2 DSI Sand	
45	-5										0.010" Screen	
						10	2 IN SS	5-8-10-8	18	2.00 / 2.00		**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade prior to drilling. 2" diameter macrocore used for direct push. Borehole advanced and reamed out with HSAs for surface casing and well construction.
50	-10				-12.06						No. 2 DSI Sand	
		Boring completed at 53.00 ft										
55	-15											
60												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo, C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-11I

Project	Chesterfield Power Station, Chester, Virginia
Client	Dominion Energy
Contractor	Geologic Exploration

File No. 133249-004
Sheet No. 1 of 4
Start February 25, 2019
Finish February 26, 2019
Driller K. Sargent
H&A Rep. A. Gerringer
Elevation 41.1
Datum NAVD88
Location See Plan
N 3661011.54
E 11810757.49

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	Override	Sonic	-	Rig Make & Model: Track-mounted Geoprobe 8150LS
Inside Diameter (in.)	6.0	4.0	-	Bit Type: None Drill Mud: None
Hammer Weight (lb)	-	-	-	Casing: Sonic
Hammer Fall (in.)	-	-	-	Hoist/Hammer: None None PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Note: Hand augered to 5 ft. Cuttings consist of poorly-graded SAND with silt (SP-SM) from 0 to 4 ft, and lean CLAY with sand (CL) from 4 to 5 ft.										
5		CR1 36	5.0 9.0		36.1 5.0	SP-SM	Yellow-brown poorly-graded SAND with silt (SP-SM), mps 0.5 in., no odor, moist	-	5	-	20	65	10				
10		CR2 24	9.0 19.0			SP-SM	Similar to above, mps 2.0 in.	5	5	-	20	60	10				
15						SP-SM	Similar to above, mps 0.75 in.	-	10	-	20	60	10				
20		CR3 84	19.0 29.0			SP-SM	Similar to above, except darker brown and more gravel										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/26/19					

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft) 99.0
Rock Cored (ft) -
Samples 10CR

Boring No. MW-11I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\130669_DOMINION\SEE 133249\GINT\2019-0401_133249_TB.GPJ Apr 2, 19

TEST BORING REPORT

HALEY ALDRICH

Boring No. MW-11I
File No. 133249-004
Sheet No. 2 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
					18.6												
					22.5	SW	Red-yellow well-graded SAND (SW)										
					18.1	SP-SM	Brown poorly-graded SAND with silt and gravel (SP-SM), mps 1.0 in., no odor, subrounded gravel	5	15	-	60	10	10				
25					23.0												
		CR4 54	29.0 39.0			SP-SM	Similar to above, less gravel										
30																	
						SP-SM	Brown poorly-graded SAND with silt (SP-SM), mps 0.25 in., no odor	-	10	-	20	60	10				
35																	
		CR5 72	39.0 49.0			SP	Brown poorly-graded SAND with gravel (SP), mps 4.0 in., no odor, moist, rounded to subrounded gravel	15	10	10	50	10	5				
40					-1.9												
					43.0												
45																	
		CR6 108	49.0 59.0		-8.9												
50					50.0	ML	Yellow-brown SILT with sand (ML), mps 0.43 mm, no odor	-	-	-	-	15	85				
					-10.9												
					52.0	SP-SM	Brown poorly-graded SAND with silt and gravel (SP-SM), mps 4.0 in., no odor	-	15	-	5	70	10				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-11I

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\130669_DOMINION\SEE 133249\GINT\2019-0401_133249_TB.GPJ Apr 2, 19

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-11I
File No. 133249-004
Sheet No. 3 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
55						SP-SM	Similar to above	10	15	5	50	10	10				
							Note: Color transitions to light tan.										
60		CR7 120	59.0 69.0		-19.9 61.0	CL	Gray lean CLAY (CL), mps 0.074 mm, no odor, moist	-	-	-	-	-	100				
65																	
70		CR8 120	69.0 79.0			CL	Similar to above	-	-	-	-	-	100				
75																	
80		CR9 120	79.0 89.0			CL	Similar to above	-	-	-	-	-	100				
85																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-11I

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\130669_DOMINION\SEE 133249\GINT\2019-0401_133249_TB.GPJ Apr 2, 19

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-11I

File No. 133249-004

Sheet No. 4 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
					-47.9 89.0												
		CR10 120	89.0 99.0			SC	Blue-gray clayey SAND with gravel (SC), mps 2.0 in., no odor	5	20	-	55	-	20				
90																	
95																	
					-57.9 99.0		BOTTOM OF EXPLORATION 99.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-11I

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\130669_DOMINION\SEE 133249\GINT\2019-0401_133249_TB.GPJ Apr 2, 19

RECORD OF BOREHOLE MW-12

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 52.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/18/16
DATE COMPLETED: 8/25/16

NORTHING: 3,660,850.86
EASTING: 11,810,294.33
GS ELEVATION: 41.31 ft
TOC ELEVATION: 44.06 ft

DEPTH W.L.: 38.40 ft
ELEVATION W.L.: 2.91 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	41	0.00 - 8.00 Fill, Sand, fine to medium-grained, some clay, some silt, brown to orange brown, no odor, dry, compact. FILL.	SP			1	MACRO CORE			2.30 5.00
5	36					2	MACRO CORE			5.00 5.00
					33.31					
		8.00 - 10.00 Clayey sand, fine to medium-grained sand, some silt, brown to orange brown, no odor, dry, compact. FILL.	SC		8.00					
10	31				31.31					
		10.00 - 12.50 Fill, Sand, fine to medium-grained sand, some clay and silt, brown to orange brown, no odor, dry, compact. FILL.	SC		10.00	3	MACRO CORE			4.70 5.00
					28.81					
		12.50 - 12.75 Piece of wood. FILL.	OH		28.56					
		12.75 - 25.00 Fill, Sand, fine to medium-grained sand, some clay and silt, brown to orange brown, no odor, dry, compact. FILL.	SC		12.75					
15	26					4	MACRO CORE			5.00 5.00
	25									
20		Log continued on next page								

Bentonite grout in 10-inch PVC casing
10-inch PVC

WELL CASING
Interval: 0.0' to 42.0
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0.5' to 38.5'
Type: bentonite grout

FILTER PACK SEAL
Interval: 38.5' to 41.0'
Type: Bentonite chip

FILTER PACK
Interval: 41.0' to 52.0
Type: No. 2 DSI sand

WELL SCREEN
Interval: 42.0' to 52.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 8.25-inch HSA & 4.25-inch HSA
Notes:

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. 2" macrocore used to collect direct push samples. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo, C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-12

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 52.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/18/16
DATE COMPLETED: 8/25/16

NORTHING: 3,660,850.86
EASTING: 11,810,294.33
GS ELEVATION: 41.31 ft
TOC ELEVATION: 44.06 ft

DEPTH W.L.: 38.40 ft
ELEVATION W.L.: 2.91 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		12.75 - 25.00 Fill, Sand, fine to medium-grained sand, some clay and silt, brown to orange brown, no odor, dry, compact. FILL. *(Continued)*	SC		16.31	5	MACRO CORE			5.00 / 5.00	surface casing cemented in	
25	20	25.00 - 26.50 Clayey silt, trace fine to medium-grained sand, brown, no odor, dry to damp, stiff. FILL.	ML		25.00 14.81							
	15	26.50 - 29.50 Sand, fine to coarse-grained sand, trace silt and clay, no odor, brown to grayish-brown, dry, compact.	SP		26.50 11.81	6	MACRO CORE			5.00 / 5.00		
30		29.50 - 33.00 Sand, fine to medium-grained sand, trace silt and clay, no odor, brown to orangish-brown, dry, compact.	SP		29.50 8.31	7	MACRO CORE			3.40 / 5.00		**SAMPLE NOTES:** Soil boring vacuum extracted to 8 feet below grade prior to drilling. 2" macrocore used to collect direct push samples. Borehole advanced and reamed out with HSAs for surface casing and well construction.
	10	33.00 - 35.00 Sand, fine to medium-grained sand, trace silt and clay, no odor, brown to orangish-brown, dry, compact.	SP		33.00 6.31							
35		35.00 - 38.50 Sand, fine to medium-grained sand, some silt and clay, brown to orange brown, no odor, dry, compact.	SP		35.00 2.81	8	MACRO CORE			2.50 / 5.00		
	5	38.50 - 43.00 Clayey silt, trace fine-grained sand, brown, no odor, damp, firm.	ML		38.50						Bentonite Chip	
40		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo, C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-12

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 52.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

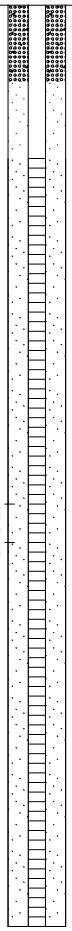
DRILL RIG: CME-55
DATE STARTED: 7/18/16
DATE COMPLETED: 8/25/16

NORTHING: 3,660,850.86
EASTING: 11,810,294.33
GS ELEVATION: 41.31 ft
TOC ELEVATION: 44.06 ft

DEPTH W.L.: 38.40 ft
ELEVATION W.L.: 2.91 ft
DATE W.L.: 10/5/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
40		38.50 - 43.00 Clayey silt, trace fine-grained sand, brown, no odor, damp, firm. *(Continued)*								
	0		ML		-1.69					
		43.00 - 51.00 Gravel and sand, coarse to medium-grained well graded sand, sub-rounded gravel, brown to orangish-brown, non-cohesive, some cobbles, wet.			43.00	9	2 IN SS	10-9-7-6	16	0.50 / 2.00
45										
	-5		GP							
						10	2 IN SS	5-10-3-4	13	2.00 / 2.00
50										
					-9.69	11	2 IN SS	7-6-2-3	8	2.00 / 2.00
	-10	51.00 - 52.00 Sand, medium to fine-grained well graded sand, reddish-brown, wet.	SW		51.00					
		Boring completed at 52.00 ft			-10.69					
55										
	-15									
60										

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

SAMPLE NOTES:
Soil boring vacuum extracted to 8 feet below grade prior to drilling. 2" macrocore used to collect direct push samples. Borehole advanced and reamed out with HSAs for surface casing and well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo, C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-13

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 25.00 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

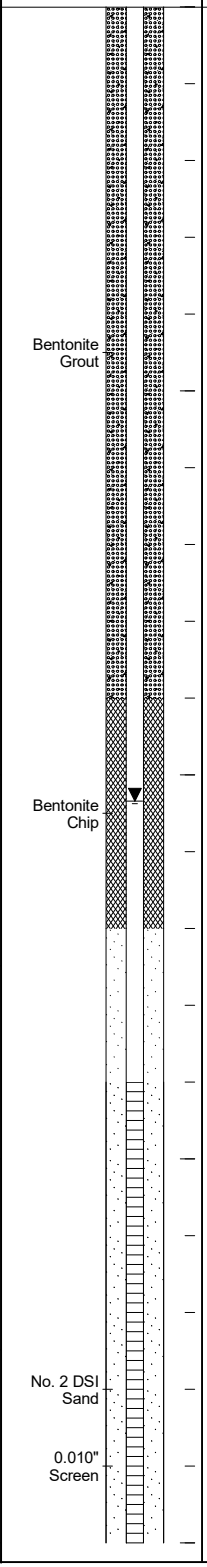
DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/12/16
DATE COMPLETED: 7/12/16

NORTHING: 3,660,477.31
EASTING: 11,809,299.07
GS ELEVATION: 10.95 ft
TOC ELEVATION: 12.68 ft

DEPTH W.L.: 10.34 ft
ELEVATION W.L.: 0.61 ft
DATE W.L.: 10/7/06
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT
0	10	0.00 - 7.50 Sand, fine to coarse-grained sand, some silt, brown, no odor, dry, compact.	SP			2.00 5.00
5	5				3.45	3.70
		7.50 - 8.00 Clayey silt, brown, no odor, moist, firm.	MH		7.50 2.95	5.00
		8.00 - 9.50 Sand, fine to coarse-grained sand, some silt, brown, moist to wet, compact.	SP		8.00 1.45	
		9.50 - 10.00 Clayey silt, moist, brown.	MH		9.50 0.95	
10	0	10.00 - 13.50 Sand, fine to coarse-grained sand, some silt, brown, moist to wet, compact.	SP		10.00 -2.55	3.50 5.00
		13.50 - 14.50 Clayey silt, trace fine to coarse-grained sand, no odor, moist to wet, firm,	MH		13.50 -3.55	
15	-5	14.50 - 23.00 Sand, fine to coarse-grained sand, trace fine gravel, some silt, grayish-brown, no odor, saturated, compact to dense.	SP		14.50	2.50 5.00
20		Log continued on next page				

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 14'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' Concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 9'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 9' to 12'
Type: Bentonite Chip

FILTER PACK
Interval: 12' to 24'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 14' to 24'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25 inch HSA and MacroCore Samples
Notes:

WELL NOTES:
Well completed with flood protection wellhead

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-13

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 25.00 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/12/16
DATE COMPLETED: 7/12/16

NORTHING: 3,660,477.31
EASTING: 11,809,299.07
GS ELEVATION: 10.95 ft
TOC ELEVATION: 12.68 ft

DEPTH W.L.: 10.34 ft
ELEVATION W.L.: 0.61 ft
DATE W.L.: 10/7/06
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		14.50 - 23.00 Sand, fine to coarse-grained sand, trace fine gravel, some silt, grayish-brown, no odor, saturated, compact to dense. *(Continued)*	SP			2.00 5.00		
	-10				-12.05			
		23.00 - 25.00 Sand, medium-grained sand with trace of coarse-sand and fine gravel, trace silt, brown, no odor, saturated, dense.	SP		23.00		No. 2 DSI Sand	
25		Boring completed at 25.00 ft			-14.05			
	-15							
30								**WELL NOTES:** Well completed with flood protection wellhead
	-20							
35								
	-25							
40								

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-14

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 45.20 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

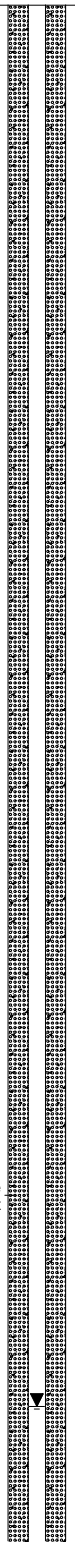
DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/12/16
DATE COMPLETED: 8/5/16

NORTHING: 3,660,027.47
EASTING: 11,809,396.53
GS ELEVATION: 19.45 ft
TOC ELEVATION: 21.19 ft

DEPTH W.L.: 18.25 ft
ELEVATION W.L.: 1.20 ft
DATE W.L.: 10/7/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	15	0.00 - 12.00 Silty sand, fine to coarse-grained sand, trace fine gravel, brown, no odor, dry, compact.	SM			1	MACRO CORE			2.00 / 5.00
5	10					2	MACRO CORE			2.00 / 5.00
10	5				7.45	3	MACRO CORE			1.50 / 5.00
		12.00 - 14.00 Silty sand, fine to coarse, trave fine gravel, brown, no odor, moist, compact.	SM		12.00 5.45					
		14.00 - 15.00 Silty sand, fine to coarse-grained sand, trave fine gravel, brown, wood fragments, no odor, moist, compact.	SM		14.00 4.45					
15	0	15.00 - 22.50 Sand, fine to coarse-grained, some silt, trace gravel, brown, no odor, saturated, dense.	SP		15.00	4	MACRO CORE			0.20 / 5.00
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 35.2'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' Concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 31'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 31' to 33'
Type: Bentonite Chip

FILTER PACK
Interval: 33.0' to 45.2'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 35.2' to 45.2'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25 inch HSA and MacroCore Samples
Notes:

WELL NOTES:
Drilled with direct push and reamed out with 4.25-inch HSA for well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-14

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 45.20 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/12/16
DATE COMPLETED: 8/5/16

NORTHING: 3,660,027.47
EASTING: 11,809,396.53
GS ELEVATION: 19.45 ft
TOC ELEVATION: 21.19 ft

DEPTH W.L.: 18.25 ft
ELEVATION W.L.: 1.20 ft
DATE W.L.: 10/7/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		15.00 - 22.50 Sand, fine to coarse-grained, some silt, trace gravel, brown, no odor, saturated, dense. *(Continued)*	SP		-3.05	5	MACRO CORE			3.00 / 3.00		
		22.50 - 23.00 Silty clay, trace fine-grained sand, bluish-gray, no odor, moist to dry, hard.	CH		22.50 -3.55							
		23.00 - 28.00 Clayey silt, some fine to medium-grained sand, bluish-green, no odor, dry, stiff.	ML		23.00	6	2 IN SS	14-10-14-15	24	2.00 / 2.00		
25	-5				-8.55							
		28.00 - 34.00 Clayey silt, some fine to medium-grained sand, bluish-green, no odor, damp to moist, stiff.	ML		28.00	7	2 IN SS	7-11-18-19	29	2.00 / 2.00		**WELL NOTES:** Drilled with direct push and reamed out with 4.25-inch HSA for well construction.
30	-10				-14.55	8	2 IN SS	5-7-11-15	18	2.00 / 2.00	Bentonite Chip	
		34.00 - 38.00 Silty sand, fine to medium-grained, some clay, grayish-green, no odor, moist, compact.	SM		34.00							
35	-15				-18.55							
		38.00 - 45.20 Silty sand, fine to medium-grained sand, some clay, grayish-green, no odor, wet, compact.	SM		38.00	9	2 IN SS	7-7-12-19	19	1.50 / 2.00	No. 2 DSI Sand	
40	-20											

Log continued on next page

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-14

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 45.20 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/12/16
DATE COMPLETED: 8/5/16

NORTHING: 3,660,027.47
EASTING: 11,809,396.53
GS ELEVATION: 19.45 ft
TOC ELEVATION: 21.19 ft

DEPTH W.L.: 18.25 ft
ELEVATION W.L.: 1.20 ft
DATE W.L.: 10/7/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40		38.00 - 45.20 Silty sand, fine to medium-grained sand, some clay, grayish-green, no odor, wet, compact. *(Continued)*	SM								0.010" Screen	
	-25					10	2 IN SS	4-12-15-17	27	1.70 / 2.00		
45					-25.75							
		Boring completed at 45.20 ft										
	-30											**WELL NOTES:** Drilled with direct push and reamed out with 4.25-inch HSA for well construction.
50												
	-35											
55												
	-40											
60												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. MW-15

Boring No. MW-15

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	J. Yonts
CONTRACTOR	Fishburne Drilling	**DATE INSTALLED**	6/22/2016
DRILLER	J. Raasio		

Ground El. - ft
El. Datum -

Location See plan

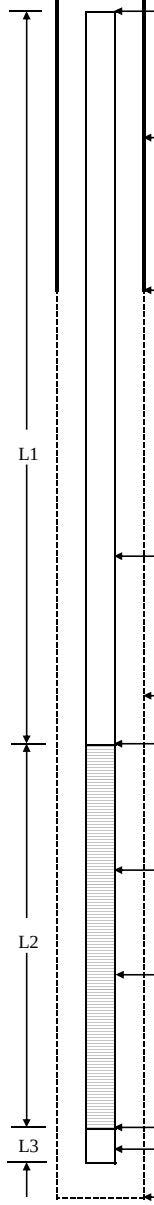
☑ **Guard Pipe**
☐ **Roadway Box**

SOIL/ROCK CONDITIONS

See boring log

BOREHOLE BACKFILL

0.0
Concrete
2.0
Bentonite
26.0
Bentonite Seal
28.0
Sand



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	24.0
Bentonite Seal	26.0	2.0
Filter Sand	28.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 30.00 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 40.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 40.5 ft

(Bottom of Exploration)
(Numbers refer to depth from ground surface in feet)

(Not to Scale)

30 ft	+	10 ft	+	0.5 ft	=	40.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-15

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Fishburne Drilling, Inc.

File No. 42735-001
Sheet No. 1 of 2
Start June 22, 2016
Finish June 22, 2016
Driller J. Raasio
H&A Rep. J. Yonts
Elevation 22.7
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: Track mounted CME 55
Inside Diameter (in.)	4.0	1 3/8	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: HSA Spun to 40.0
				Hoist/Hammer: Automatic Hammer
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0				19.7		Note: Advanced HSA to 3.0 ft to begin sampling.										
	3 6 8 9	S1 15	3.0 5.0	3.0	SP	Medium dense brown to tan poorly-graded SAND (SP), mps 0.25 in., no odor, dry to moist	--	5	10	50	25	10				
5				14.7		-FILL-										
	2 2 3 3	S2 18	8.0 10.0	8.0	SP	Loose tan to brown poorly-graded SAND (SP), no odor, dry	--	--	--	5	80	15				
10																
	2 5 7 6	S3 12	13.0 15.0		SP	Similar to S2, except medium dense with coarser lenses	--	--	5	15	70	10				
15																
	1 2 2 2	S4 20	18.0 20.0		SP	Similar to S3, except very loose, moist to wet	--	5	5	10	60	20				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
Refer to groundwater level table					

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 40.0
Rock Cored (ft) -
Samples 8S

Boring No. MW-15

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-15
File No. 42735-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20				-0.3												
	1 7 10 11	S5 12	23.0 25.0	23.0	SM	Medium dense brown to gray silty SAND (SM), no odor, moist to wet	--	--	5	30	40	25				
25				-5.3												
	1 4 6 9	S6 24	28.0 30.0	28.0	CL	Stiff gray to brown sandy lean CLAY (CL), no odor, moist, plastic	--	--	--	20	40	40				
30				-10.3												
	5 14 19 21	S7 24	33.0 35.0	33.0	SM	Dense tan, white, and orange silty SAND with gravel (SM), mps 1.25 in., no odor, moist to wet, well rounded gravel	10	10	20	30	10	20				
35																
	5 12 31 50	S8 24	38.0 40.0		SM	Dense gray, white, and orange silty SAND with gravel (SM), mps 1.1 in., no odor, wet, well rounded gravel, coarsens with depth	10	10	20	30	20	10				
40				-17.3 40.0		BOTTOM OF EXPLORATION 40.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-15

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

RECORD OF BOREHOLE MW-16

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 34.40 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/13/16
DATE COMPLETED: 7/13/16

NORTHING: 3,659,489.24
EASTING: 11,810,179.79
GS ELEVATION: 20.10 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES PID (ppm)	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
0	20	0.00 - 10.00 Sand, fine to medium grained, trace silt and clay, brown, no odor, dry, compact.	SP					
5	15							
10	10				10.10		Bentonite Grout	
		10.00 - 20.00 Sand, fine to medium grained, trace silt and clay, brown, no odor, dry, compact to loose.	SP		10.00			
15	5							
20					0.10			

Log continued on next page

WELL CASING
Interval: 0' to 24.4'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 19'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 19' to 22'
Type: Bentonite Chip

FILTER PACK
Interval: 22.0' to 34.4
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 24.4' to 34.4'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

Well Notes:
Drilled with direct push, reamed out with 4.25-inch HSA for well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory Gamewell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-16

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 34.40 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/13/16
DATE COMPLETED: 7/13/16

NORTHING: 3,659,489.24
EASTING: 11,810,179.79
GS ELEVATION: 20.10 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	MONITORING WELL / PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
20	0	20.00 - 22.00 Sand, fine to medium grained, trace silt and clay, brown, no odor, damp to moist, compact to loose.	SP		20.00 -1.90		Bentonite Chip	**WELL CASING** Interval: 0' to 24.4' Material: PVC Diameter: 2" Joint Type: threaded **WELL COMPLETION** Pad: 3' by 3' concrete Protective Casing: 4" by 4" Aluminum **ANNULUS SEAL** Interval: 0' to 19' Type: Bentonite Grout **FILTER PACK SEAL** Interval: 19' to 22' Type: Bentonite Chip **FILTER PACK** Interval: 22.0' to 34.4 Type: No. 2 DSI Sand **WELL SCREEN** Interval: 24.4' to 34.4' Material: PVC Diameter: 2" Slot Size: 0.010" End Cap: 2"
		22.00 - 24.00 Silty sand, fine to medium grained, trace clay, no odor, wet, compact to dense, grayish-brown.	SM		22.00 -3.90			
25	-5	24.00 - 33.00 Sand, fine to coarse grained, some silt, trace fine gravel, no odor, saturated, dense, grayish-brown to brown.	SP		24.00		No. 2 DSI Sand 0.010" Screen	**Well Notes:** Drilled with direct push, reamed out with 4.25-inch HSA for well construction.
30	-10							
		33.00 - 34.40 Silty clay, damp to moist, no odor, hard.	CH		33.00 -14.30			
35	-15	Boring completed at 34.40 ft						
40								

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory Gamewell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-16D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 69.80 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/13/16
DATE COMPLETED: 7/13/16

NORTHING: 3,659,491.31
EASTING: 11,810,173.48
GS ELEVATION: 20.35 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
0	20	0.00 - 10.00 Sand, fine to medium-grained sand, trace silt and clay, brown, no odor, dry, compact.	SP				1	MACRO CORE	N/A		4.10 / 5.00		**WELL CASING** Interval: 0' to 60.0' Material: PVC Diameter: 2" Joint Type: threaded **WELL COMPLETION** Pad: 3' by 3' concrete Protective Casing: 4" by 4" Aluminum **ANNULUS SEAL** Interval: 0' to 53.5' Type: Bentonite Grout **FILTER PACK SEAL** Interval: 53.5' to 57.0' Type: Bentonite Chip **FILTER PACK** Interval: 57.0' to 60.0' Type: No. 2 DSI Sand **WELL SCREEN** Interval: 60.0' to 70.0' Material: PVC Diameter: 2" Slot Size: 0.010" End Cap: 2"
5	15						2	MACRO CORE	N/A		1.90 / 5.00		
10	10	10.00 - 20.00 Sand, fine to medium-grained sand, trace silt and clay, brown, no odor, dry, compact to loose.	SP		10.35 10.00		3	MACRO CORE	N/A		2.50 / 5.00		
15	5						4	MACRO CORE	N/A		1.30 / 5.00		
20		Log continued on next page			0.35								

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-16D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 69.80 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/13/16
DATE COMPLETED: 7/13/16

NORTHING: 3,659,491.31
EASTING: 11,810,173.48
GS ELEVATION: 20.35 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
20	0	20.00 - 22.00 Sand, fine to medium-grained sand, trace silt and clay, brown, no odor, damp to moist, compact to loose.	SP		20.00 -1.65								
		22.00 - 24.00 Silty sand, fine to medium-grained sand, trace clay, no odor, wet, compact to dense, grayish-brown.	SM		22.00 -3.65		5	MACRO CORE	N/A		3.00 / 5.00		
		24.00 - 33.00 Sand, fine to coarse-grained sand, some silt, trace fine gravel, no odor, saturated, dense, grayish-brown to brown.	SP		24.00								
25	-5						6	MACRO CORE	N/A		2.50 / 5.00	Bentonite Grout	
30	-10						7	MACRO CORE	N/A		3.50 / 4.00		
		33.00 - 38.00 Silty clay, damp to moist, no odor, hard.	CH		33.00 -17.65								
35	-15	38.00 - 43.00 Sandy silt with clay, fine-grained sand, no odor, olive green, damp to dry, stiff.	ML		38.00		8	2 IN SS	7 -10 -14 -20	24	2.00 / 2.00		
40		Log continued on next page											

WELL CASING
Interval: 0' to 60.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 53.5'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 53.5' to 57.0'
Type: Bentonite Chip

FILTER PACK
Interval: 57.0' to 60.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 60.0' to 70.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-16D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 69.80 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/13/16
DATE COMPLETED: 7/13/16

NORTHING: 3,659,491.31
EASTING: 11,810,173.48
GS ELEVATION: 20.35 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
40	-20	38.00 - 43.00 Sandy silt with clay, fine-grained sand, no odor, olive green, damp to dry, stiff. *(Continued)*	ML		-22.65								
		43.00 - 48.00 Sandy silt with clay, fine-grained sand, no odor, olive green, damp to moist, very stiff.			43.00		9	2 IN SS	13 -17 -17 -21	34	2.00 / 2.00		
45	-25		ML		-27.65								
		48.00 - 53.50 Sandy silt with clay, fine-grained sand, no odor, green to light green, damp to moist, stiff.			48.00		10	2 IN SS	8 -11 -12 -25	23	2.00 / 2.00		
50	-30		ML		-33.15								
		53.50 - 54.25 Silty sand, fine to medium-grained sand, greenish-gray.	SM		53.50 -33.90		11	2 IN SS	10 -13 -13 -18	26	2.00 / 2.00		
		54.25 - 58.00 Sandy silt with clay, fine-grained sand, no odor, green to light green, damp to moist, stiff.			54.25							Bentonite Chip	
55	-35		ML		-37.65								
		58.00 - 63.00 Silty sand, fine to coarse-grained sand, some clay, no odor, light green to grayish-green, moist to wet, very dense.	SM		58.00		12	2 IN SS	23 -26 -26 -50/5.5"	>50	1.50 / 2.00		
60		Log continued on next page											

WELL CASING
Interval: 0' to 60.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 53.5'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 53.5' to 57.0'
Type: Bentonite Chip

FILTER PACK
Interval: 57.0' to 60.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 60.0' to 70.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-16D

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 69.80 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/13/16
DATE COMPLETED: 7/13/16

NORTHING: 3,659,491.31
EASTING: 11,810,173.48
GS ELEVATION: 20.35 ft

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
60	-40	58.00 - 63.00 Silty sand, fine to coarse-grained sand, some clay, no odor, light green to grayish-green, moist to wet, very dense. *(Continued)*	SM		-42.65								
		63.00 - 68.00 Sand, fine to coarse-grained sand, trace gravel, some silt and clay, grayish-green, no odor, moist to wet, very dense.			63.00		13	2 IN SS	11 -23 -39 -50/5.5"	>50	1.40 / 2.00	No. 2 DSI Sand	
65	-45		SP		-47.65							0.010" Screen	
		68.00 - 70.00 Sand, fine to coarse-grained sand, trace gravel, some silt and clay, grayish-green, no odor, moist to wet, compact to dense.	SP		68.00 -49.65		14	2 IN SS	8 -15 -14 -26	29	1.40 / 2.00		
70	-50	Boring completed at 69.80 ft			70.00								
75	-55												
80													

WELL CASING
Interval: 0' to 60.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 53.5'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 53.5' to 57.0'
Type: Bentonite Chip

FILTER PACK
Interval: 57.0' to 60.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 60.0' to 70.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

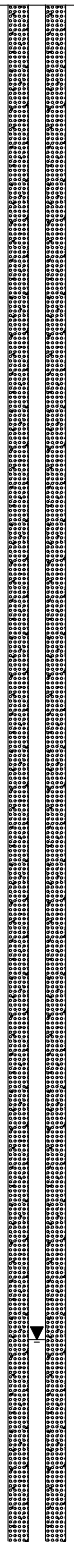
NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	20	0.00 - 10.00 Sand, fine to medium grained, trace silt and clay, brown, no odor, dry, compact.	SP			1	MACRO CORE			4.10 / 5.00
5	15					2	MACRO CORE			1.90 / 5.00
10	10				11.01					
		10.00 - 20.00 Sand, fine to medium grained, trace silt and clay, brown, no odor, dry, compact to loose.			10.00	3	MACRO CORE			2.50 / 5.00
15	5		SP			4	MACRO CORE			1.30 / 5.00
20					1.01					

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 150.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 140.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 140.0' to 146.0'
Type: Bentonite

FILTER PACK
Interval: 146.0' to 160.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 150.0' to 160.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 6 5/8 mud rotary roller bit
Notes:

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20	0	20.00 - 22.00 Sand, fine to medium grained, trace silt and clay, brown, no odor, damp to moist, compact to loose.	SP		20.00 -0.99					
		22.00 - 24.00 Silty sand, fine to medium grained, trace clay, no odor, wet, compact to dense, grayish-brown.	SM		22.00 -2.99	5	MACRO CORE			3.00 / 5.00
25	-5	24.00 - 33.00 Sand, fine to coarse grained, some silt, trace fine gravel, no odor, saturated, dense, grayish-brown to brown.	SP		24.00	6	MACRO CORE			2.50 / 5.00
30	-10					7	MACRO CORE			3.50 / 4.00
		33.00 - 38.00 Silty clay, damp to moist, no odor, hard.	CH		33.00 -16.99					
35	-15	38.00 - 43.00 Sandy silt with clay, fine-grained sand, no odor, olive green, damp to dry, stiff.	ML		38.00	8	2 IN SS	7-10-14-20	24	2.00 / 2.00
40		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

WELL CONSTRUCTION DETAILS / COMMENTS

SAMPLE NOTES:
Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40		38.00 - 43.00 Sandy silt with clay, fine-grained sand, no odor, olive green, damp to dry, stiff. *(Continued)*	ML		-21.99							
	-20											
		43.00 - 48.00 Sandy silt with clay, fine-grained sand, no odor, olive green, damp to moist, very stiff.	ML		43.00	9	2 IN SS	13-17-17-21	34	2.00 / 2.00		
45					-26.99							
	-25											
		48.00 - 53.50 Sandy silt with clay, fine-grained sand, no odor, green to light green, damp to moist, stiff.	ML		48.00	10	2 IN SS	8-11-12-25	23	2.00 / 2.00		
50					-32.49							**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.
	-30	53.50 - 54.25 Silty sand, fine to medium-grained, greenish-gray.	SM		53.50 -33.24	11	2 IN SS	10-13-13-18	26	2.00 / 2.00		
		54.25 - 58.00 Sandy silt with clay, fine-grained sand, no odor, green to light green, damp to moist, stiff.	ML		54.25							
55					-36.99							
	-35											
		58.00 - 63.00 Silty sand, fine to coarse-grained, some clay, no odor, light green to grayish-green, moist to wet, very dense.	SM		58.00	12	2 IN SS	23-26-26-50	>50	1.50 / 2.00		
60		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N / REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
60	-40	58.00 - 63.00 Silty sand, fine to coarse-grained, some clay, no odor, light green to grayish-green, moist to wet, very dense. *(Continued)*	SM		-41.99						
		63.00 - 68.00 Sand, fine to coarse-grained, trace gravel, some silt and clay, grayish-green, no odor, moist to wet, very dense.	SP		63.00	13	2 IN SS	11-23-39-50	>50 1.40/2.00		
65	-45				-46.99						
		68.00 - 70.00 Sand, fine to coarse-grained, trace gravel, some silt and clay, grayish-green, no odor, moist to wet, compact to dense.	SP		68.00	14	2 IN SS	8-15-14-26	29 1.40/2.00		
70	-50				-48.99					Bentonite Grout	
		70.00 - 95.00 Sand, fine to coarse-grained, some small sandy clay strips, light-gray to green.	SP		70.00	15	CUTTINGS		10.00		**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.
75	-55										
80		Log continued on next page									

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
80		70.00 - 95.00 Sand, fine to coarse-grained, some small sandy clay strips, light-gray to green. *(Continued)*										
	-60											
85						16	CUTTINGS			10.00		
	-65											
			SP									
90												**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.
	-70											
					-73.99							
95		95.00 - 110.00 Clay, light green, some fine sand, trace coarse sand.			95.00	17	CUTTINGS			10.00		
	-75											
			CH									
100		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
100		95.00 - 110.00 Clay, light green, some fine sand, trace coarse sand. *(Continued)*										
	-80											
105			CH			18	CUTTINGS			10.00		
	-85											
110					-88.99							
		110.00 - 120.00 Clay, reddish-brown with large chips.			110.00							**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.
	-90											
115			CH			19	CUTTINGh			10.00		
	-95											
120					-98.99							
		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
120		120.00 - 130.00 Clay, light gray, large chips.			120.00							
	-100											
125			CH			20	CUTTINGS			10.00		
	-105											
					-108.99							
130		130.00 - 140.00 Sandy clay, fine to coarse-grained, green.			130.00							**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.
	-110											
135			CH			21	CUTTINGS			10.00		
	-115											
					-118.99							
140		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
140	-120	140.00 - 150.00 Dense thin siltstone lenses (fragments) interbedded with sandy clay, fine to coarse-grained, green.	CH		140.00						Bentonite Grout	
145	-125											
150	-130				-128.99							
		150.00 - 155.00 Dense thin siltstone lenses (fragments) interbedded with clay with fine to coarse-grained sand, green.	CH		150.00						No. 2 DSI Sand	**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.
155	-135				-133.99						0.010" Screen	
		155.00 - 156.00 Sand cuttings. Granitic bedrock or boulders.	Rock		155.00							
		156.00 - 157.50 No resistance on drill bit (soft clay or void).	Void		-134.99 156.00							
160		157.50 - 175.00 Sand cuttings. Granitic bedrock.	Rock		-136.49 157.50							
		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-16DD

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 175.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/28/16
DATE COMPLETED: 9/28/16

NORTHING: 3,659,495.58
EASTING: 11,810,159.40
GS ELEVATION: 21.01 ft
TOC ELEVATION: 23.64 ft

DEPTH W.L.: 17.38 ft
ELEVATION W.L.: 3.63 ft
DATE W.L.: 10/6/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
160		157.50 - 175.00 Sand cuttings. Granitic bedrock. *(Continued)*										
	-140										No. 2 DSI Sand Backfill	
165											Bentonite Chip	
	-145		Rock									
170											No. 2 DSI Sand Backfill	**SAMPLE NOTES:** Split spoon data from adjacent borehole MW-16D. Ran geophysical log on open borehole.
	-150											
175					-153.99							
		Boring completed at 175.00 ft										
	-155											
180												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

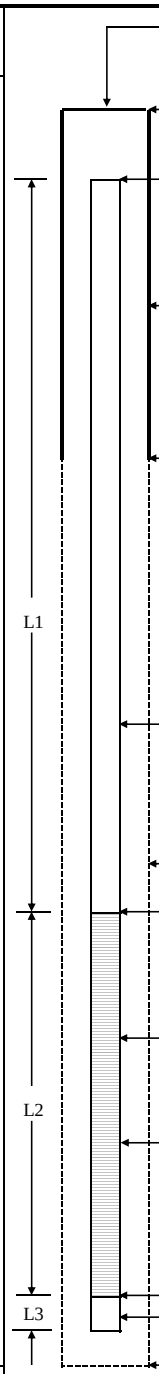
Well No.	Boring No.
MW-17S	MW-17S

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	H. Hollauer
CONTRACTOR	Cascade Drilling	**DATE INSTALLED**	6/20/2016
DRILLER	Chris Ruffer		

Ground El. - ft **Location** See plan ☑ **Guard Pipe** ☐ **Roadway Box**

El. Datum -

SOIL/ROCK CONDITIONS	BOREHOLE BACKFILL
See boring log	0.0 Concrete 2.0 Bentonite 16.0 Bentonite Seal 18.0 Sand



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe

Length 5.0 ft

Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	14.0
Bentonite Seal	16.0	2.0
Filter Sand	18.0	12.5

Type of riser pipe: Schedule 40 PVC

Inside diameter of riser pipe 2.1 in

Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 20.0 ft

Type of screen PVC

Screen gauge or size of openings 0.010 in

Diameter of screen 2.0 in

Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 30.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 30.5 ft

(Bottom of Exploration)

(Numbers refer to depth from ground surface in feet)

(Not to Scale)

20 ft	+	10 ft	+	0.5 ft	=	30.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT DRAFT

Boring No. MW-17S

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Cascade Drilling

File No. 42735-001
Sheet No. 1 of 2
Start June 20, 2016
Finish June 20, 2016
Driller C. Ruffer
H&A Rep. H. Hollauer
Elevation 9.0
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	Sonic	-	-	Rig Make & Model: Track mounted TS: 150 CE
Inside Diameter (in.)	6.875	-	-	Bit Type:
Hammer Weight (lb)	-	-	-	Drill Mud: None
Hammer Fall (in.)	-	-	-	Casing: Override
				Hoist/Hammer: None
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0		S1 10	0.0 10.0	SM		Orange-brown silty SAND (SM), mps less than 4.75 mm, no odor, no structure, slightly moist	--	--	5	5	70	20				
					1.0 8.0	-FILL/REWORKED NATIVE-										
10		S2 10	10.0 20.0	SM		Red-brown silty SAND (SM), mps 2.0 in., no odor, no structure, moist, gravel rounded	5	5	5	5	60	20				
15				SM	-6.0 15.0	Orange-brown to light gray silty SAND (SM), mps 1.0 in., no odor, no structure, gravel rounded, slightly bonded, slightly moist	5	5	15	15	30	30				
20		S3 10	20.0 30.0			Note: Gravel increasing with depth. -FLUVIAL DEPOSITS-										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
Refer to groundwater level table					

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 30.5
Rock Cored (ft) -
Samples 3S

Boring No. MW-17S

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV HA-LIB10.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT Z:\42735\GINT\42735-001_TB.GPJ Nov 9, 16

HALEY ALDRICH

TEST BORING REPORT DRAFT

Boring No. MW-17S
File No. 42735-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																
30				SM	-21.5	-FLUVIAL DEPOSITS-										
					30.5	Orange-brown and light-gray slightly bonded silty SAND with gravel (SM), mps 0.5 in., no odor, no structure, slightly moist	--	20	10	10	35	25				
						BOTTOM OF EXPLORATION 30.5 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-17S

H&A-TEST BORING-09 REV HA-LIB10.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT Z:\42735\GINT\42735-001_TB.GPJ Nov 9, 16

RECORD OF BOREHOLE MW-20

SHEET 1 of 2

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 4.25-inch HSA

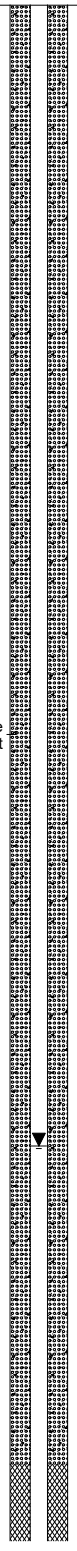
DRILL RIG: CME-55
DATE STARTED: 7/21/16
DATE COMPLETED: 8/2/16

NORTHING: 3,663,340.91
EASTING: 11,808,794.84
GS ELEVATION: 19.16 ft
TOC ELEVATION: 21.30 ft

DEPTH W.L.: 14.86 ft
ELEVATION W.L.: 4.30 ft
DATE W.L.: 10/7/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0		0.00 - 11.00 Sand, fine to medium-grained sand, some silt and clay, trace cobbles, brown to orange brown, no odor, dry, compact.	SP			1	CUT'G			10.00
					8.16					
		11.00 - 12.50 Sand, fine to medium-grained, some silt and clay, trace cobbles, brown to orange brown, no odor, dry, compact.	SP		11.00					
					6.66	2	MACRO CORE			5.00 5.00
		12.50 - 14.00 Silt, some clay, grayish-brown, no odor, saturated, soft.	ML		12.50					
					5.16					
		14.00 - 18.00 Silty clay, trace of fine-grained sand, brown to orangish-brown, no odor, wet, stiff.	CL		14.00					
					1.16	3	MACRO CORE			5.00 5.00
		18.00 - 24.00 Silty sand, some clay, fine to medium-grained sand, brown to orangish-brown, no odor, saturated, compact.	SM		18.00					
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 22'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 19'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 19' to 22'
Type: Bentonite Chips

FILTER PACK
Interval: 22' to 35'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 25' to 35'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25-inch HSA
Notes:

SAMPLE NOTES:
Boring vacuum extracted to 8 feet before drilling. Refusal with direct push at 25 feet, boring finished and reamed with augers for well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-20

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 7/21/16
DATE COMPLETED: 8/2/16

NORTHING: 3,663,340.91
EASTING: 11,808,794.84
GS ELEVATION: 19.16 ft
TOC ELEVATION: 21.30 ft

DEPTH W.L.: 14.86 ft
ELEVATION W.L.: 4.30 ft
DATE W.L.: 10/7/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		18.00 - 24.00 Silty sand, some clay, fine to medium-grained sand, brown to orangish-brown, no odor, saturated, compact. *(Continued)*	SM			4	MACRO CORE			2.80 / 5.00	Bentonite Chip	
					-4.84							
	-5	24.00 - 28.50 Sand, fine to coarse-grained sand, some silt, trace fine gravel, brown to orangish-brown, saturated, dense.	SP		24.00							
25												
					-9.34							
	-10	28.50 - 35.00 Clayey sand, fine to medium-grained sand, some silt, grayish-brown to light brown, no odor, wet, compact.	SC		28.50	5	2 IN SS	3-7-9	16	1.10 / 1.50	No. 2 DSI Sand	
30											0.010" Screen	**SAMPLE NOTES:** Boring vacuum extracted to 8 feet before drilling. Refusal with direct push at 25 feet, boring finished and reamed with augers for well construction.
	-15					6	2 IN SS	1-12-11	23	1.50 / 1.50		
35		Boring completed at 35.00 ft			-15.84							
	-20											
40												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. MW-21
Boring No. MW-21

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	J. Yonts
CONTRACTOR	Fishburne Drilling	**DATE INSTALLED**	6/23/2016
DRILLER	J. Raasio		

Ground El. - ft
El. Datum -

Location See plan

☑ **Guard Pipe**
☐ **Roadway Box**

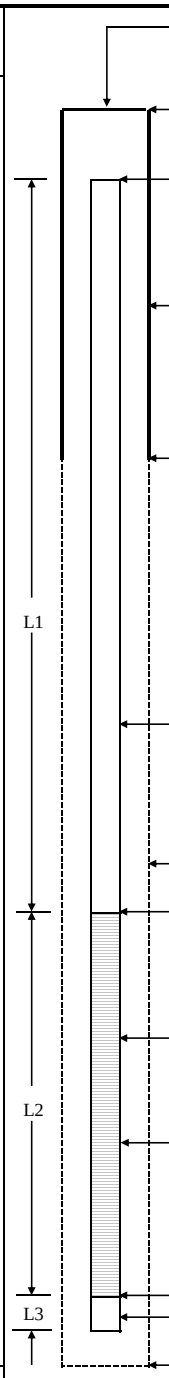
SOIL/ROCK CONDITIONS

See boring log

BOREHOLE BACKFILL

0.0
Concrete
2.0
Bentonite
11.0
Bentonite Seal
13.0
Sand
(Bottom of Exploration)

(Numbers refer to depth from ground surface in feet)



(Not to Scale)

Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	9.0
Bentonite Seal	11.0	2.0
Filter Sand	13.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 15.00 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 25.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 25.5 ft

15 ft	+	10 ft	+	0.5 ft	=	25.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-21

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Geologic Exploration, Inc.

File No. 42735-001
Sheet No. 1 of 3
Start June 30, 2016
Finish June 30, 2016
Driller B. Thomas
H&A Rep. H. Hollauer
Elevation 10.0
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: Track mounted Diedrich D-120
Inside Diameter (in.)	4.25	1 3/8	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: HSA
				Hoist/Hammer: Automatic Hammer
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	1 5 3 1	S1 14	0.0 2.0		SP	Loose gray-brown poorly-graded SAND (SP), mps 0.5 in., no odor, no structure, dry	--	5	--	10	80	5				
				7.0 3.0		-FILL-										
5	1 1 WOH WOH	S2 7	4.0 6.0		ML	Very soft gray-brown SILT with sand (ML), mps less than 0.43 mm, organic odor, no structure, moist, trace clay, trace roots	--	--	--	--	20	80				
10	4 4 3 3	S3 16	9.0 11.0		ML	Medium stiff gray and orange-brown SILT (ML), trace clay, mps less than 0.43 mm, no odor, mottled, moist	--	--	--	--	10	90				
15	3 3 3 2	S4 16	14.0 16.0		ML	Similar to S3, except fine sand increases slightly, orange-brown	--	--	--	--	20	80				
20	30 34 36 40	S5 22	19.0 21.0	-9.5 19.5	SW-SM	Very dense orange-brown well-graded SAND with silt and gravel (SW-SM), mps 1.0 in., no odor, no structure, wet	10	10	25	30	15	10				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
Refer to groundwater level table					

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 81.0
Rock Cored (ft) -
Samples 17S

Boring No. MW-21

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-21
File No. 42735-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25	14 18 23 27	S6	24.0 26.0	-18.0 28.0	SW-SM	Similar to S5, except dense	10	10	25	30	15	10				
30	14 13 8 9	S7 14	29.0 31.0	-20.5 30.5	SW-SM	Similar to S6, except medium dense	10	10	25	30	15	10				
					SM	Dark gray silty CLAY on top of medium dense medium gray silty SAND (SM), trace clay, mps less than 40, no odor, depositional structure, moist to wet Note: Color change to orange-brown in spoon at approximately 30.9 ft.	--	--	--	--	70	30				
35	14 22 28 30	S8 0	34.0 36.0			No recovery										
				-27.0 37.0												
40	11 23 25 27	S9 16	39.0 41.0		SM	Dense gray to orange-brown silty SAND (SM), trace clay, mps 0.5 in., contains coarse gravel, no odor, no structure, moist to wet	5	5	--	--	60	30				
45	14 22 27 34	S10 16	44.0 46.0		SM	Similar to S9, except coarser sand, gray, wet	5	5	15	20	30	25				
50	15 36 50/5"	S11 8	49.0 50.4		SC	Very dense gray silty SAND with gravel (SC), mps 1.0 in., trace clay, no odor, no structure, wet	10	10	20	20	20	20				
55		S12 0	54.0 56.0			No recovery										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-21

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-21
File No. 42735-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
				-47.5 / 57.5												
60	28 28 33 36	S13 12	59.0 61.0		ML	Hard green-gray clayey SILT (ML), mps less than 0.074 mm, no odor, no structure, wet, sample disturbed, possibly by plug at bottom	--	--	--	--	--	100				
65	11 11 12 14	S14 10	64.0 66.0		ML	Very stiff dark gray SILT (ML), mps less than 0.074 mm, no odor, no structure, moist	--	--	--	--	--	100				
70	9 9 33 40	S15 14	69.0 71.0		ML	Similar to S14, except gray-brown, hard	--	--	--	--	--	100				
75	38 42 44 50/6"	S16 18	74.0 76.0		ML	Hard dark gray sandy SILT (ML), mps less than 0.43 mm, no odor, no structure, damp to moist	--	--	--	--	70	30				
				-67.0 / 77.0												
80	23 33 38 41	S17 22	79.0 81.0			Hard/very dense red and light gray-green with red SAPROLITE										
				-71.0 / 81.0		BOTTOM OF EXPLORATION 81.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-21

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

RECORD OF BOREHOLE MW-22

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

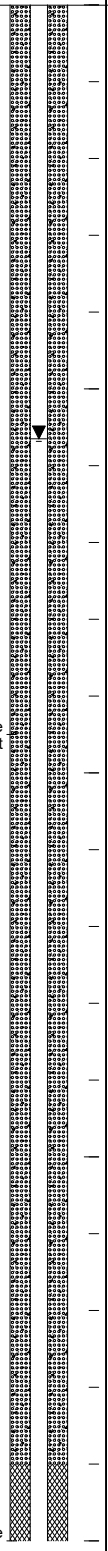
DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/7/16
DATE COMPLETED: 7/8/16

NORTHING: 3,662,650.43
EASTING: 11,809,438.06
GS ELEVATION: 10.43 ft
TOC ELEVATION: 12.33 ft

DEPTH W.L.: 5.65 ft
ELEVATION W.L.: 4.78 ft
DATE W.L.: 7/8/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT
0	10	0.00 - 8.00 No sample, soil boring vacuum extracted to 8 feet below grade per Digging, Drilling, Cutting permit.	Fill		2.43	8.00 8.00
5	5	8.00 - 10.50 Silty sand to well graded sand, dark gray to gray-brown.	SW		8.00 -0.07	2.00 2.00
10	0	10.50 - 14.00 Silty sand mottled dark gray and olive brown.	SW		10.50 -3.57	5.00 5.00
15	-5	14.00 - 19.00 Silty gravel, fines mottled gray and yellowish-brown.	GP		14.00 -8.57	3.50 5.00
20		19.00 - 32.00 Silty sand, well graded sand, mottled gray and reddish-brown. Log continued on next page	SW		19.00	

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 21'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 19'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 19' to 21'
Type: Bentonite Chips

FILTER PACK
Interval: 21' to 33'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 23' to 33'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25 inch HSA and MacroCore Samples
Notes:

WELL NOTES:
Floodplain well head

SAMPLE NOTES:
Fill, borehole vacuum extracted to 8 feet below grade.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: G. Morelli
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-22

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 4.25 inch HSA and MacroCore Samples

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/7/16
DATE COMPLETED: 7/8/16

NORTHING: 3,662,650.43
EASTING: 11,809,438.06
GS ELEVATION: 10.43 ft
TOC ELEVATION: 12.33 ft

DEPTH W.L.: 5.65 ft
ELEVATION W.L.: 4.78 ft
DATE W.L.: 7/8/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20	-10	19.00 - 32.00 Silty sand, well graded sand, mottled gray and reddish-brown. *(Continued)*	SW			3.00 / 5.00	Chip	
25	-15					3.00 / 5.00	No. 2 DSI Sand 0.010" Screen	**WELL NOTES:** Floodplain well head **SAMPLE NOTES:** Fill, borehole vacuum extracted to 8 feet below grade.
30	-20				-21.57			
		32.00 - 33.00 Sand and gravel, rounded gravel, reddish-brown fines.	GP		32.00 -22.57	3.00 / 5.00		
		33.00 - 35.00 Sandy silt, black.	ML		33.00		No. 2 DSI Sand	
35	-25	Boring completed at 35.00 ft			-24.57			
40								

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & CAI
DRILLER: Cory, J. Leatherman

PREPARED: G. Morelli
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

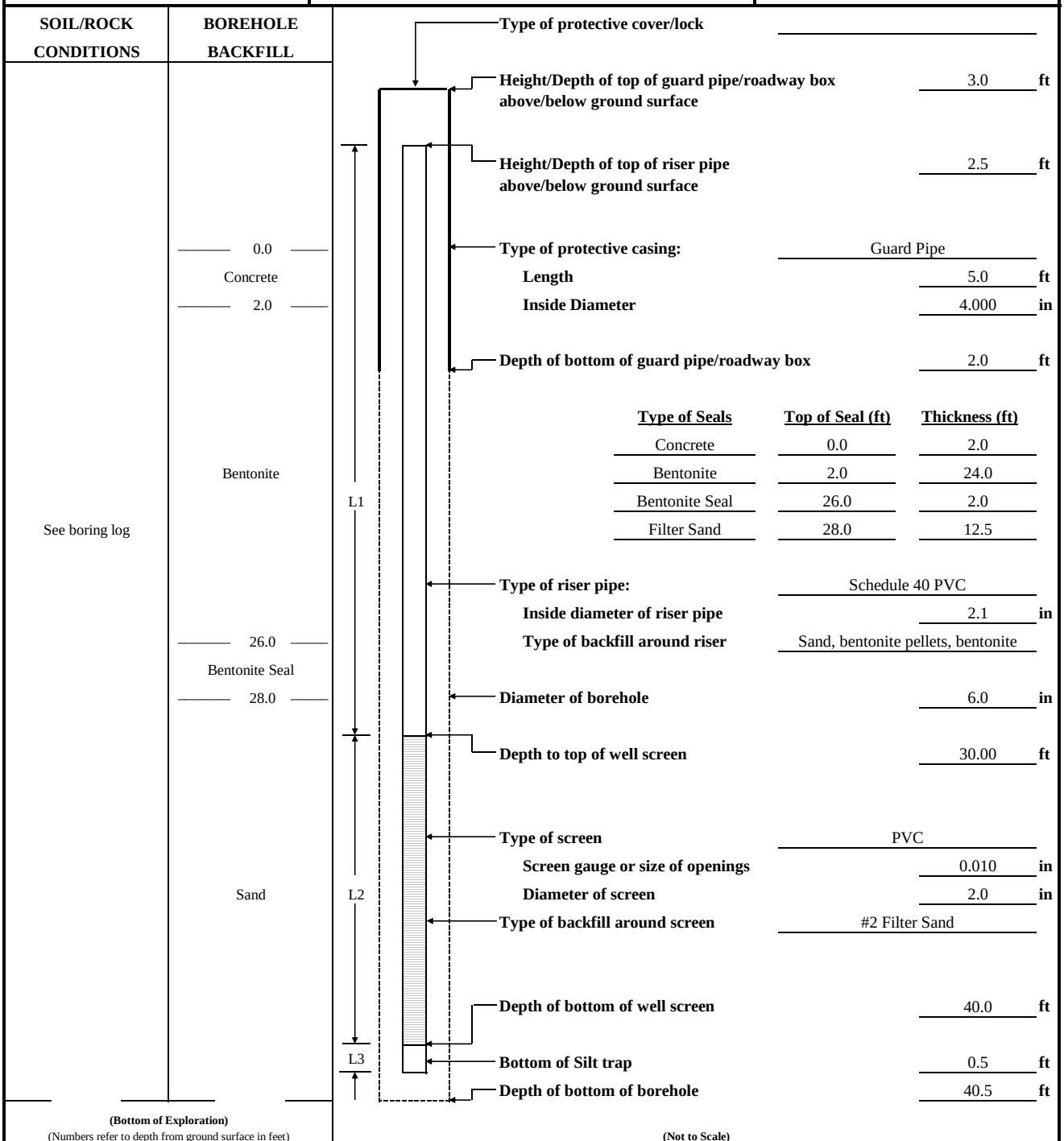
Well No.	Boring No.
MW-23	MW-23

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	H. Hollauer
CONTRACTOR	Geologic Exploration	**DATE INSTALLED**	6/29/2016
DRILLER	B. Thomas		

Ground El. - ft
El. Datum -

Location See plan

☑ **Guard Pipe**
☐ **Roadway Box**



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	24.0
Bentonite Seal	26.0	2.0
Filter Sand	28.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 30.00 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 40.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 40.5 ft

30 ft	+	10 ft	+	0.5 ft	=	40.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

Form 2007

TEST BORING REPORT

Boring No. MW-23

Project	Dominion Power/Chesterfield, Chester, VA
Client	Dominion
Contractor	Fishburne Drilling Inc.

File No. 42735-001
Sheet No. 1 of 2
Start June 29, 2016
Finish June 29, 2016
Driller B. Thomas
H&A Rep. H. Hollauer
Elevation 6.3
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	-	Rig Make & Model: Track mounted Diedrich D-120
Inside Diameter (in.)	4.25	1 3/8	-	Bit Type: Cutting Head
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: HSA
				Hoist/Hammer: Safety Hammer
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	2 3 4 4	S1 24	0.0 2.0		SM	Loose orange-brown and gray silty SAND (SM), mps less than 2.0 mm, no odor, no structure, damp to moist, coarser with depth	--	--	5	5	55	35				
				2.3		-FILL-										
	9 10 4 2	S2 18	4.0 6.0	4.0	SM	Medium dense gray-brown silty SAND (SM), mps less than 4.75 mm, no odor, slight depositional structure, moist to wet	--	5	5	10	50	30				
5				-1.7 8.0												
	1 1 1 1	S3 20	9.0 11.0		ML	Very soft dark gray clayey SILT (ML), mps less than 0.074 mm, depositional structure, slight organic odor, wet, trace decomposed wood	--	--	--	--	--	100				
10																
	4 1 1 2	S4 16	14.0 16.0		ML	Similar to S3	--	--	--	--	--	100				
15						-FLUVIAL DEPOSITS										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 41.0
Rock Cored (ft) -
Samples 9S

Boring No. MW-23

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-23
File No. 42735-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	3 2 3 4	S5 16	19.0 21.0		ML	Similar to S4, except one piece of gravel, soft	5	--	--	--	--	95				
				-16.7 23.0												
25	2 3 5 6	S6 20	24.0 26.0		SM	Loose dark gray silty SAND (SM), mps less than 0.43 mm, no odor, depositional structure, moist to wet, trace roots	--	--	--	--	60	40				
30	3 5 6 8	S7 18	29.0 31.0		ML	Stiff gray-brown sandy SILT (ML), mps less than 0.43 mm, no odor, slight depositional structure, moist	--	--	--	--	35	65				
35	2 6 5 6	S8 15	34.0 36.0	-29.2		-FLUVIAL DEPOSITS-										
				35.5	SM	Medium dense gray-brown silty SAND (SM), mps less than 0.43 mm, no odor, no structure, wet	--	--	--	--	85	15				
40	2 5 6 8	S9 15	39.0 41.0		SM	Similar to S8	--	--	--	--	85	15				
				-34.7		-NEED STRATA-										
				41.0		BOTTOM OF EXPLORATION 41.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-23

H&A-TEST BORING-09 HA-LIB09-BOS.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-001_TB.GPJ Jul 14, 16

RECORD OF BOREHOLE MW-24

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

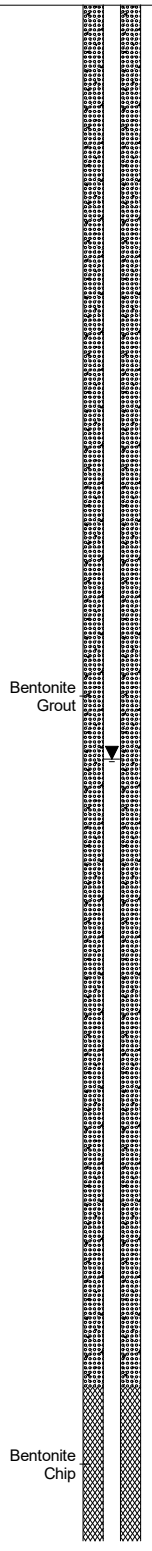
DRILL RIG: CME-55
DATE STARTED: 9/19/16
DATE COMPLETED: 9/19/16

NORTHING: 3,660,510.02
EASTING: 11,808,151.46
GS ELEVATION: 16.15 ft
TOC ELEVATION: 18.66 ft

DEPTH W.L.: 9.82 ft
ELEVATION W.L.: 6.33 ft
DATE W.L.: 9/19/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT
0	15	0.00 - 5.00 Sand, poorly sorted, brown.	SP		11.15	5.00 5.00
5	10	5.00 - 11.00 Silty sand with rounded gravel, brown.	SM		5.15	5.00 5.00
	5	11.00 - 12.00 Clayey sand, black.	SC		11.00 4.15	
		12.00 - 13.00 Sand and gravel. Rig chattering at 12 to 13 feet.	GP		12.00 3.15	5.00 5.00
10		13.00 - 17.00 Clayey sand, black.	SC		13.00	
15	0				-0.85	
		17.00 - 20.50 Sand with rounded gravel, trace clay, brownish-black.	SP		17.00	5.00 5.00
20		Log continued on next page				

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 20'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 18'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 18' to 20'
Type: Bentonite Chips

FILTER PACK
Interval: 20' to 35'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 25' to 35'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 6 5/8 mud rotary roller bit
Notes:

SAMPLE NOTES:
Borehole drilled with mud rotary.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-24

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: CME-55
DATE STARTED: 9/19/16
DATE COMPLETED: 9/19/16

NORTHING: 3,660,510.02
EASTING: 11,808,151.46
GS ELEVATION: 16.15 ft
TOC ELEVATION: 18.66 ft

DEPTH W.L.: 9.82 ft
ELEVATION W.L.: 6.33 ft
DATE W.L.: 9/19/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL / PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20			SP		-4.35			
		20.50 - 21.50 Sand and gravel. Rig chattering at 21 feet.	GP		20.50 -5.35			
	-5	21.50 - 28.50 Clayey sand, mica flakes, trace organic material (degraded wood), brown.			21.50	5.00 5.00		
25			SC					
	-10					5.00 5.00	No. 2 DSI Sand	
					-12.35			
		28.50 - 29.50 Sand and gravel. Rig chattering at 29 feet.	GP		28.50 -13.35			
30		29.50 - 35.00 Sand with trace gravel, fine-grained sand, brown. Fast drilling 31 to 25 (loose sand).			29.50		0.010" Screen	**SAMPLE NOTES:** Borehole drilled with mud rotary.
	-15		SP			5.00 5.00		
35					-18.85			
		Boring completed at 35.00 ft						
	-20							
40								

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: M. Williams
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-25

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 57.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 9/14/16
DATE COMPLETED: 9/14/16

NORTHING: 3,661,281.36
EASTING: 11,807,565.35
GS ELEVATION: 10.78 ft
TOC ELEVATION: 12.64 ft

DEPTH W.L.: 9.66 ft
ELEVATION W.L.: 1.12 ft
DATE W.L.: 10/12/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
0	10	0.00 - 3.75 Fill, silty sandy clay, fine-grained sand, some decayed organic plant material, slight organic (decayed material) odor, brown to light gray, W>PL, soft.	CL			1	2 IN SS	2-2-2-2	4	2.00 / 2.00		**WELL CASING** Interval: 0' to 45' Material: PVC Diameter: 2" Joint Type: threaded
						2	2 IN SS	3-2-3-3	5	2.00 / 2.00		**WELL COMPLETION** Pad: 3' by 3' concrete Protective Casing: 6" PVC
					7.03							**ANNULUS SEAL** Interval: 0' to 38' Type: Bentonite grout
5		3.75 - 5.50 Silty clay, decayed fiberous organic plant material, light brown to gray, W>PL, no odor.	CL		3.75	3	2 IN SS	2-2-2-3	4	2.00 / 2.00		**FILTER PACK SEAL** Interval: 38' to 40' Type: Bentonite Chips
	5	5.50 - 10.25 Silty clay, trace fine-grained sand and sub-rounded gravel, some decayed fiberous plant material, W>PL, no odor, soft.			5.28 5.50							**FILTER PACK** Interval: 40' to 55' Type: No. 2 DSI Sand
						4	2 IN SS	WOH-12-4-8	16	2.00 / 2.00		**WELL SCREEN** Interval: 45' to 55' Material: PVC Diameter: 2" Slot Size: 0.010" End Cap: 2"
			CL			5	2 IN SS	4-4-7-9	11	0.80 / 2.00		**DRILLING METHODS** Type: 4.25-inch HSA Notes:
10					0.53							**WELL NOTES:** Floodplain well head
	0	10.25 - 14.00 Silty clay, some fine-grained sand, trace sub-rounded gravel up to 1 inch in diameter, light brown, W~PL, no odor, wet at 10 feet, soft.			10.25	6	2 IN SS	3-4-5-7	9	1.60 / 2.00		
			CL			7	2 IN SS	2-4-3-5	7	1.30 / 2.00		
					-3.22							
		14.00 - 23.00 Silty clay, some fine-grained sand, trace sub-rounded gravel up to 1 inch in diameter, gray, W>PL, no odor, very soft.			14.00	8	2 IN SS	1-1-1-1	2	2.00 / 2.00		
15	-5											
			CL			9	2 IN SS	1-1-1-1	2	0.20 / 2.00		
						10	2 IN SS	WOH-1-1-1	2	0.40 / 2.00	Bentonite Grout	
20		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-25

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 57.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 9/14/16
DATE COMPLETED: 9/14/16

NORTHING: 3,661,281.36
EASTING: 11,807,565.35
GS ELEVATION: 10.78 ft
TOC ELEVATION: 12.64 ft

DEPTH W.L.: 9.66 ft
ELEVATION W.L.: 1.12 ft
DATE W.L.: 10/12/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20	-10	14.00 - 23.00 Silty clay, some fine-grained sand, trace sub-rounded gravel up to 1 inch in diameter, gray, W>PL, no odor, very soft. *(Continued)*	CL			11	2 IN SS	WOH-WOH-18-2	0	2.00/2.00		
					-12.22 / 23.00	12	2 IN SS	WOH-WOH-18-3	0	2.00/2.00		
		23.00 - 26.50 Silty clay, some fine-grained sand, trace sub-rounded gravel up to 1 inch in diameter, lenses of decayed fiberous plant material, gray, W>PL, no odor, wet at 24 feet below grade, very soft.	CL			13	2 IN SS	WOH-12-2-4	14	2.00/2.00		
25	-15				-15.72 / 26.50	14	2 IN SS	2-2-2-3	4	2.00/2.00		
		26.50 - 27.50 Organic material, woody decayed fiberous material with silty clay.	OH		-16.72 / 27.50							
		27.50 - 33.00 Silty clay, some fine-grained sand, gray, W>PL, no odor, very soft.	CL			15	2 IN SS	WOH-WOH-18-3	0	2.00/2.00		**WELL NOTES:** Floodplain well head
30	-20					16	2 IN SS	WOH-WOH-18-6	0	2.00/2.00		
					-22.22 / 33.00	17	2 IN SS	12-4-5-5	9	2.00/2.00		
		33.00 - 41.00 Silty clay, trace fine sand, W>PL, gray. soft.	CL			18	2 IN SS	WOH-12-5-7	17	2.00/2.00		
35	-25					19	2 IN SS	WOH-12-3-5	15	2.00/2.00		
						20	2 IN SS	4-5-4-5	9	2.00/2.00	Bentonite Chip	
40		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-25

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 57.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 9/14/16
DATE COMPLETED: 9/14/16

NORTHING: 3,661,281.36
EASTING: 11,807,565.35
GS ELEVATION: 10.78 ft
TOC ELEVATION: 12.64 ft

DEPTH W.L.: 9.66 ft
ELEVATION W.L.: 1.12 ft
DATE W.L.: 10/12/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40		33.00 - 41.00 Silty clay, trace fine sand, W>PL, gray. soft. *(Continued)*	CL									
	-30				-30.22	21	2 IN SS	2-4-6-6	10	2.00 / 2.00		
		41.00 - 50.00 Silty clay, trace fine-grained sand, W>PL, gray to brown, soft.			41.00							
						22	2 IN SS	4-5-5-6	10	2.00 / 2.00		
45						23	2 IN SS	WOH-12-3-4	15	2.00 / 2.00		
	-35		CL									
											No. 2 DSI Sand	**WELL NOTES:** Floodplain well head
50					-39.22							
		50.00 - 51.00 Clayey sand, fine-grained sand, gray, wet, loose.	SC		50.00						0.010" Screen	
	-40				-40.22	24	2 IN SS	3-7-7-9	14	2.00 / 2.00		
		51.00 - 55.00 Sand and gravel, fine-grained sand, gravel is sub- to well-rounded up to 1 inch in diameter, fines are brown, wet, loose.			51.00							
			GP									
55					-44.22							
		55.00 - 57.00 Silty clayey sand, fine to medium-grained sand with some sub- to well-rounded gravel up to 1 inch in diameter, fines are light gray, wet, compact.	SC		55.00							
	-45					25	2 IN SS	2-11-7-12	18	1.20 / 2.00	No. 2 DSI Sand	
					-46.22							
		Boring completed at 57.00 ft										
60												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-26

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/24/16
DATE COMPLETED: 8/24/16

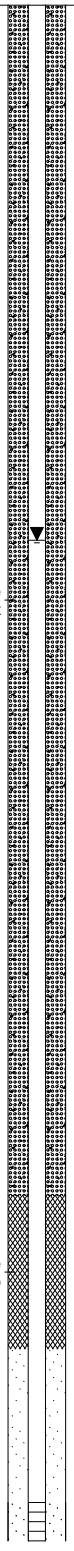
NORTHING: 3,661,811.49
EASTING: 11,807,505.17
GS ELEVATION: 7.85 ft
TOC ELEVATION: 9.71 ft

DEPTH W.L.: 6.97 ft
ELEVATION W.L.: 0.88 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0		0.00 - 4.00 FILL. Silty sandy clay with gravel, fine sub-rounded gravel up to 1 inch in diameter, W<PL, brown, firm, no odor.	CL		3.85	1	2 IN SS	5-4-4-5	8	0.80 / 2.00
	5					2	2 IN SS	5-7-8-9	15	1.60 / 2.00
		4.00 - 7.50 Silty clay, some sub-rounded gravel up to 1 inch in diameter, gray-brown, no odor, W~PL, firm.	CL		4.00	3	2 IN SS	5-4-6-5	10	1.10 / 2.00
5					0.35	4	2 IN SS	3-4-6-11	10	1.30 / 2.00
	0	7.50 - 8.20 Sand, fine to medium-grained sand, some silt, gray, moist, compact.	SP		7.50 -0.35					
		8.20 - 11.50 Silty clay, some fine-grained sand, some rounded gravel up to 0.5-inch diameter, brown, W>PL, soft.	CL		8.20	5	2 IN SS	2-3-3-5	6	1.40 / 2.00
10					-3.65	6	2 IN SS	2-2-3-3	5	1.00 / 2.00
	-5	11.50 - 13.50 Silty clay, trace fine-grained sand, gray, no odor, W>PL, soft, root fragments present.	CL		11.50	7	2 IN SS	WOH-WOH-WOH-WOH	0	2.00 / 2.00
		13.50 - 13.70 Sand, fine-grained.	SW		-5.65 13.70					
		13.70 - 14.50 Silty clay, trace fine-grained sand, gray, no odor, W>PL, soft, root fragments present.	CL		-6.65 14.50					
15		14.50 - 19.50 Silty clay with decayed wood fibers up to 1-inch thick, dark brown, W>PL, soft.	OH			8	2 IN SS	WOH-12-2-1	14	2.00 / 2.00
	-10					9	2 IN SS	WOH-8-2--	10	2.00 / 2.00
						10	2 IN SS	WOH-WOH-WOH-WOH	0	1.60 / 2.00
					-11.65 19.50					
20			CL							

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 19.5'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.0' to 15.5'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 15.5' to 17.5'
Type: Bentonite Chips

FILTER PACK
Interval: 17.5' to 29.5'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 19.5' to 29.5'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25-inch HSA
Notes:

WELL NOTES:
Floodplain well head

SAMPLE NOTES:
140#/30-inch drop auto hammer used.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/8/16

RECORD OF BOREHOLE MW-26

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/24/16
DATE COMPLETED: 8/24/16

NORTHING: 3,661,811.49
EASTING: 11,807,505.17
GS ELEVATION: 7.85 ft
TOC ELEVATION: 9.71 ft

DEPTH W.L.: 6.97 ft
ELEVATION W.L.: 0.88 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		19.50 - 22.00 Silty clay, trace fine-grained sand, trace root fragments, gray to brown, no odor, soft. *(Continued)*	CL		-14.15	11	2 IN SS	WOH-18-4--	22	2.00 / 2.00		
	-15	22.00 - 26.00 Silty clay, trace fine-grained sand, trace sub-angular to sub-rounded gravel up to 1-inch diameter, brownish-gray to brown, W>PL, soft.	CL		22.00	12	2 IN SS	2-3-3-4	6	- / 2.00	No. 2 DSI Sand	
25					-18.15	13	2 IN SS	3-3-8-27	11	- / 2.00	0.010" Screen	
	-20	26.00 - 30.00 Silty clayey sand and gravel, fine to medium-grained sand, sub-rounded gravel up to 2-inch diameter, brown, wet, loose.	SP		26.00	14	2 IN SS	4-11-14-7	25	- / 2.00		
						15	2 IN SS	4-7-9-13	16	- / 2.00	No. 2 DSI Sand	**WELL NOTES:** Floodplain well head
30		Boring completed at 30.00 ft			-22.15							**SAMPLE NOTES:** 140#/30-inch drop auto hammer used.
	-25											
35												
	-30											
40												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-27

SHEET 1 of 2

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: 4.25-inch HSA

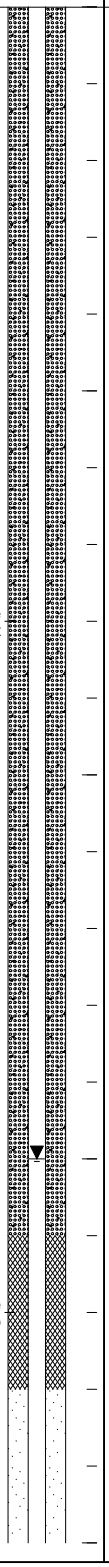
DRILL RIG: CME-850
DATE STARTED: 8/25/16
DATE COMPLETED: 8/25/16

NORTHING: 3,662,287.10
EASTING: 11,807,604.24
GS ELEVATION: 15.44 ft
TOC ELEVATION: 17.15 ft

DEPTH W.L.: 15.00 ft
ELEVATION W.L.: 0.44 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	15	0.00 - 4.00 FILL, silty clay and gravel, trace fine-grained sand, brown, no odor, W<PL, firm, quartzite gravel up to 2-inch diameter, sub- to well-rounded.	CL			1	2 IN SS	4-6-7-11	13	1.70 / 2.00
						2	2 IN SS	10-21-34-21	>50	1.10 / 2.00
					11.44 / 4.00					
5	10	4.00 - 10.00 Silty clay,some gravel, trace fine-grained sand, gray to brown, no odor, W<PL, firm, gravel up to 1-inch diameter.	CL			3	2 IN SS	18-10-8-7	18	1.80 / 2.00
						4	2 IN SS	9-22-13-17	35	1.80 / 2.00
						5	2 IN SS	14-14-10-12	24	1.70 / 2.00
10	5	10.00 - 14.50 Silty clay, trace fine-grained sand, gray, no odor, W>PL, soft.	CL		5.44 / 10.00	6	2 IN SS	3-3-2-2	5	0.50 / 2.00
						7	2 IN SS	WOH-WOH-WOH-24	0	2.00 / 2.00
					0.94 / 14.50	8	2 IN SS	WOH-WOH-4-4	0	1.50 / 2.00
15	0	14.50 - 16.50 Silty clay, trace fine-grained sand, gray, no odor, W>PL, soft to firm.	CL							
		16.50 - 18.50 Gravelly sandy clay, fine to medium-grained sand, sub-rounded gravel up to 1.5-inch diameter, brown to tan, W>PL, soft.	CL		-1.06 / 16.50	9	2 IN SS	2-5-7-8	12	0.70 / 2.00
		18.50 - 25.00 Silty sand and gravel, some clay, fine to coarse-grained sand, gravel rounded to sub-rounded up to 1.5-inch diameter, brown to dark brown, wet, compact.	SP		-3.06 / 18.50	10	2 IN SS	7-8-34-25	42	1.50 / 2.00
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 20.'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 16.0
Type: Bentonite grout

FILTER PACK SEAL
Interval: 16.0 to 18.0'
Type: Bentonite Chips

FILTER PACK
Interval: 18.0' to 3.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 20.0' to 30.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25-inch HSA
Notes:

WELL NOTES:
Floodplain well head

SAMPLE NOTES:
140#/30-inch drop auto hammer used.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-27

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-850
DATE STARTED: 8/25/16
DATE COMPLETED: 8/25/16

NORTHING: 3,662,287.10
EASTING: 11,807,604.24
GS ELEVATION: 15.44 ft
TOC ELEVATION: 17.15 ft

DEPTH W.L.: 15.00 ft
ELEVATION W.L.: 0.44 ft
DATE W.L.: 10/4/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20	-5	18.50 - 25.00 Silty sand and gravel, some clay, fine to coarse-grained sand, gravel rounded to sub-rounded up to 1.5-inch diameter, brown to dark brown, wet, compact. *(Continued)*	SP			11	2 IN SS	13-13-17-16	30	1.80 / 2.00		
						12	2 IN SS	9-1-2-16	3	1.30 / 2.00	No. 2 DSI Sand	
25	-10	25.00 - 30.00 Sand and gravel, fine to coarse-grained sand, rounded to sub-rounded gravel up to 1.0-inch diameter, light brown, wet, compact.	SP		-9.56 / 25.00	13	2 IN SS	6-17-24-31	41	1.90 / 2.00	0.010" Screen	
						14	2 IN SS	4-15-22-21	37	2.00 / 2.00		
						15	2 IN SS	5-12-19-19	31	- / 2.00		**WELL NOTES:** Floodplain well head
30	-15	Boring completed at 30.00 ft			-14.56							**SAMPLE NOTES:** 140#/30-inch drop auto hammer used.
35	-20											
40												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Parratt Wolffe, Inc.
DRILLER: P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-28

SHEET 1 of 2

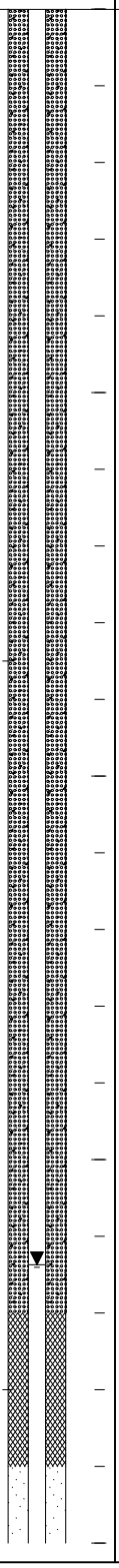
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 8/3/16
DATE COMPLETED: 8/3/16

NORTHING: 3,663,025.11
EASTING: 11,808,370.03
GS ELEVATION: 19.67 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0		0.00 - 8.00 Fill, silty sand, fine to medium-grained sand, some clay, brown to orangish-brown, no odor, compact, saturated at 1 foot below grade.	SM		11.67 8.00		1	CUT-TINGS	N/A		8.00 8.00
5	15	8.00 - 13.00 Clayey silt, some fine-grained sand with root fragments, brown to gray, no odor, soft, wet.	ML		6.67 13.00		2	2 IN SS	2 -2 -3 -4	5	1.80 2.00
10	10	13.00 - 18.00 Silty clay, trace fine-grained sand and root fragments, gray to brown, no odor, very soft, wet.	CL		1.67 18.00		3	2 IN SS	WOH -WOH -WOH -WOH	0	0.80 2.00
15	5	18.00 - 24.00 Silty sand, fine to medium-grained sand, some clay, brown to grayish-brown, no odor, loose, saturated.	SM				4	2 IN SS	2 -2 -3 -3	5	1.80 2.00
20	0	Log continued on next page									

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0' to 24.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 17.0
Type: Bentonite grout

FILTER PACK SEAL
Interval: 17.0 to 19.0'
Type: Bentonite Chips

FILTER PACK
Interval: 19.0' to 34.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 24.0' to 34.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: Nadal

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-28

SHEET 2 of 2

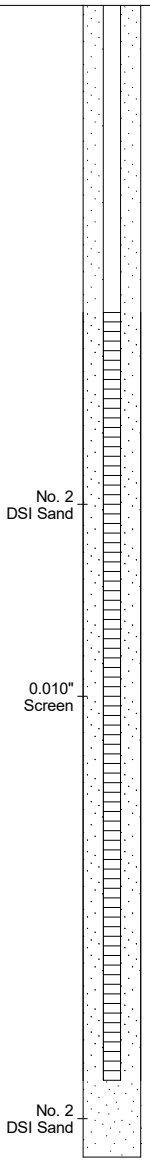
PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 8/3/16
DATE COMPLETED: 8/3/16

NORTHING: 3,663,025.11
EASTING: 11,808,370.03
GS ELEVATION: 19.67 ft

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	PID (ppm)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20		18.00 - 24.00 Silty sand, fine to medium-grained sand, some clay, brown to grayish-brown, no odor, loose, saturated. *(Continued)*	SM								
					-4.33		5	2 IN SS	3 -3 -19 -30	22	1.00 / 2.00
		24.00 - 27.00 Gravelly sand, fine to coarse-grained sand, fine gravel, trace silt, no odor, compact, saturated.	SP		24.00						
25	-5				-7.33						
		27.00 - 33.00 Silty sand, fine to medium-grained sand, some clay, light brown to greenish-yellow, no odor, wet with some dry seams, compact.	SM		27.00		6	2 IN SS	6 -7 -12 -15	19	1.80 / 2.00
30	-10										
							7	2 IN SS	18 -18 -19 -20	37	1.20 / 2.00
					-13.33						
		33.00 - 35.00 Silty sand, fine to medium-grained sand, some clay, grayish-green.	SM		33.00						
35	-15				-15.33						
		Boring completed at 35.00 ft									
40	-20										

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: 0' to 24.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 4" by 4" Aluminum

ANNULUS SEAL
Interval: 0' to 17.0
Type: Bentonite grout

FILTER PACK SEAL
Interval: 17.0 to 19.0'
Type: Bentonite Chips

FILTER PACK
Interval: 19.0' to 34.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 24.0' to 34.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: Nadal

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

AA BOREHOLE RECORD CPS LOGS.GPJ ENVIRONMENTAL DATA TEMPLATE.GDT 2/2/17

RECORD OF BOREHOLE MW-29U

SHEET 1 of 2

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 40.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

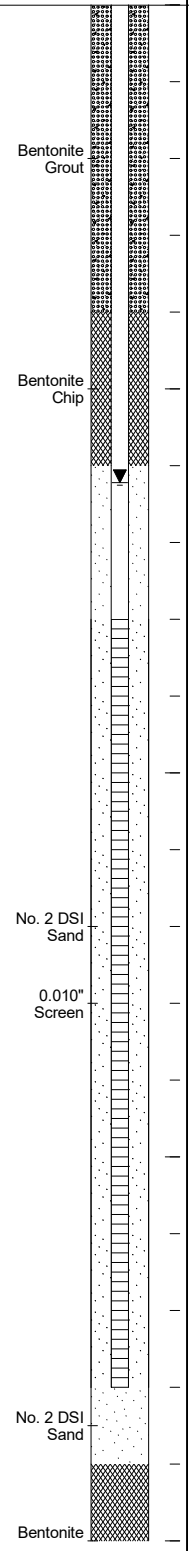
DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/7/16
DATE COMPLETED: 7/7/16

NORTHING: 3,661,275.70
EASTING: 11,807,107.29
GS ELEVATION: 5.25 ft
TOC ELEVATION: 7.13 ft

DEPTH W.L.: 6.22 ft
ELEVATION W.L.: -0.97 ft
DATE W.L.: 10/7/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT
0	5	0.00 - 2.00 FILL, sand and gravel, medium-grained sand, angular gravel (crushed stone).	Fill		3.25	
		2.00 - 7.00 Silty sand, brown to yellow.	SP		2.00	3.00 5.00
5	0				-1.75	
		7.00 - 8.50 Silty sand, mottled brown and gray.	SP		7.00 -3.25	3.00 5.00
		8.50 - 10.00 Silty sand, brown.	SP		8.50 -4.75	
10	-5	10.00 - 29.00 Clayey silt, dark brownish-gray, decaying woody material.			10.00	2.00 5.00
15	-10		MH			3.50 5.00
20		Log continued on next page				

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 8.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 4.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 4.0 to 6.0'
Type: Bentonite Chips

FILTER PACK
Interval: 6.0' to 18.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 8.0' to 18.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: Direct Push, 4.25-inch HSA
Notes:

WELL NOTES:
Floodplain wellhead installed.

SAMPLE NOTES:
2-inch OD Macrocore sampler. Borehole reamed to 18 feet with 4.25-inch HSAs for well construction.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory

PREPARED: G. Morelli
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-29U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 40.00 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/7/16
DATE COMPLETED: 7/7/16

NORTHING: 3,661,275.70
EASTING: 11,807,107.29
GS ELEVATION: 5.25 ft
TOC ELEVATION: 7.13 ft

DEPTH W.L.: 6.22 ft
ELEVATION W.L.: -0.97 ft
DATE W.L.: 10/7/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20	-15	10.00 - 29.00 Clayey silt, dark brownish-gray, decaying woody material. *(Continued)*	MH			2.50 5.00	Chip	
25	-20					3.00 5.00		
					-23.75 29.00			**WELL NOTES:** Floodplain wellhead installed.
30	-25	29.00 - 39.00 Clay, dark gray.	CL			3.00 5.00	No. 2 DSI Sand	**SAMPLE NOTES:** 2-inch OD Macrocore sampler. Borehole reamed to 18 feet with 4.25-inch HSAs for well construction.
35	-30					5.00 5.00		
					-33.75 39.00			
40		39.00 - 40.00 Silty sand, dark gray.	SP		-34.75			
		Boring completed at 40.00 ft						

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory

PREPARED: G. Morelli
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-30U

SHEET 1 of 3

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 54.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/7/16
DATE COMPLETED: 8/23/16

NORTHING: 3,661,266.44
EASTING: 11,807,111.93
GS ELEVATION: 5.14 ft
TOC ELEVATION: 6.94 ft

DEPTH W.L.:
ELEVATION W.L.:
DATE W.L.:
TIME W.L.:

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0	5	0.00 - 2.00 FILL, sand and gravel, medium-grained sand, angular gravel (crushed stone).	Fill		3.14					
		2.00 - 7.00 Silty sand, brown to yellow.	SP		2.00	1	MACRO CORE			3.00 / 5.00
5	0				-1.86					
		7.00 - 8.50 Silty sand, mottled brown and gray.	SP		7.00	2	MACRO CORE			3.00 / 5.00
		8.50 - 10.00 Silty sand, brown.	SP		8.50					
10	-5				-4.86					
		10.00 - 29.00 Clayey silt, dark brownish-gray, decaying woody material.	MH		10.00	3	MACRO CORE			2.00 / 5.00
15	-10					4	MACRO CORE			3.50 / 5.00
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

Bentonite

WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 44.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0' to 40.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 40.0 to 42.0'
Type: Bentonite Chips

FILTER PACK
Interval: 42.0' to 54.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 44.0' to 54.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 8.25-inch HSA & 4.25-inch HSA
Notes:

WELL NOTES:
Floodplain wellhead installed.

SAMPLE NOTES:
2-inch OD Macrocore sampler for direct push to 40 feet. Borehole advanced with 4.25-inch HSAs for well construction. Sample descriptions to 35 feet from adjacent well MW-29U.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & PW
DRILLER: Cory, P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-30U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 54.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/7/16
DATE COMPLETED: 8/23/16

NORTHING: 3,661,266.44
EASTING: 11,807,111.93
GS ELEVATION: 5.14 ft
TOC ELEVATION: 6.94 ft

DEPTH W.L.:
ELEVATION W.L.:
DATE W.L.:
TIME W.L.:

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20	-15	10.00 - 29.00 Clayey silt, dark brownish-gray, decaying woody material. *(Continued)*	MH			5	MACRO CORE			2.50 / 5.00	Grout	
25	-20					6	MACRO CORE			3.00 / 5.00		
					-23.86							**WELL NOTES:** Floodplain wellhead installed.
		29.00 - 39.00 Clay, dark gray.			29.00							
30	-25					7	MACRO CORE			3.00 / 5.00		**SAMPLE NOTES:** 2-inch OD Macrocore sampler for direct push to 40 feet. Borehole advanced with 4.25-inch HSAs for well construction. Sample descriptions to 35 feet from adjacent well MW-29U.
35	-30		CL			8	MACRO CORE			5.00 / 5.00		
					-33.86							
		39.00 - 40.00 Silty sand, dark gray.	SP		39.00							
40					-34.86							
		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & PW
DRILLER: Cory, P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-30U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 54.00 ft
DRILL METHOD: 8.25-inch HSA & 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT/CME-55
DATE STARTED: 7/7/16
DATE COMPLETED: 8/23/16

NORTHING: 3,661,266.44
EASTING: 11,807,111.93
GS ELEVATION: 5.14 ft
TOC ELEVATION: 6.94 ft

DEPTH W.L.:
ELEVATION W.L.:
DATE W.L.:
TIME W.L.:

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40	-35	40.00 - 42.00 Silty clay, trace fine-grained sand, micaceous, gray, no oodor, W>PL, soft	CL		40.00 -36.86	9	2 IN SS	2-3-3-3	6	1.30 / 2.00	Bentonite Chip	
		42.00 - 43.50 Silty clayey sand, fine-grained sand, micaceous, gray, no odor, wet, very loose.	SC		42.00 -38.36	10	2 IN SS	WOH-WOH-WOH-WOH	0	2.00 / 2.00		
		43.50 - 45.50 Sandy silty clay, fine-grained sand, micaceous, gray, no odor, W>PL, soft.	CL		43.50 -40.36	11	2 IN SS	5-6-1-14	7	2.00 / 2.00		
45	-40	45.50 - 45.80 Gravel lense, thinly bedded sub-rounded gravel up to 1.5-inch diameter.	GP		-40.66							
		45.80 - 47.00 Silty clay, some fine-grained sand, micaceous, gray, no odor, W<PL, firm.	CL		45.80 -41.86	12	2 IN SS	9-15-16-18	31	1.60 / 2.00		
		47.00 - 48.00 Silty sand, fine-grained sand, gray, wet, no odor, compact.	SM		47.00 -42.86						No. 2 DSI Sand	
		48.00 - 54.00 Silty clay, micaceous, gray, no odor, W<PL, firm.	CL		48.00	13	2 IN SS	8-11-11-15	22	1.80 / 2.00	0.010" Screen	**WELL NOTES:** Floodplain wellhead installed.
50	-45					14	2 IN SS	WOH-WOH-8-11	0	1.70 / 2.00		**SAMPLE NOTES:** 2-inch OD Macrocore sampler for direct push to 40 feet. Borehole advanced with 4.25-inch HSAs for well construction. Sample descriptions to 35 feet from adjacent well MW-29U.
						15	2 IN SS	2-10-16-19	26	- / 2.00		
					-48.86							
		Boring completed at 54.00 ft										
55	-50											
60												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: GZ & PW
DRILLER: Cory, P. Poyner

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

SHEET 1 of 10

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0		0.00 - 2.00 FILL, sand and gravel, medium-grained sand, angular gravel (crushed stone).	Fill		2.55					
		2.00 - 7.00 Silty sand, brown to yellow.			2.00	1	MACRO CORE			3.00 / 5.00
	0		SP							
5					-2.45					
		7.00 - 8.50 Silty sand, mottled brown and gray.	SP		7.00 -3.95	2	MACRO CORE			3.00 / 5.00
		8.50 - 10.00 Silty sand, brown.	SP		8.50 -5.45					
	-5									
10		10.00 - 29.00 Clayey silt, dark brownish-gray, decaying woody material.			10.00	3	MACRO CORE			2.00 / 5.00
	-10									
15			MH			4	MACRO CORE			3.50 / 5.00
	-15									
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0' to 120.0'
Material: PVC
Diameter: 2"
Joint Type: threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.0' to 110.0'
Type: Bentonite grout

FILTER PACK SEAL
Interval: 110.0 to 115.0'
Type: Bentonite Chips

FILTER PACK
Interval: 115.0' to 140.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 120.0' to 140.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 6 5/8 mud rotary roller bit
Notes:

WELL NOTES:
Floodplain wellhead installed.

SAMPLE NOTES:
Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

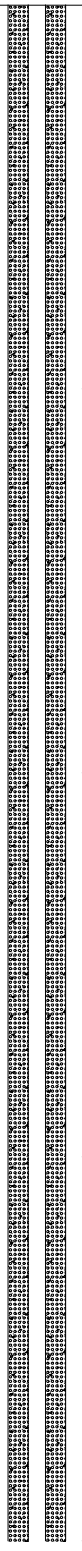
DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
20		10.00 - 29.00 Clayey silt, dark brownish-gray, decaying woody material. *(Continued)*				5	MACRO CORE			2.50 / 5.00
	-20		MH							
25						6	MACRO CORE			3.00 / 5.00
					-24.45					
		29.00 - 39.00 Clay, dark gray.			29.00					
	-25									
30						7	MACRO CORE			3.00 / 5.00
	-30		CL							
35						8	MACRO CORE			5.00 / 5.00
					-34.45					
		39.00 - 40.00 Silty sand, dark gray.			39.00					
	-35		SP							
40					-35.45					
		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Floodplain wellhead installed.

SAMPLE NOTES:
Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
40		40.00 - 42.00 Silty clay, trace fine-grained sand, micaceous, gray, no oodor, W>PL, soft	CL		40.00 -37.45	9	2 IN SS	2-3-3-3	6	1.30/2.00		
		42.00 - 43.50 Silty clayey sand, fine-grained sand, micaceous, gray, no odor, wet, very loose.	SC		42.00 -38.95	10	2 IN SS	WOH-WOH-WOH-WOH	0	2.00/2.00		
		43.50 - 45.50 Sandy silty clay, fine-grained sand, micaceous, gray, no odor, W>PL, soft.	CL		43.50 -40.95	11	2 IN SS	5-6-1-14	7	2.00/2.00		
45	-40	45.50 - 45.80 Gravel lense, thinly bedded sub-rounded gravel up to 1.5-inch diameter.	GP		-41.25							
		45.80 - 47.00 Silty clay, some fine-grained sand, micaceous, gray, no odor, W<PL, firm.	CL		45.80 -42.45	12	2 IN SS	9-15-16-18	31	1.60/2.00		
		47.00 - 48.00 Silty sand, fine-grained sand, gray, wet, no odor, compact.	SM		47.00 -43.45							
		48.00 - 54.00 Silty clay, micaceous, gray, no odor, W<PL, firm.	CL		48.00	13	2 IN SS	8-11-11-15	22	1.80/2.00		**WELL NOTES:** Floodplain wellhead installed.
50	-45					14	2 IN SS	WOH-WOH-8-11	0	1.70/2.00		**SAMPLE NOTES:** Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.
						15	2 IN SS	2-10-16-19	26	-/2.00		
					-49.45							
	-50	54.00 - 74.00 Clay, large chips, light gray.			54.00							
55											Bentonite Grout	
			CL									
	-55											
60		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
60		54.00 - 74.00 Clay, large chips, light gray. *(Continued)*								
	-60									
65			CL			16	CUT'G			14.00 14.00
	-65									
70					-69.45					
	-70	74.00 - 76.00 Clay, large chips, light gray, some dark-gray hard laminar chunks of clay.	CL		74.00 -71.45					
75		76.00 - 77.00 Clay, large chips, light gray, some small white sandy clay chips.	CL		76.00 -72.45	17	CUT'G			10.00 10.00
		77.00 - 85.00 Sandy clay, fine-grained sand, large chips, light gray.	SC		77.00					
	-75									
80		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Floodplain wellhead installed.

SAMPLE NOTES:
Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
80		77.00 - 85.00 Sandy clay, fine-grained sand, large chips, light gray. *(Continued)*	SC			17	CUT'G			10.00 10.00		
	-80				-80.45							
85		85.00 - 94.00 Sand, fine to medium-grained sand, white, with some quartz rock fragments.	SC		85.00							
	-85					18	CUT'G			12.00 12.00		**WELL NOTES:** Floodplain wellhead installed.
90												**SAMPLE NOTES:** Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.
					-89.45							
	-90	94.00 - 107.00 Sand and gravel, medium to coarse-grained sand, small quartzite pebbles, and siltstone fragments.	GP		94.00							
95												
	-95					19	CUT'G			10.00 10.00		
100		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL / PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
100		94.00 - 107.00 Sand and gravel, medium to coarse-grained sand, small quartzite pebbles, and siltstone fragments. *(Continued)*	GP			19	CUT'G			10.00 10.00		
	-100				-102.45							
105		107.00 - 114.00 Silty clay with trace of sand, light green, large clay chip cuttings.	CL		107.00							
	-105					20	CUT'G			10.00 10.00		
110											Bentonite Grout	**WELL NOTES:** Floodplain wellhead installed. **SAMPLE NOTES:** Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.
	-110	114.00 - 118.00 Silty sandy clay, light green, small clay chip cuttings.	ML		114.00							
115												
					-113.45	21	CUT'G			10.00 10.00		
	-115	118.00 - 125.00 Granite, sand cuttings, changed from drag bit to tri-cone bit.	Rock		118.00							
120		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
120		118.00 - 125.00 Granite, sand cuttings, changed from drag bit to tri-cone bit. *(Continued)*	Rock			21	CUT'G			10.00 10.00		
	-120				-120.45							
125		125.00 - 134.00 Granite, sand cuttings, changed from tri-cone bit to button bit.			125.00						No. 2 DSI Sand	
	-125		Rock									**WELL NOTES:** Floodplain wellhead installed.
130											0.010" Screen	
						22	CUT'G			10.00 10.00		**SAMPLE NOTES:** Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.
	-129.45											
	-130	134.00 - 140.00 Granite, sand cuttings, 26 minutes from 134 to 140 feet.			134.00							
135												
			Rock			23	CUT'G			10.00 10.00		
	-135				-135.45							
140		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
140		140.00 - 145.00 Granite, sand cuttings, 45 minutes from 140 to 145 feet.	Rock		140.00						No. 2 DSI Sand Backfill	
	-140				-140.45	23	CUT'G			10.00 10.00		
145		145.00 - 150.00 Granite, sand cuttings, 36 minutes from 145 to 150 feet.	Rock		145.00						Bentonite Chip	
	-145				-145.45							**WELL NOTES:** Floodplain wellhead installed.
150		150.00 - 155.00 Granite, sand cuttings, 39 minutes from 150 to 155 feet.	Rock		150.00	24	CUT'G			10.00 10.00		**SAMPLE NOTES:** Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.
	-150				-150.45							
155		155.00 - 160.00 Granite, sand cuttings, 52 minutes from 155 to 160 feet.	Rock		155.00	25	CUT'G			10.00 10.00		
	-155				-155.45							
160		Log continued on next page										

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
160		160.00 - 168.00 Granite, sand cuttings, 34 minutes from 160 to 168 feet.	Rock		160.00	25	CUT'G			10.00 10.00		
	-160											
165					-163.45							
		168.00 - 175.00 Granite, sand cuttings, 85 minutes from 168 to 175 feet.	Rock		168.00	26	CUT'G			10.00 10.00		**WELL NOTES:** Floodplain wellhead installed. **SAMPLE NOTES:** Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.
	-165											
170												
	-170				-170.45						No. 2 DSI Sand Backfill	
175		175.00 - 178.00 Granite, sand cuttings, 28 minutes from 175 to 178 feet.	Rock		175.00	27	CUT'G			10.00 10.00		
	-175				-173.45							
180		178.00 - 180.00 Granite, sand cuttings, 15 minutes from 178 to 180 feet.	Rock		178.00							
					-175.45							

Log continued on next page

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

RECORD OF BOREHOLE MW-31U

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 200.00 ft
DRILL METHOD: 6 5/8 mud rotary roller bit

DRILL RIG: Custom
DATE STARTED: 9/19/16
DATE COMPLETED: 9/21/16

NORTHING: 3,661,235.21
EASTING: 11,807,125.11
GS ELEVATION: 4.55 ft
TOC ELEVATION: 6.29 ft

DEPTH W.L.: 3.24 ft
ELEVATION W.L.: 1.31 ft
DATE W.L.: 5/22/77
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
180		180.00 - 188.00 Granite, sand cuttings, 15 minutes from 178 to 180 feet.	Rock		180.00	27	CUT'G			10.00 10.00
	-180				-183.45					
185		188.00 - 190.00 Granite, sand cuttings, 13 minutes from 188 to 190 feet.	Rock		188.00					
	-185				-185.45					
190		190.00 - 195.00 Granite, sand cuttings, 40 minutes from 190 to 195 feet.	Rock		190.00	28	CUT'G			10.00 10.00
	-190				-190.45					
195		195.00 - 200.00 Granite, sand cuttings, 43 minutes from 195 to 200 feet. Run geophysical log on borehole after tripping tools.	Rock		195.00	28	CUT'G			10.00 4.00
	-195				-195.45					
200		Boring completed at 200.00 ft								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Floodplain wellhead installed.

SAMPLE NOTES:
Sample descriptions from 0 to 52 feet from adjacent wells MW-29U and MW-30U. Ran geophysical log on open borehole.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Water Well Solut. LLC
DRILLER: R. O'dell

PREPARED: R. Mongillo
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

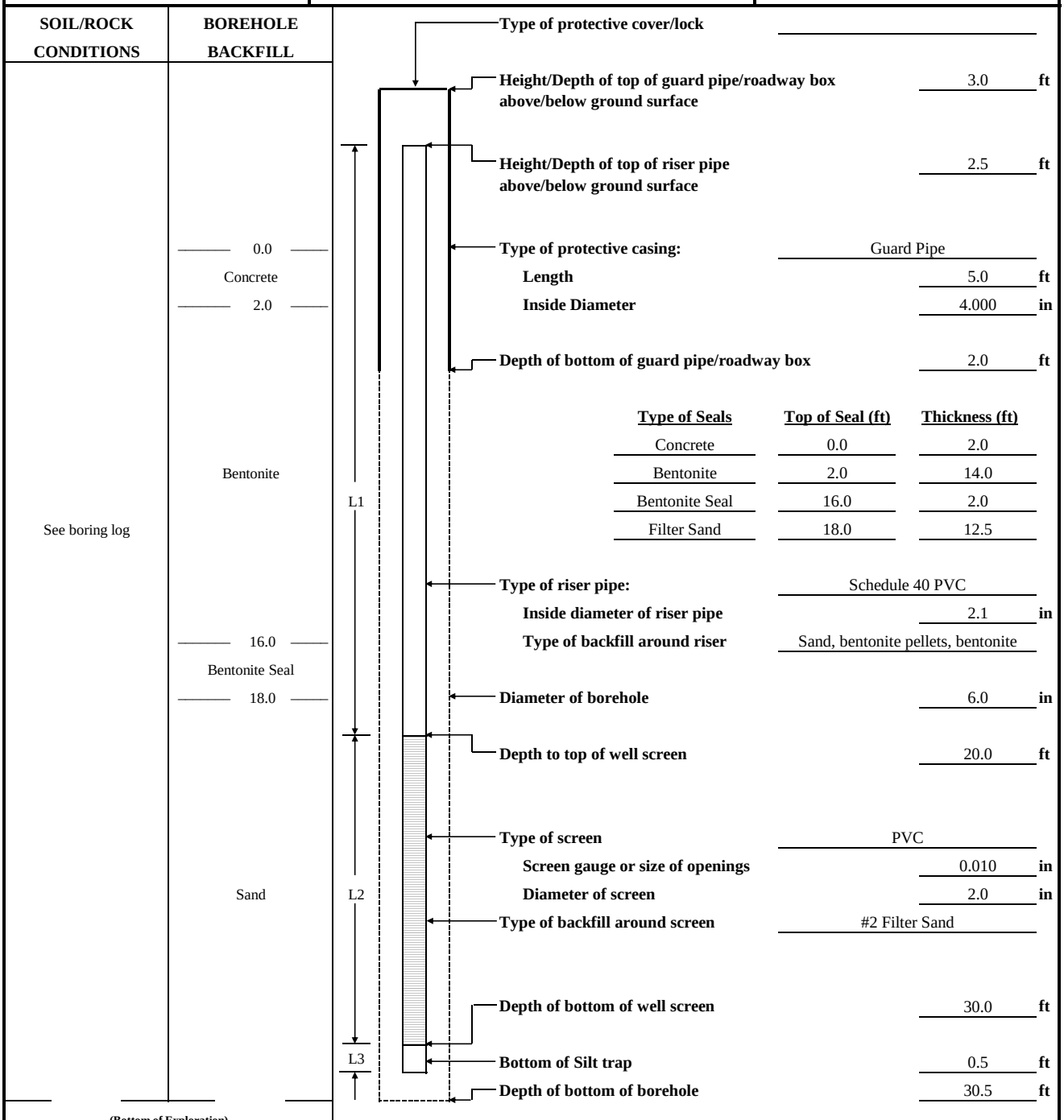
Well No. MW-32S
Boring No. MW-32S

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-001
LOCATION	Chester, VA	**PROJECT MGR.**	J. Kingston
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	H. Hollauer
CONTRACTOR	Geologic Exploration	**DATE INSTALLED**	6/29/2016
DRILLER	B. Thomas		

Ground El. - ft
El. Datum -

Location See plan

☑ **Guard Pipe**
☐ **Roadway Box**



Type of protective cover/lock

Height/Depth of top of guard pipe/roadway box above/below ground surface 3.0 ft

Height/Depth of top of riser pipe above/below ground surface 2.5 ft

Type of protective casing: Guard Pipe
Length 5.0 ft
Inside Diameter 4.000 in

Depth of bottom of guard pipe/roadway box 2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite	2.0	14.0
Bentonite Seal	16.0	2.0
Filter Sand	18.0	12.5

Type of riser pipe: Schedule 40 PVC
Inside diameter of riser pipe 2.1 in
Type of backfill around riser Sand, bentonite pellets, bentonite

Diameter of borehole 6.0 in

Depth to top of well screen 20.0 ft

Type of screen PVC
Screen gauge or size of openings 0.010 in
Diameter of screen 2.0 in
Type of backfill around screen #2 Filter Sand

Depth of bottom of well screen 30.0 ft

Bottom of Silt trap 0.5 ft

Depth of bottom of borehole 30.5 ft

20 ft	+	10 ft	+	0.5 ft	=	30.5 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

Form 2007

HALEY ALDRICH

TEST BORING REPORT DRAFT

Boring No. MW-32S

Project Dominion Power/Chesterfield, Chester, VA
Client Dominion
Contractor Geological Exploration, Inc.

File No. 42735-001
Sheet No. 1 of 2
Start June 29, 2016
Finish June 29, 2016
Driller B. Thomas
H&A Rep. H. Hollauer
Elevation 10.8
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	--	Rig Make & Model: Track
Inside Diameter (in.)	4.25	1 3/8	--	Bit Type:
Hammer Weight (lb)	-	140	-	Drill Mud: None
Hammer Fall (in.)	-	30	-	Casing: HSA 4.25
				Hoist/Hammer: Automatic Hammer
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	2 2 5 6	S1 24	0.0 2.0	ML	10.6 0.2	0.0 - 0.2 ft: Topsoil and Root Mat 0.2 - 0.5 ft: Loose orange brown silty fine yellow sandy SILT (ML), mps < 0.42 mm, no structure, no odor, slightly mottled, becomes denser with depth, slightly moist				5	35	60				
						-FILL-										
	5 5 4 4	S2 24	4.0 6.0	SM SM	6.8 4.0	Loose orange brown silty fine SAND (SM), mps < 0.42 mm, slight structure, no odor, slightly moist, trace roots Gray loose silty fine SAND (SM), mps < 2.0 mm, no structure, organic odor (swampy), moist, trace organics (roots)				10	70 55	30 30				
5				ML	4.8 6.0	Loose orange brown sandy SILT (ML), mps < 0.42 mm, no structure, no odor, moist, trace roots (same as 0.2 - 5.0 ft)				5	35	60				
	2 1 2 1	S3 18	9.0 11.0		0.8											
10				SM	10.0	Loose dark gray silty SAND (SM), mps < 2.0 mm, no structure, no odor, wet										
	1 1 WOH 1	S4 20	14.0 16.0		-4.2											
15				ML	15.0	Grades to very soft dark gray SILT (ML), mps <0.42 mm, no structure, organic odor, trace organics (decomposed wood), wet						100				
					-8.2											
	2 1	S5 20	19.0 21.0	ML	19.0	Grading to soft orange brown and gray brown sandy SILT (ML), mps < 0.42 mm, no structure, no odor, wet, trace roots					30	70				
20																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 31.0
Rock Cored (ft) -
Samples 7S

Boring No. MW-32S

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV HA-LIB10.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT Z:\42735\GINT\42735-001_TB.GPJ Nov 9, 16

HALEY ALDRICH

TEST BORING REPORT

DRAFT

Boring No. MW-32S
File No. 42735-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	2 2					Grading to…										
					-12.2 23.0											
	1 2 3 4	S6 20	24.0 26.0	SM		Loose gray brown silty SAND (SM), mps < 2.0 mm, no structure, organic odor, wet, few layers of fine SAND				5	60	35				
25																
	1 1 2 3	S7 20	29.0 31.0													
30					-20.2 31.0	BOTTOM OF EXPLORATION 31 FT Note: No refusal.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-32S

H&A-TEST BORING-09 REV HA-LIB10.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT Z:\42735\GINT\42735-001_TB.GPJ Nov 9, 16

RECORD OF BOREHOLE MW-33

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.20 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/8/16
DATE COMPLETED: 7/11/16

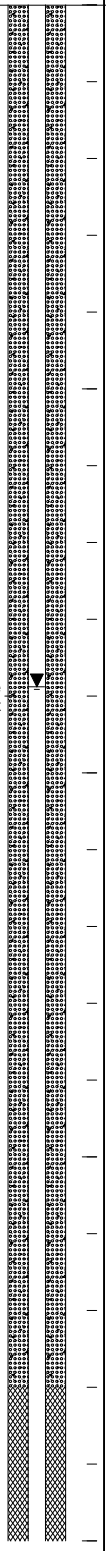
NORTHING: 3,661,029.44
EASTING: 11,809,704.77
GS ELEVATION: 11.09 ft
TOC ELEVATION: 12.73 ft

DEPTH W.L.: 8.88 ft
ELEVATION W.L.: 2.21 ft
DATE W.L.: 10/3/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT
0	10	0.00 - 8.00 FILL, soil boring vacuum extracted to 8 feet below grade per Digging, Drilling, Cutting Permit requirements.	Fill		3.09	8.00 8.00 2.00 5.00
5	5	8.00 - 13.00 Sand, fine-grained sand, brown.	SP		8.00 -1.91	2.00 2.00 5.00 5.00
10	0	13.00 - 15.00 Sand, fine-grained sand, small angular gravel, trace silt, brown.	SP		13.00 -3.91	
15	-5	15.00 - 18.00 Sand, fine-grained sand, trace silt, brown.	SP		15.00 -6.91	3.50 5.00
20		18.00 - 24.50 Sandy silt, dark grayish-brown.	ML		18.00	

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0.0' to 25.2'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.0' to 18.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 18.0' to 23.0'
Type: Bentonite Chip

FILTER PACK
Interval: 23.0' to 35.2'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 25.2' to 35.2'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: Direct Push, 4.25-inch HSA
Notes:

WELL NOTES:
Floodplain wellhead

SAMPLE NOTES:
Vacuum extracted drill cuttings.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory

PREPARED: G. Morelli
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-33

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 35.20 ft
DRILL METHOD: Direct Push, 4.25-inch HSA

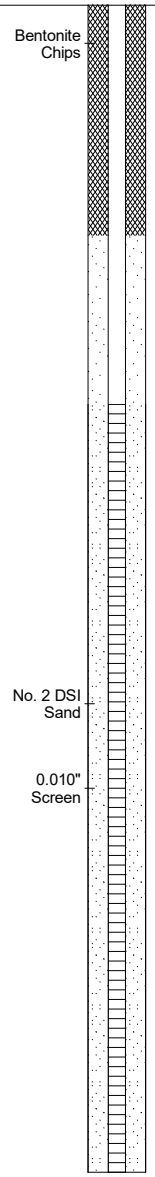
DRILL RIG: Geoprobe 7822 DT
DATE STARTED: 7/8/16
DATE COMPLETED: 7/11/16

NORTHING: 3,661,029.44
EASTING: 11,809,704.77
GS ELEVATION: 11.09 ft
TOC ELEVATION: 12.73 ft

DEPTH W.L.: 8.88 ft
ELEVATION W.L.: 2.21 ft
DATE W.L.: 10/3/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT
20		18.00 - 24.50 Sandy silt, dark grayish-brown. *(Continued)*	ML			4.00 5.00
	-10				-13.41	
		24.50 - 25.00 Sand, fine-grained sand, trace silt, dark grayish-brown.	SW		24.50 -13.91	
25		25.00 - 30.00 No recovery, loose material.	SW		25.00	0.00 5.00
	-15				-18.91	
30		30.00 - 35.20 Sand, well graded dark grayish-brown.	SW		30.00	2.00 5.20
	-20					
35					-24.11	
	-25	Boring completed at 35.20 ft				
40						

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL NOTES:
Floodplain wellhead

SAMPLE NOTES:
Vacuum extracted drill cuttings.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Ground Zero
DRILLER: Cory

PREPARED: G. Morelli
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-34

SHEET 1 of 2

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: 4.25-inch HSA

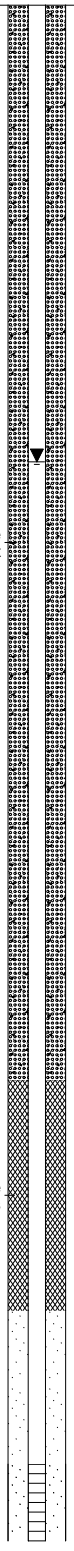
DRILL RIG: CME-55
DATE STARTED: 9/9/16
DATE COMPLETED: 9/12/16

NORTHING: 3,660,827.15
EASTING: 11,807,767.32
GS ELEVATION: 8.10 ft
TOC ELEVATION: 9.70 ft

DEPTH W.L.: 5.95 ft
ELEVATION W.L.: 2.15 ft
DATE W.L.: 10/12/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT
0		0.00 - 3.50 Sand with silt, micaceous fine-grained sand with gravel, gravel is subrounded, fines are orangish-brown to tan with reddish-brown concretions, compact, dry.	SM		4.60	1	2 IN SS	2-2-2-5	4	2.00/2.00
	5					2	2 IN SS	3-4-5-5	9	2.00/2.00
		3.50 - 5.00 Sand with silt, micaceous fine-grained sand with gravel, gravel is subrounded, fines are orangish-brown to tan with reddish-brown concretions, soft, dry.	SM		3.50 3.10	3	2 IN SS	8-2-2-3	4	2.00/2.00
5		5.00 - 5.50 Sandy clay, bluish-gray with brown, moist, micaceous.	CL		5.00 2.60					
		5.50 - 10.00 Sandy clay, some gravel, dark brown, moist, medium to coarse-grained sand.	CL		5.50	4	2 IN SS	3-2-2-3	4	1.00/2.00
	0					5	2 IN SS	WOH-WOH-WOH-WOH	0	0.25/2.00
10		10.00 - 12.00 Silt, bluish-brown, micaceous, moist to wet, soft, contains leaf and root matter.	ML		10.00 -3.90	6	2 IN SS	1-1-1-1	2	2.00/2.00
		12.00 - 14.00 Silt, bluish-brown, micaceous, wet, soft, contains leaf and root matter.	ML		12.00 -5.90	7	2 IN SS	WOH-WOH-1-1	0	2.00/2.00
	-5	14.00 - 15.50 Silt, brown, micaceous, wet, soft, contains leaf and root matter.	ML		14.00 -7.40	8	2 IN SS	WOH-WOH-1-1	0	2.00/2.00
15		15.50 - 15.75 Sand lense with some silt, dark brown.	SP		-7.65 15.75					
		15.75 - 22.00 Sand, fine to medium-grained sand, micaceous, wet, well graded, dark brown.	SW			9	2 IN SS	WOH-WOH-2-3	0	2.00/2.00
	-10					10	2 IN SS	WOH-WOH-WOH-WOH	0	0.25/2.00
20		Log continued on next page								

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS / COMMENTS

WELL CASING
Interval: 0.0' to 19.0'
Material: PVC
Diameter: 2"
Joint Type: Threaded

WELL COMPLETION
Pad: 3' by 3' concrete
Protective Casing: 6" PVC

ANNULUS SEAL
Interval: 0.0' to 14.0'
Type: Bentonite Grout

FILTER PACK SEAL
Interval: 14.0' to 17.0'
Type: Bentonite Chip

FILTER PACK
Interval: 17.0' to 29.0'
Type: No. 2 DSI Sand

WELL SCREEN
Interval: 19.0' to 29.0'
Material: PVC
Diameter: 2"
Slot Size: 0.010"
End Cap: 2"

DRILLING METHODS
Type: 4.25-inch HSA
Notes:

WELL NOTES:
Floodplain wellhead

SAMPLE NOTES:
Boring advanced to 30 feet below grade.

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

RECORD OF BOREHOLE MW-34

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 30.00 ft
DRILL METHOD: 4.25-inch HSA

DRILL RIG: CME-55
DATE STARTED: 9/9/16
DATE COMPLETED: 9/12/16

NORTHING: 3,660,827.15
EASTING: 11,807,767.32
GS ELEVATION: 8.10 ft
TOC ELEVATION: 9.70 ft

DEPTH W.L.: 5.95 ft
ELEVATION W.L.: 2.15 ft
DATE W.L.: 10/12/16
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		15.75 - 22.00 Sand, fine to medium-grained sand, micaceous, wet, well graded, dark brown. *(Continued)*	SW		-13.90	11	2 IN SS	WOH-WOH- WOH-WOH	0	0.50 / 2.00		
	-15	22.00 - 30.00 Sand, fine to medium-grained sand, micaceous, wet, dark brown.	SP		22.00	12	2 IN SS	WOH-1-18-3	19	2.00 / 2.00	No. 2 DSI Sand	
25						13	2 IN SS	WOH-15-5-9	20	2.00 / 2.00	0.010" Screen	
	-20					14	2 IN SS	4-3-5-2	8	2.00 / 2.00		
						15	2 IN SS	1-1-4-3	5	2.00 / 2.00	No. 2 DSI Sand	**WELL NOTES:** Floodplain wellhead
30		Boring completed at 30.00 ft			-21.90							**SAMPLE NOTES:** Boring advanced to 30 feet below grade.
	-25											
35												
	-30											
40												

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Connelly & Assoc. Inc.
DRILLER: J. Leatherman

PREPARED: C. Giordano
REVIEWED: M. Williams
DATE: 10/15/16

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 11/9/16

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. OW-35S
Boring No. OW-35S

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-804
LOCATION	Chester, VA	**PROJECT MGR.**	M. Groseclose
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	H. Hollauer
CONTRACTOR	Geologic Exploration, Inc.	**DATE INSTALLED**	9/29/2016
DRILLER	M. Ireland		

Ground El. 55.25 ft
El. Datum -
Location See plan
☑ **Guard Pipe**
☐ **Roadway Box**

SOIL/ROCK CONDITIONS

See boring log

BOREHOLE BACKFILL

0.0

Grout

47.0

Bentonite Seal

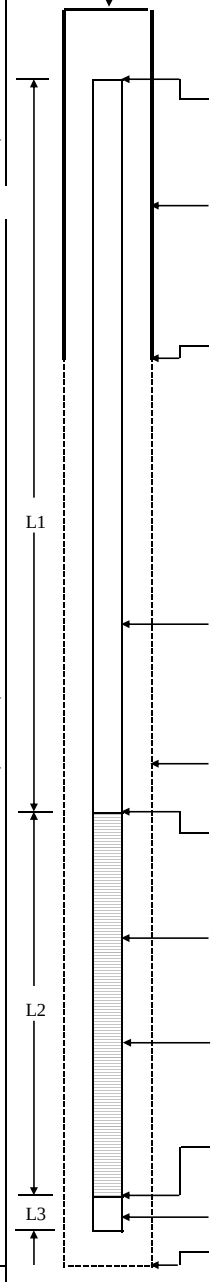
50.0

Sand

64.0

(Bottom of Exploration)

(Numbers refer to depth from ground surface in feet)



(Not to Scale)

Type of protective cover/lock	Protective Cover with Padlock
Height of top of riser pipe above ground surface	3.09 ft
Type of protective casing:	Guard Pipe
Length	5.0 ft
Inside Diameter	4.0 in
Depth of bottom of guard pipe/roadway box	2.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite Slurry	2.0	45.0
Bentonite Chipes	47.0	3.0

Type of riser pipe:	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in
Type of backfill around riser	Sand, Bentonite, Concrete
Diameter of borehole	6.0 in
Depth to top of well screen	54.0 ft
Type of screen	Machine Slotted Sch. 40 PVC
Screen gauge or size of openings	0.010 in
Diameter of screen	2.0 in
Type of backfill around screen	#2 Filter Sand
Depth of bottom of well screen	64.0 ft
Bottom of Silt trap	64.0 ft
Depth of bottom of borehole	64.0 ft

57.09 ft	+	10 ft	+	0 ft	=	67.09 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

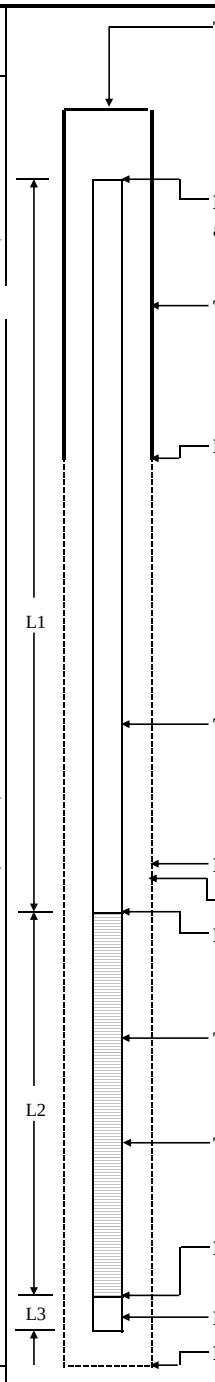
Well No.
OW-35D
Boring No.
OW-35D

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	42735-804
LOCATION	Chester, VA	**PROJECT MGR.**	M. Groseclose
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	H. Hollauer
CONTRACTOR	Geologic Exploration, Inc.	**DATE INSTALLED**	9/28/2016
DRILLER	M. Ireland		

Ground El.	**55.23**	ft	**Location**	See plan	☑ **Guard Pipe**
El. Datum	**-**				☐ **Roadway Box**

SOIL/ROCK CONDITIONS	BOREHOLE BACKFILL
	0.0
	Grout
See boring log	
	83.0
	Bentonite Seal
	86.0
	Sand
	99.0
(Bottom of Exploration)	

(Numbers refer to depth from ground surface in feet)



(Not to Scale)

Type of protective cover/lock	Protective Cover with Padlock	
Height of top of riser pipe above ground surface	3.03	**ft**
Type of protective casing:	Guard Pipe	
Length	5.0	**ft**
Inside Diameter	4.0	**in**
Depth of bottom of guard pipe/roadway box	2.0	**ft**

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	2.0
Bentonite Slurry	2.0	81.0
Bentonite Chips	83.0	3.0

Type of riser pipe:	Schedule 40 PVC	
Inside diameter of riser pipe	2.0	**in**
Type of backfill around riser	Sand, bentonite, concrete	
Diameter of borehole	6.0	**in**
Depth to top of sand filter pack	86.0	**ft**
Depth to top of well screen	89.0	**ft**
Type of screen	Machine Slotted Sch. 40 PVC	
Screen gauge or size of openings	0.010	**in**
Diameter of screen	2.0	**in**
Type of backfill around screen	#2 Filter Sand	
Depth of bottom of well screen	99.0	**ft**
Bottom of Silt trap	99.0	**ft**
Depth of bottom of borehole	99.0	**ft**

93.03 ft	+	10 ft	+	0 ft	=	103.03 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No.	Boring No.
MW-35B	MW-35B

PROJECT	Chesterfield Power Station	**H&A FILE NO.**	129732-002
LOCATION	Chester, VA	**PROJECT MGR.**	M. Groseclose
CLIENT	Dominion Resources Services, Inc.	**FIELD REP.**	C. Mitiguy
CONTRACTOR	Geologic Exploration, Inc.	**DATE INSTALLED**	1/26/2017
DRILLER	A. Gloege		

Ground El.	**55.09** ft	**Location**	See plan	☑	**Guard Pipe**
El. Datum	**NVGD29**			☐	**Roadway Box**

SOIL/ROCK CONDITIONS	BOREHOLE BACKFILL		
			Type of protective cover/lock — Protective Cover with Padlock
			Height of top of riser pipe above ground surface — 3.09 ft
	0.0		
			Type of protective casing: — Guard Pipe
			Length — 5.0 ft
			Inside Diameter — 4.0 in
	Grout		**Depth of bottom of guard pipe/roadway box** — 2.0 ft
			Type of Seals / **Top of Seal (ft)** / **Thickness (ft)**
			Concrete / 0.0 / 2.0
			Bentonite Slurry / 2.0 / 136.0
		L1	Aqua Guard / 138.0 / 20.0
See boring log	138.0		Bentonite Chips / 158.0 / 4.0
	Aqua Guard		**Type of riser pipe:** — Schedule 40 PVC
			Inside diameter of riser pipe — 2.0 in
	158.0		**Type of backfill around riser** — Sand, bentonite, Aqua Guard, grout
	Bentonite Seal		
	162.0		**Diameter of borehole** — 6.0 in
			Depth to top of sand filter pack — 162.0 ft
			Depth to top of well screen — 165.0 ft
			Type of screen — Machine Slotted Sch. 40 PVC
			Screen gauge or size of openings — 0.010 in
	Sand	L2	**Diameter of screen** — 2.0 in
			Type of backfill around screen — #3 Filter Sand
			Depth of bottom of well screen — 175.0 ft
		L3	**Bottom of Silt trap** — 175.0 ft
	175.0		**Depth of bottom of borehole** — 175.0 ft

(Bottom of Exploration)

(Numbers refer to depth from ground surface in feet)

(Not to Scale)

168.09 ft	+	10 ft	+	0 ft	=	178.09 ft
Riser Pay Length (L1)		Length of screen (L2)		Length of silt trap (L3)		Pay length

COMMENTS:

TEST BORING REPORT

Boring No. MW-35B

Project	Dominion/Chesterfield Power Station, Chester, VA
Client	Dominion
Contractor	Cascade Drilling

File No. 129732-002
Sheet No. 1 of 7
Start 25 January 2017
Finish 26 January 2017
Driller A. Gloege
H&A Rep. C. Mitiguy
Elevation 55.1
Datum NGVD29
Location See Plan
N 3663416.56
E 11806314.55

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	Sonic	Sonic	Sonic	Rig Make & Model: Geoprobe 8150LS
Inside Diameter (in.)	6.0/7.0	4.0	4.0	Bit Type: None
Hammer Weight (lb)	-	-	-	Drill Mud: None
Hammer Fall (in.)	-	-	-	Casing: Sonic
				Hoist/Hammer: - -
				PID Make & Model: None

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0		C1 60	0.0 5.0			ML	Note: Boring advanced with airknife from 0.0 ft to 8.0 ft. Orange-brown sandy SILT (ML), trace clay, mps 0.425 mm, no structure, no odor, slightly moist	-	-	-	-	30	70				
5		C2 120	5.0 15.0														
10					45.1		-FILL-										
					10.0	ML	Brown SILT (ML), with roots, mps 0.425 mm, no structure, no odor,	-	-	-	-	10	90				
					44.7	ML	moist, (native topsoil surface)	-	-	-	-	40	60				
					10.4		Orange-brown sandy SILT (ML), mps 0.425 mm, no odor, slightly moist, mottled, bonded color, (native)										
15		C3 240	15.0 35.0		40.1 15.0	SP	Orange-brown poorly-graded SAND (SP), mps 0.425 mm, no structure, no odor, dry	-	-	-	-	95	5				
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 160.0
Rock Cored (ft) 15.0
Samples 12C

Boring No. MW-35B

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-804_TB.GPJ 16 Feb 17

TEST BORING REPORT

HALEY ALDRICH

Boring No. MW-35B
File No. 129732-002
Sheet No. 2 of 7

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
						SP	Orange-brown poorly-graded SAND with silt and trace clay (SP), mps 0.425 mm, no odor, mottled, dry to slightly moist	-	-	-	-	90	10				
25																	
30							Note: Gravel and cobbles appear at 30.0 ft, mps 4.0 in., dry.										
					22.1												
					33.0	SW-SM	Light to brown well-graded SAND with silt and gravel (SW-SM), trace cobbles, mps 88.9 mm, no structure, slightly moist to dry, gravel rounded	5	10	20	15	20	10				
35		C4 120	35.0 45.0														
40																	
45		C5 180	45.0 55.0														
					6.1												
					49.0	SP-SW	Light tan poorly-graded SAND with silt (SP-SM), mps 1.0 in., trace clay, slightly bonded, no structure, gravel rounded, no odor, slightly moist	5	5	5	50	25	10				
50																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-35B

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-804_TB.GPJ 16 Feb 17

TEST BORING REPORT

HALEY ALDRICH

Boring No. MW-35B
File No. 129732-002
Sheet No. 3 of 7

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
55		C6 132	55.0 65.0				Note: Installed well screen from 54.0 to 64.0 ft at OW-35S.										
60																	
65		C7 96	65.0 75.0		-9.9 65.0	CL	Medium-gray CLAY (CL), mps 25.4mm, trace rounded gravel, no structure	5	-	-	-	-	95				
					-11.9 67.0		Note: Weathered cobbles and quartzite gravel.										
					-12.4 67.5	SP-SM	Tan to orange-brown poorly-graded SAND with silt (SP-SM), mps 38.1mm, slightly bonded, trace clay, no structure, gravel rounded, no odor, slightly moist	5	5	5	50	25	10				
70							Note: CLAY layer from approximately 71.5 ft to 72.0 ft.										
75		C8 216	75.0 95.0		-19.9 75.0	CL	Dark gray-green CLAY (CL), mps <0.425mm, relatively dense, no structure, no odor, slightly moist	-	-	-	-	10	90				
80						CL	Note: Similar to C8, except dark brown, trace mica flakes.	-	-	-	-	10	90				

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-35B

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-804_TB.GPJ 16 Feb 17

TEST BORING REPORT

HALEY ALDRICH

Boring No. MW-35B
File No. 129732-002
Sheet No. 4 of 7

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
						CL	Note: Similar to above, except medium gray.	-	-	-	-	10	90				
85						CL	Note: Similar to above, except dark brown.	-	-	-	-	10	90				
						CL	Note: Similar to above, except gray.	-	-	-	-	10	90				
							Note: Installed well screen from 89.0 to 99.0 at OW-35D.										
90					-38.9												
					94.0	CL	Light gray sandy CLAY (CL), trace mica flakes, no odor, slightly moist to dry	-	5	-	-	40	55				
95					-39.9												
		C9 240	95.0 115.0		95.0	SC	Gray clayey SAND with gravel (SC), mps 76.2mm, no structure, no odor, moist, gravel rounded	5	10	5	10	50	20				
100							Note: Soil becomes denser with depth.										
105																	
110																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-35B

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-804_TB.GPJ 16 Feb 17

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-35B
File No. 129732-002
Sheet No. 5 of 7

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
115		C10 300	115.0 135.0			SM	Gray silty SAND with gravel (SM),mps 88.9mm, no structure, rounded gravel and cobbles, no odor, slightly moist, relatively dense	10	10	5	10	45	20				
120																	
125																	
130																	
135		C11 120	135.0 155.0			SC	Similar to C10	10	10	5	10	45	20				
140																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-35B

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-804_TB.GPJ 16 Feb 17

TEST BORING REPORT

Boring No. MW-35B
File No. 129732-002
Sheet No. 6 of 7

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
145																	
					-93.9												
					149.0		Gray-green highly weathered GNEISS, rock structure, mica flakes										
150																	
							Note: Rock becomes more competent with depth.										
155		C12 240	155.0 175.0														
							-WEATHERED BEDROCK-										
					-104.9												
160					160.0		Hard, fresh to slightly weathered, gray, black and white, fine to coarse grained GNEISS, moderately fractured. Few fracture surfaces with slight iron staining. Primary joints dipping horizontal with secondary joints dipping moderately. Joints spaced close, undulating and smooth, trace garnets. RQD 50%										
165							Note: Installed well screen from 165.0 to175.0 at OW-35B.										
							-COMPETENT BEDROCK-										
170																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-35B

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-804_TB.GPJ 16 Feb 17

HALEY ALDRICH

TEST BORING REPORT

Boring No. MW-35B
File No. 129732-002
Sheet No. 7 of 7

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
					-119.9		-COMPETENT BEDROCK-										
175					175.0		BOTTOM OF EXPLORATION 175.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. MW-35B

H&A-TEST BORING-09 HA-LIB09-BOS-HAR.GLB HA-TB+CORE+WELL-07-1.GDT G:\42735\GINT\42735-804_TB.GPJ 16 Feb 17

RECORD OF BOREHOLE MW-B31

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 24.50 ft
DRILL METHOD: Unknown

DRILL RIG: Unknown
DATE STARTED:
DATE COMPLETED:

NORTHING: 3,660,340.77
EASTING: 11,812,582.82
GS ELEVATION: 11.82 ft
TOC ELEVATION: 12.81 ft

DEPTH W.L.: 6.85 ft
ELEVATION W.L.: 4.97 ft
DATE W.L.: 1/9/17
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
0	10	0.00 - 24.50						**WELL CASING** Interval: 0' to 24.5' Material: PVC Diameter: 2" Joint Type: Unknown **WELL COMPLETION** Pad: 3' by 3' Protective Casing: 6" PVC **ANNULUS SEAL** Interval: Unknown Type: Unknown **FILTER PACK SEAL** Interval: Unknown Type: Unknown **FILTER PACK** Interval: Unknown Type: Unknown **WELL SCREEN** Interval: 19.5' to 24.5' Material: PVC Diameter: 2" Slot Size: Unknown End Cap: 2"
5	5						▼	
10	0							**DRILLING METHODS** Type: Unknown Notes: **WELL NOTES:** Floodplain wellhead
15	-5							
20		Log continued on next page						

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Unknown
DRILLER: Unknown

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 2/9/17

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 2/13/17

RECORD OF BOREHOLE MW-B31

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 24.50 ft
DRILL METHOD: Unknown

DRILL RIG: Unknown
DATE STARTED:
DATE COMPLETED:

NORTHING: 3,660,340.77
EASTING: 11,812,582.82
GS ELEVATION: 11.82 ft
TOC ELEVATION: 12.81 ft

DEPTH W.L.: 6.85 ft
ELEVATION W.L.: 4.97 ft
DATE W.L.: 1/9/17
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		0.00 - 24.50 *(Continued)*						
	-10						Unknown	
					-12.68			
		Boring completed at 24.50 ft						
25								
	-15							
								WELL NOTES: Floodplain wellhead
30								
	-20							
35								
	-25							
40								

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Unknown
DRILLER: Unknown

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 2/9/17

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 2/13/17

RECORD OF BOREHOLE MW-B32

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 33.00 ft
DRILL METHOD: Unknown

DRILL RIG: Unknown
DATE STARTED:
DATE COMPLETED:

NORTHING: 3,659,332.19
EASTING: 11,810,654.15
GS ELEVATION: 12.63 ft
TOC ELEVATION: 13.58 ft

DEPTH W.L.: 12.15 ft
ELEVATION W.L.: 0.48 ft
DATE W.L.: 1/9/17
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
0	10	0.00 - 33.00						**WELL CASING** Interval: 0' to 33' Material: PVC Diameter: 2" Joint Type: Unknown **WELL COMPLETION** Pad: 3' by 3' Protective Casing: 6" PVC **ANNULUS SEAL** Interval: Unknown Type: Unknown **FILTER PACK SEAL** Interval: Unknown Type: Unknown **FILTER PACK** Interval: Unknown Type: Unknown **WELL SCREEN** Interval: 29.0' to 33.0' Material: PVC Diameter: 2" Slot Size: Unknown End Cap: 2"
5	5							
10	0						▼	
15	-5							
20		Log continued on next page						

DRILLING METHODS
Type: Unknown
Notes:

WELL NOTES:
Floodplain wellhead

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Unknown
DRILLER: Unknown

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 2/9/17

Golder Associates

BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 2/13/17

RECORD OF BOREHOLE MW-B32

PROJECT: CPS - LAP & UAP
PROJECT NUMBER: 1532-864
DRILLED DEPTH: 33.00 ft
DRILL METHOD: Unknown

DRILL RIG: Unknown
DATE STARTED:
DATE COMPLETED:

NORTHING: 3,659,332.19
EASTING: 11,810,654.15
GS ELEVATION: 12.63 ft
TOC ELEVATION: 13.58 ft

DEPTH W.L.: 12.15 ft
ELEVATION W.L.: 0.48 ft
DATE W.L.: 1/9/17
TIME W.L.: 8:00 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	REC / ATT	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS / COMMENTS
20		0.00 - 33.00 *(Continued)*						
	-10							
25								
	-15							
30							Unknown	**WELL NOTES:** Floodplain wellhead
	-20				-20.37			
		Boring completed at 33.00 ft						
35								
	-25							
40								

LOG SCALE: 1 in = 2.5 ft

DRILLING COMPANY: Unknown
DRILLER: Unknown

PREPARED: C. LaCosse
REVIEWED: M. Williams
DATE: 2/9/17

Golder Associates

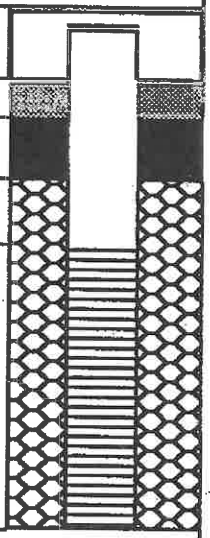
BOREHOLE RECORD CPS LOGS.GPJ ENV_BORING.GDT 2/13/17

BORING LOG

Identification:	B-40A	Location:	Chesterfield Power Station	Project No.	95058.62
Drilling Contractor	Fishburne Drilling Inc.	Name of Logger:	Julius Balzac	Date:	19 October, 2001
Type: HSA	Total Depth: ~15.0'	Screen/Casing Type:	0.010" Slot 2" PVC	Screened Interval:	15'-5'

Depth (feet)	Sample No. (Depth, ft)	Blow Counts	Recovery (inches)	Description of Material
0				
4	3-5	1-1-2-1	0"	Olive gray clayey medium SAND.
8				
	8-10	2-2-3-1	14"	Dark gray soft CLAY, moist.
12				
	13-15	2-2-2-3	16"	Dark gray to gray fine clayey SAND.
16				

Well Construction Details



NOTES:
1. PVC Well Riser set in locked metal cover in 2' x 2' x 4" concrete pad.

2. Water level is ~ 13.0'.

WELL LEGEND

- PVC Riser
- PVC Screen
- Bentonite
- Cement Grout
- No. 2 Morie Sand

RESOURCE INTERNATIONAL, LTD.

ENGINEERS • SCIENTISTS • SURVEYORS • PLANNERS

9560 KINGS CHARTER DRIVE • P.O. BOX 6160 • ASHLAND, VA 23005

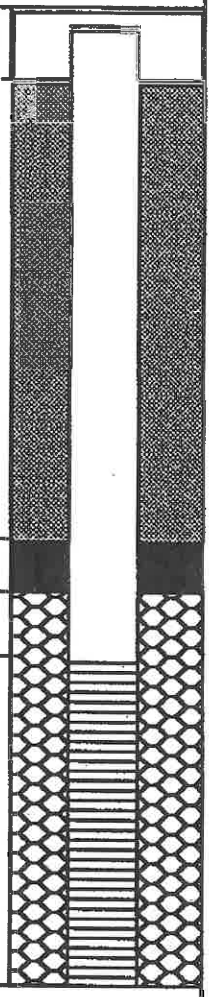
(804) 550-9200 • FAX (804) 550-9259

BORING LOG

Identification:	B-50	Location:	Chesterfield Power Station	Project No.	95058.62
Drilling Contractor	Fishburne Drilling Inc.	Name of Logger:	Anthony W. Creech, P.G.	Date:	18 October, 2001
Type: HSA	Total Depth: ~30.0'	Screen/Casing Type:	0.010" Slot 2" PVC	Screened Interval:	30'-20'

Depth (feet)	Sample No. (Depth, ft)	Blow Counts	Recovery (inches)	Description of Material
0				
4	3-5	4-4-4-3	15"	Light brown soft inorganic SILT.
8				
	8-10	2-1-1-1	21"	Dark gray inorganic soft SILT.
12				
	13-15	weight of rod	6"	Dark gray SILT, soft.
16				
	18-20	1-3-4-5	24"	Olive gray CLAY with SAND, soft.
20				
24	23-25	3-2-5-23	14"	Yellowish orange fine SAND.
28				
	28-30	3-22-18-16	16"	Light brown coarse SAND and white GRAVEL, medium dense.
32				

Well Construction Details



NOTES:
1. PVC Well Riser set in locked metal cover in 2' x 2' x 4" concrete pad.

2. Water level is ~ 23.0'.

WELL LEGEND

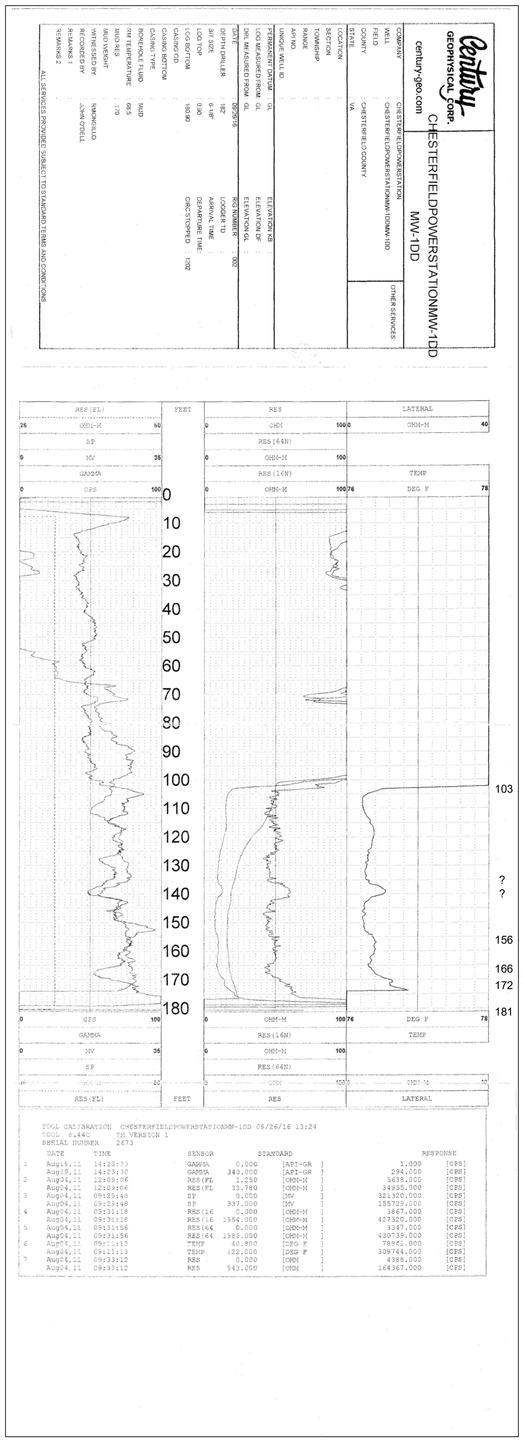
- PVC Riser
- PVC Screen
- Bentonite
- Cement Grout
- No. 2 Morie Sand

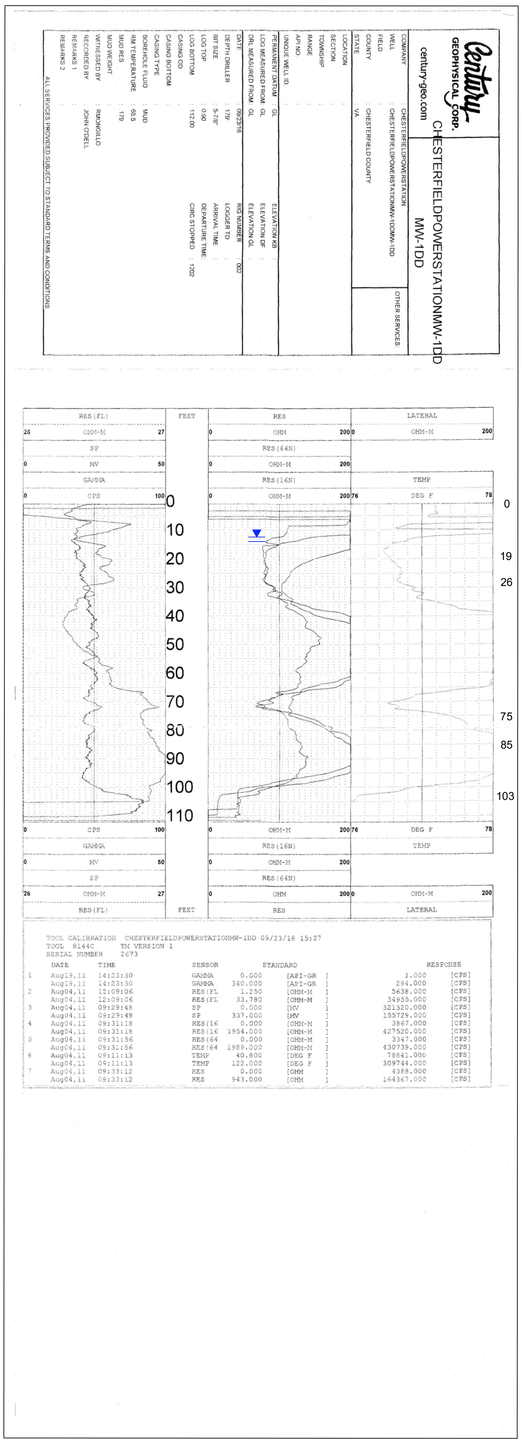
RESOURCE INTERNATIONAL, LTD.

ENGINEERS ◦ SCIENTISTS ◦ SURVEYORS ◦ PLANNERS

9560 KINGS CHARTER DRIVE ◦ P.O. BOX 6160 ◦ ASHLAND, VA 23005

(804) 550-9200 ◦ FAX (804) 550-9259





REV. 1

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

CLIENT
DOMINION ENERGY

SEAL

TITLE
GEOPHYSICAL LOGS
MW-1DD

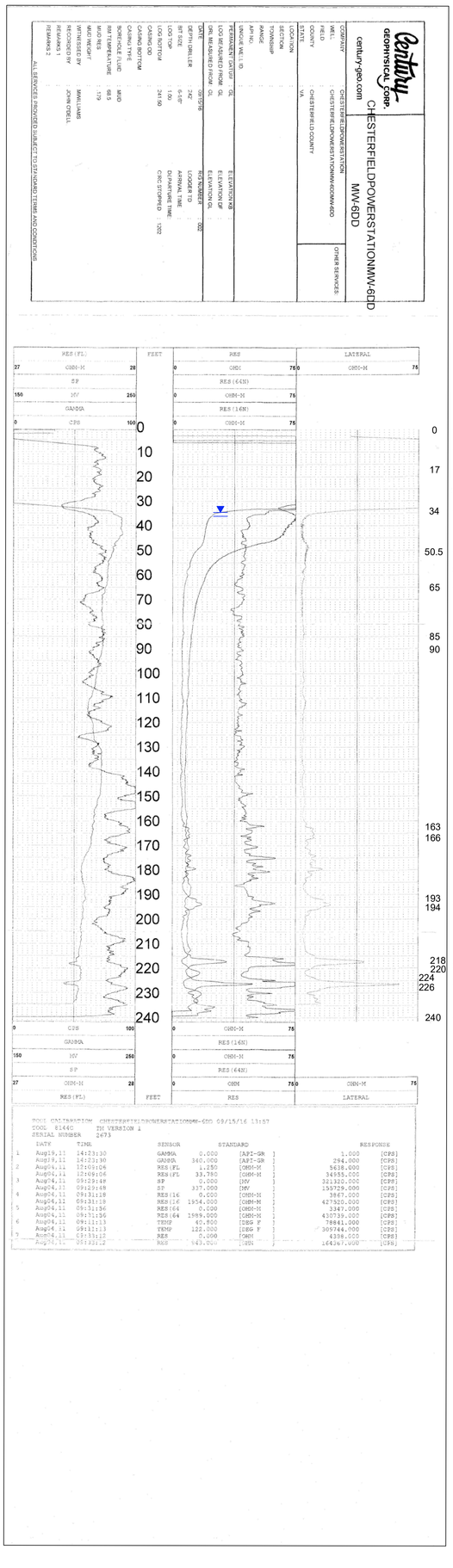
CONSULTANT
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

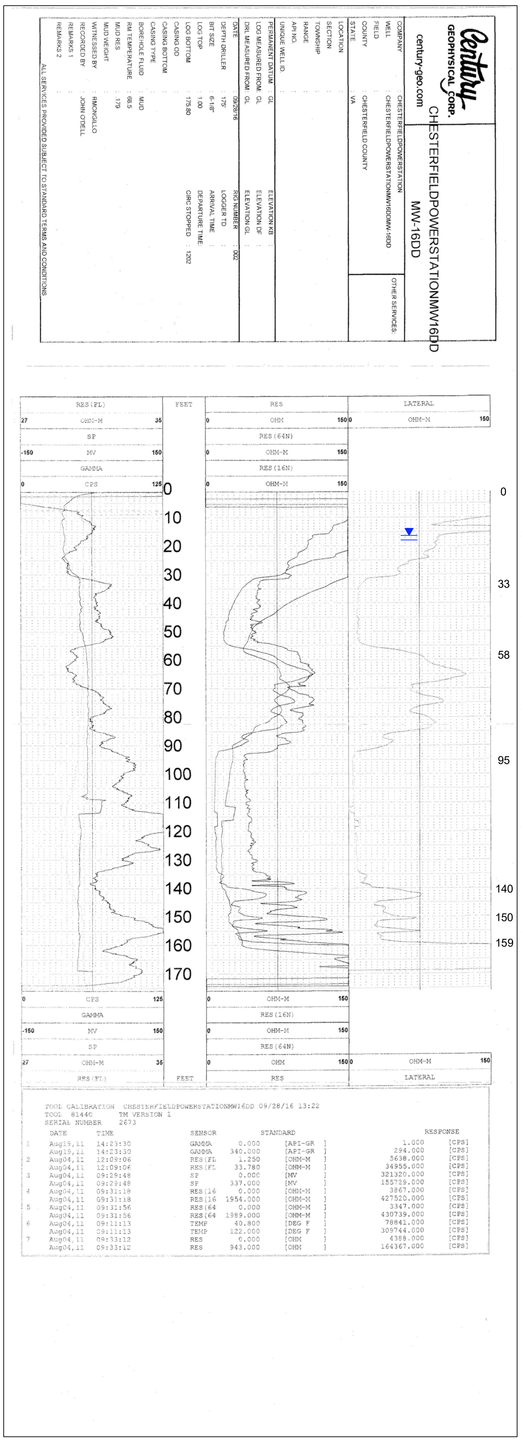
PROJECT NO.
20-139767

PLATE 1

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

0 1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D





REV.	DATE	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

CLIENT
DOMINION ENERGY

SEAL

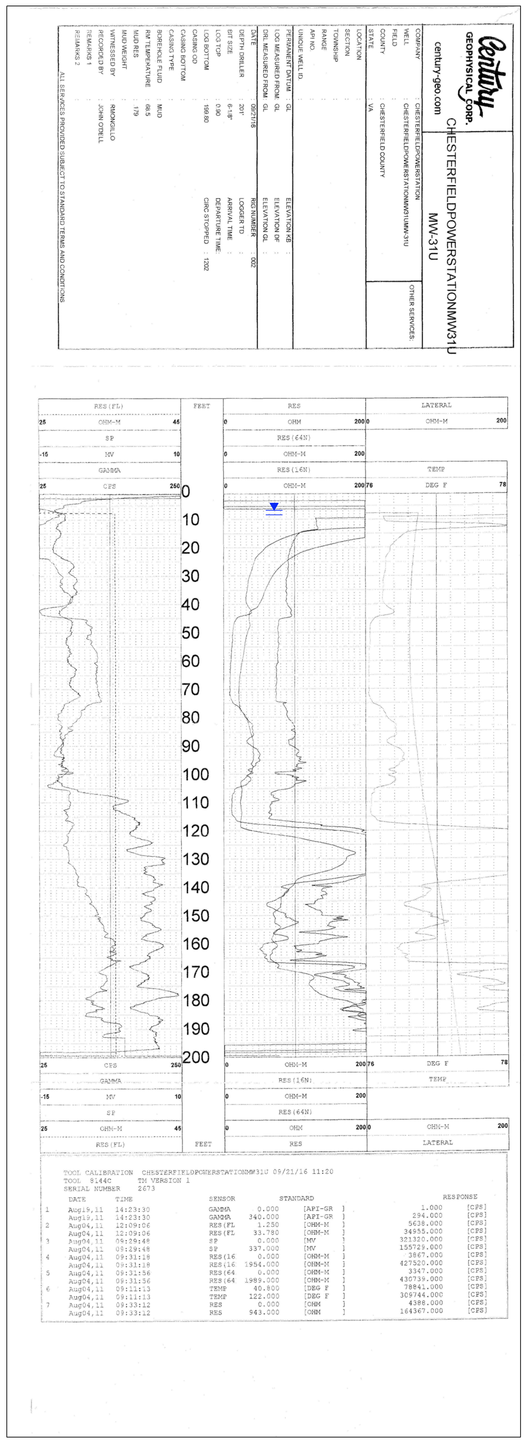
TITLE
GEOPHYSICAL LOGS
MW-6DD & MW-16DD

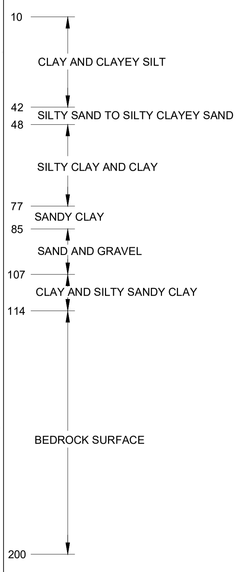
CONSULTANT
GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT NO.
20-139767

REV. 1
PLATE 2

0 1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D





REV. 1

PROJECT
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

CLIENT
DOMINION ENERGY

SEAL

TITLE
GEOPHYSICAL LOGS
MW-31U

CONSULTANT
GOLDER

GOLDER ASSOCIATES
2108 WEST LABURNUM AVENUE
SUITE 200
RICHMOND, VA 23227
(804) 358-7900
www.golder.com

PROJECT NO.
20-139767

PLATE 3

REV.	MM/DD/YY	DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
1	06/15/20	UPDATED TITLEBLOCK	MGW	BPG	MGW	MGW

0 1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ARCH D

Appendix B

Groundwater Monitoring Well Construction Specifications
Well Development Guidance
Well Decommissioning Guidance
Figure 1 – Monitoring Well Details

GROUNDWATER MONITORING WELL CONSTRUCTION SPECIFICATIONS

1.0 DRILLING

1.1 Nominal Boring Diameter

In all cases where the diameter of the well pipe will be 2 inches, the minimum nominal borehole diameter of borings advanced through soil materials will be 6 inches in order to help ensure that the minimum width of the annulus around the well pipe will be 2 inches.

1.2 Drilling Methods

Boring should be advanced with drilling technology appropriate for the subsurface conditions at the site.

1.3 Cuttings

Drilling will be performed in a manner that minimizes the spreading of soil cuttings. Disposition of cuttings upon project completion will be the responsibility of Owner/Operator or the Owner/Operator's designated representative. Cuttings will be disposed of in accordance with the DEQ's Investigative Derived Waste Disposal Policy.

2.0 SOIL SAMPLING

2.1 Cuttings

During borehole drilling, the driller will attempt to sample the soil cuttings by providing samples of the cuttings at intervals specified by the Owner/Operator or the Owner/Operator's representative. The driller will keep cuttings clear of the borehole.

2.3 Sample Disposition

Disposition of sample material upon completion of the project will be the responsibility of the Owner/Operator or the Owner/Operator's designated representative.

3.0 WELL CONSTRUCTION

3.1 Well Pipe and Screen

Each monitoring well will be constructed of pre-cleaned Schedule 40 PVC pipe having an inner diameter of 2 inches.

The base of each well will terminate with a screen 10 feet in length unless otherwise requested by the client or regulatory agency or dictated by geologic conditions. Screens will be factory-slotted. Slots will be 0.01 inch in width.

The driller will wear clean surgical-type gloves whenever handling PVC well pipe, and the pipe will be maintained in a clean manner.

In order to provide a clean cut, a PVC pipe cutter will be used whenever it is necessary to shorten sections of the PVC well pipe; a hacksaw will not be used.

3.3 Sand Pack

Filter sand will be a clean sand of proper size in relation to the screen slots to prevent its passage into the well, with no fraction coarser than 0.25-inch nominal diameter.

Filter sand will be placed in the annulus around the well riser and to a point approximately 2 feet above the top of the screen. A tremie pipe will be used as feasible.

3.4 Bentonite Seal

The annulus around the well pipe will be sealed with a layer of bentonite pellets, to be placed directly above the sand filter pack. The minimum thickness of the bentonite layer will be approximately two feet. The bentonite pellets should ideally be allowed 24 hours for hydration prior to continuing with well construction. A tremie pipe will be used as feasible

3.5 Grout

Following hydration of the bentonite seal, each boring will be sealed with a Portland Type I bentonite/cement slurry, using the tremie pipe method or a bentonite slurry grout if required by the project.

Bentonite content in the cement slurry will be 2 to 5 percent by weight to help reduce shrinkage.

3.6 Surface Completion

The driller will be prepared for either manhole or stickup surface completions.

In the case of manhole installations, suitable surface completion will consist of capped PVC riser and steel manhole.

The PVC riser will be provided with a lockable, watertight, expansion cap. The driller will provide a lock for each cap. All locks will be keyed identically and all keys relinquished to the owner.

The manhole will be placed in a manner that permits surface water to runoff and drain away from the manhole cover.

In the case of stickup installations, suitable surface completion will consist of a concrete apron, capped PVC well riser, and outer protective casing. The apron will be constructed in such a manner that surface water will not return to it.

The concrete apron will have the following minimum dimensions: 3 feet x 3 feet x 3.5 inches, and will be centered with respects to the riser. A form will be used in constructing the apron. The form will be centered with respect to the PVC riser. The upper surface of the apron will be graded to provide drainage away from the PVC riser. A spike will be set into the pad for surveying purposes.

The inner PVC riser (well pipe) will extend to an approximate height of 1.75 feet above the top of the concrete pad. A vent hole having a diameter of 0.25 inches will be drilled through the PVC riser at a point 2 inches below its top. Shavings generated by drilling the PVC riser will be prevented from falling into the well. The PVC riser will be provided with a slip on PVC cap.

The outer protective casing will be constructed of steel pipe having a diameter, or diagonal, of not less than 8 inches. The top of the outer protective casing, when uncovered, will be placed at a point between 0.5-inch above the top of the PVC well pipe and 0.5-inch below the top of the PVC pipe. A drain hole having a diameter of 0.5-inch will be drilled through the outer protective casing near the top of the concrete apron. Shavings generated by drilling the steel casing will be prevented from falling into the well. The casing will be marked for surveying purposes.

The outer protective casing will be lockable. The driller will provide a lock for each protective casing cap. All locks will be keyed identically.

4.0 SURVEYING

A licensed surveyor will survey well elevation. Survey point(s) will include:

- concrete pad (marked with a spike);
- outer protective steel casing, when open (engraved mark);
- inner PVC well pipe (engraved mark);
- ground surface (not marked);
- well location to within $\pm$ 0.5 foot in horizontal plane;
- ground surface elevation to within $\pm$ 0.01 foot;

- surveyor's pin elevation on concrete apron within ± 0.01 foot;
- top of monitoring well casing elevation to within ± 0.01 foot; and,
- top of protective steel casing elevation to within ± 0.01 foot.

5.0 WELL DEVELOPMENT AND INSPECTION

The driller will develop each well until sediment free water with stabilized field constituents (i.e., temperature, pH and specific conductance) is obtained.

Development will be conducted using a surge block followed by pumping or bailing. The surge block may be used as a means of assessing the integrity of the well screen and riser.

In the event a pump is employed, the design of the pump will be such that any groundwater that has come into contact with air is not allowed to drain back into the well. Air surging will not be used.

All well development equipment (bailers, pumps, surge blocks) and any additional equipment that contacts subsurface formations will be decontaminated prior to on site use, between consecutive on site uses, and/or between consecutive well installations, as directed by Owner/Operator or Owner/Operator's designated representative.

6.0 ANCILLARY REQUIREMENTS

6.1 Extraneous Material

The driller will take all reasonable care to ensure that each boring is free from all materials other than those required for well construction. Materials required for well construction is here defined to include polyvinyl chloride (PVC), sand, bentonite, Portland cement and natural soil materials. All other materials accidentally or purposely placed in the hole will be removed by driller prior to well completion.

6.2 Decontamination

All drilling equipment (drill steel, bits, casing materials) and any additional equipment, that contacts subsurface formations will be decontaminated prior to on site use, between consecutive on site uses, and/or between consecutive well installations, as directed by Owner/Operator or Owner/Operator's designated representative.

Appropriate decontamination procedure will consist of steam cleaning with potable water and biodegradable detergent (e.g., Liquinox) approved by Owner/Operator

or Owner/Operator's designated representative. Steam cleaning will be conducted in a manner that minimizes over-spray and runoff.

6.3 Disposition of Waste Water

If drilling fluids are used or monitoring wells constructed in an area of suspected contamination, well development wastewater will be placed in 55-gallon drums at the well site and subsequently transported to a publicly operated treatment works (POTW) or the sites leachate collection system for disposal.

6.4 Site Safety Plan

The driller is responsible for maintaining the personal safety of his employees while on site. The driller will keep a fire extinguisher (in good working condition) and first aid kit at the site at all times during which his employees occupy the site.

The driller will be responsible for providing any personal protective equipment that might be required by state and federal occupational safety and health agencies, including, but not necessarily limited to, hard hats, hearing protection and steel-toed boots, for all personnel employed by the driller.

6.5 Cleanup

The driller will be responsible for removing all refuse from each well site. Such refuse typically includes, but is not limited to, PVC pipe wrappers, sand bags, bentonite bags, cement bags, beverage containers, food wrappers and other forms of litter. Smoking on site will not be permitted.

The driller will be responsible for providing the following information to the Owner/Operator's designated representative after well installation has been performed:

- date and time of construction;
- drilling method and fluid used (if applicable);
- boring diameter;
- well pipe (inner casing) specifications;
- well depth (+/-0.01 ft.);
- drilling/lithologic logs;
- specifications for other casing materials (if applicable);
- screen specifications;
- well pipe/screen joint type;
- filter pack specifications (material, size);
- filter pack volume and calculations;
- filter pack placement methods;

- bentonite seal specifications;
- bentonite seal volume;
- bentonite seal placement method;
- grout specifications;
- grout volume;
- grout placement method;
- surface completion specifications; and
- well development procedure

7.0 WELL CONSTRUCTION AND SOIL BORING LOGS

In accordance with 9VAC-20-81-250-A.3.g of the Virginia Solid Waste Management Regulations or other applicable regulations, certified copies of well construction and soil boring logs will be forwarded to the DEQ following completion of well construction activities.

g:\projects\dominion\chesterfield power stn\1532-864 uap and lap groundwater\uap groundwater monitoring plan\2016-04 submittal - rtc deq ltr 2016-02-26\appendices\appendix iia monitoring well construction specifications - golder vswmr amendment 7 update.docx

WELL DEVELOPMENT PROCEDURES

- Record the static water level in the well.
- If a pump is present in the well, remove the pump from the well and measure the total depth of the well.
- Calculate saturated volume of the well and filter pack.
- Using a disposable bailer, collect a water sample from the top of the water column and record field measurements of water quality parameters (Water Quality Parameters (WQP): turbidity, pH, temperature, and specific conductance).
- Surge the well with the teflon surge block or large diameter weighted bailer for three to five minutes.
- Remove the surging device and purge the well with a pneumatic well development pump at a rate that is greater than the natural recharge rate of the well.
- Containerize all purge water for disposal at the location designated by the site.
- Record measurements of WQP on development logs following the removal of each consecutive well and filter pack volume.
- Continue purging until the turbidity level stabilizes or is reduced to less than 5 NTU, then repeat surging with surge block. Surging and purging are to be continued for a minimum of 4 hours, or until turbidity levels following a surging event are less than 10 NTU.
- If the well purges dry, record the rate of recharge and continue purging and surging activities after the well has recovered. Reduce the purge rate to slightly less than the natural recharge rate of the well.
- All non-disposable equipment that will be placed inside of the well during the development process will be decontaminated prior to each day's use using a phosphate-free detergent followed by a deionized water rinse.
- Purge water should be disposed of in a manner that is consistent with the Virginia Department of Environmental Quality's Investigative Derived Waste Disposal Policy.

g:\projects\dominion\chesterfield power stn\073-6607 dominion reymet rd lf\environmental\groundwater monitoring plan 2012\attachments\app iib well development standard operating guidance.docx

1.0 STANDARD OVERVIEW

This Standard represents recommended procedures for decommissioning monitoring wells at solid waste facilities. All wells (monitor wells, water supply wells, etc.) and piezometers not actively being used for their intended purpose and with no future plan for utilization should be decommissioned. Wells and piezometers represent potential conduits for cross-contamination through annulus transfer, improper construction, corrosion, accidents and vandalism. Proper decommissioning eliminates the potential for cross-contamination. In addition to the threat of cross-contamination, improperly decommissioned wells can pose a threat to the integrity of future baseliners. In expansion areas over unconsolidated material, unless the well casing is removed and replaced with a flexible grout, the casing can damage the baseliner in the event of differential settlement or subsidence. The weight of the overlying waste mass often causes a limited amount of subsidence, especially in fine-grained deposits. Since future expansions can occur in areas not currently foreseen, all unused wells within the vicinity of a solid waste disposal facility should be abandoned in accordance with this Standard.

The following well decommissioning procedures are designed to ensure that well materials (including cement grout) will not cause damage to liner materials in the event of subsidence and to minimize the potential for contaminant migration through annular materials. Where regulatory requirements conflict with the procedures described herein, approval should be sought to adhere to this Standard. The procedures described in this Standard generally meet or exceed most regulatory requirements. Possible reasons for variation to this Standard include, but are not limited to, unusual site hydrogeologic conditions, deep wells (>100 feet), multiple cased monitor wells or larger diameter wells (>4”), driven casing wells and State-specific well decommissioning requirements that differ from this Standard.

The goal of well decommissioning is to remove all borehole components including the existing grout and gravel pack and replace the borehole contents with a suitable grout mixture. Removal of all borehole components is best accomplished by overdrilling the well using an auger of a diameter 1.25 times that of the original borehole coupled with a centering device.

This standard was developed in consideration of the following reference materials:

- ASTM D 5299-99, 2005. Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities. ASTM 1993 Annual Book of Standards, vol. 04.08, pp. 1318-1333.
- AWWA/ANSI A100-06, 2006. AWWA Standard for Water Wells, American Water Works Association, Denver Colorado. Appendix G.
- Lutenegger, A.J. and DeGroot, D.J. 1993, Hydrologic properties of contaminant transport barriers as borehole sealants. Hydraulic conductivity and Waste Contaminant Transport in Soils, ASTM STP 1142, D.E. Daniel and S.J. Trautwein, eds., ASTM Philadelphia, Pennsylvania.
- NWWA, 1975 (National Water Well Association Committee on Water Well Standards, 1975) Manual of Water Well Construction Practices, EPA –570/9-75-001. Office of Water Supply, Washington D.C.
- Smith, S.A., 1994, Well & Borehole Sealing, S.A. Smith Consulting Services, Ada, Ohio with Wisconsin Water Well Association for Groundwater publishing Co., Dublin, Ohio, 69p.

2.0 SURVEY CONTROL

Unless detailed survey information exists, each well shall be surveyed for both horizontal and vertical control, prior to decommissioning. The location of the well shall be surveyed to the nearest 0.5 feet. The ground surface elevation and top of well casing shall also be surveyed to the nearest 0.1 feet and 0.1 feet, respectively, relative to mean sea level. A State-licensed surveyor shall perform surveying.

3.0 GROUT SPECIFICATIONS

The following are specifications for three grout mixtures commonly used in well decommissioning and referenced throughout this Standard:

1. Neat cement grout - a mixture in the proportion of 94 pounds of Portland cement and not more than six gallons of water. Used to decommission wells completed in competent bedrock formations.
2. Neat Bentonite grout - a mixture in the proportion of 94 pounds of Portland cement and not more than six gallons of water, with bentonite up to five percent by weight of cement (between 3 and 4.7 pounds of bentonite per 94 pounds of Portland cement). Used to decommission wells completed in competent bedrock formations.
3. High solids bentonite grout - a mixture of water and a minimum of 30 percent by weight of bentonite (see discussion below), with no additives (minimum of 2.5 pounds of bentonite per gallon of water). Used to decommission wells completed in unconsolidated materials and competent rock, where appropriate.

Typically, a high solids grout can be prepared using granular bentonite and pumped at a relatively low-viscosity state if done quickly (within 15 minutes). This is due to the slower hydration of the granular bentonite as compared to powdered bentonite. However, if these timeframes cannot be achieved or if it is desirable to have a slower "set," an alternative is to use what has been termed the "Ohio mix". The "Ohio mix" involves preparing a low-solids bentonite grout slurry (30 to 50lbs/100 gallons of water) using API 200-mesh bentonite (e.g., Natural Gel, Gold Seal), into which 125 lb. of granular bentonite (8 to 20-mesh) is added and mixed (stirred). The hydrated bentonite in the slurry delays hydration of the granular bentonite without the addition of polymers or other agents. The result is a high solids bentonite grout at a viscosity that is feasible to pump with reasonable working time (Eidil et al. 1992 from Smith, 1994).

3.1 Cement

The cement shall be Portland Cement® Type 1 in accordance with ASTM C150, Type 1 or API-10A, Class A.

3.2 Water

Water shall be obtained from an approved source. Water used for down-hole purposes shall have a Total Dissolved Solids (TDS) concentration of less than 500 mg/L (Smith, 1994) and be certified free from contaminants, or sampled for volatile organic compounds by EPA method 8260.

3.3 Bentonite

Bentonite shall be an additive free granular sodium bentonite (Benseal, Enviroplug, PDS Granular, Volclay Crumbles or equivalent) generally 8 to 20 mesh particle size. Use of granular bentonite *in lieu* of powdered bentonite allows the placement of a high-solids grout with relatively low viscosity, if mixing and pumping are done quickly. If following the "Ohio mix" discussed above, additive free API 200-mesh bentonite is used for the initial slurry (e.g., Natural Gel, Gold Seal) into which granular bentonite (8 to 20 mesh) is added and mixed.

3.4 Grouting Equipment

Grout mixers shall be paddle or blade type capable of thoroughly mixing grout. All grouting lines (i.e., hoses, pipes, drill rods, etc.) shall have an inside diameter of at least 0.50 inches to prevent clogging. Grout pumps shall be of a positive displacement or progressive cavity type (Moyno) capable of delivering a minimum pressure of 20 psi. Venturi mixing and centrifugal pumps are less desirable alternatives due to clay particle shearing and clogging problems, respectively.

4.0 DECOMMISSIONING PROCEDURES

Decommissioning procedures must be tailored to each well type and geologic environment. The broad range of suitable decommissioning methods for different situations is covered in detail in ASTM D5299-99 and the above referenced standards and literature. The purpose of this standard is to establish minimum requirements for the most common well construction types at our facilities. For landfill facilities, the most common type of well installation consists of single cased wells installed in unconsolidated material at relatively shallow depths (i.e., < 100 feet). The procedures described herein can be used to decommission two-inch or four-inch diameter single cased PVC or steel wells installed at depths generally less than 100 feet. Other less common well types requiring specialized procedures and materials include large diameter wells, multiple cased wells and driven casing wells.

The goal of decommissioning is to completely remove all well materials either through overdrilling or pulling of the well or casing. Once all well materials have been removed, the resulting borehole can be properly sealed with a suitable grout mixture.

In general, a high solids bentonite grout mixture (30% by weight) is preferred for most well decommissioning projects. State regulations often stipulate that for wells installed in bedrock, non-flexible grout mixtures must be used, such as neat cement grout or neat bentonite grout. Non-flexible grout mixtures more closely match the physical characteristics of competent bedrock. For all wells or portions of wells completed in unconsolidated material a high solids bentonite grout as defined above is the requisite grouting material. For wells of portions of wells completed in competent bedrock grouting materials can be either of the three grout types specified above with preference given to high solids bentonite grout.

The following are specific decommissioning procedures. These steps shall generally be completed in the order listed below.

1. Ensure that adequate survey control exists for each well and obtain a copy of the original well construction log.
2. Well decommissioning drilling equipment, augers, water level marker, and other tools must be decontaminated before being brought to the site.
3. The depth of the well shall be measured and compared to the anticipated well depth to determine if any obstructions are in the well. If the well is obstructed, the obstruction will be removed prior to sealing the well, if possible.
4. Expected grout volume calculations shall be completed using the depth information derived from Steps 1 and 3. The expected volume shall be recorded for reconciliation with the final grout volumes used.
5. Remove the protective casing. Position the drill rig directly over the well and attach a chain to the outer protective casing. Pull directly upward on the protective casing. Often for shallow wells this procedure will also pull up the inner-casing and annular materials. If this occurs, continue to pull all well materials out, as practicable.

6. Remove the well casing and associated annular materials. Typically, removal is accomplished through overdrilling using a Hollow Stem Auger (HSA) drill rig equipped with an auger bit that exceeds the diameter of the original bit (1.25 times the original auger diameter) used to construct the well. The key to successful overdrilling is insuring the auger bit remains centered on the well for the duration of overdrilling. For wells constructed of PVC, either employ a pilot bit to insure centering is maintained or place A-rod (steel rod) throughout the length of the well to act as a guide during overdrilling. A pilot bit consists of an elongate pointed pin with a maximum diameter slightly less than that of the inner well casing. For wells constructed of steel materials, the steel casing itself can be used to maintain centering during overdrilling. Essentially, an auger is selected with an inner diameter slightly larger than the diameter of the steel casing. During overdrilling the auger follows the steel casing to the target depth. Centering must be assured through use of one of the above-described centering methods. The overdrilling shall progress slowly to insure that the drilling operation remains centered over the well/boring. Once the base of the well is reached the auger or drilling equipment shall be left in place, to prevent cave in of materials, while proceeding to Step 6.

   For unconsolidated wells installed using driven casing or equivalent methods (i.e., no annular materials), it may be possible to pull the outer casing or well *in lieu* of overdrilling. If this procedure is used, grouting must be completed concurrently with the pulling of casing with grout level maintained within 5 feet of ground surface while the casing is pulled. The grout shall be introduced into the well from the base using a tremie line through the innermost casing (with the base of the well removed). The grout mixtures and procedures shall be as described in Step 6.

   Driven casing wells completed entirely in competent bedrock may be decommissioned without removing the casing by tremie grouting according to the procedures described in Step 6.

7. Upon removal of the casing, well screen and annular materials, the resulting boring shall be tremie grouted. The grout shall be a high solids bentonite grout as defined above. Essentially, the grout mixture shall contain as high a bentonite content as can be reasonably pumped (30% bentonite by weight). For wells installed in competent bedrock state regulations often mandate use of a neat cement grout mixture. It is preferable in cases where the borehole intersects both competent bedrock and unconsolidated materials that the unconsolidated interval shall be abandoned using a high solids bentonite grout. Grout shall be mixed to a uniform consistency. The grout shall be pumped into the boring through a tremie pipe placed at the bottom of the boring. The auger flights shall be left in place until the tremie line is situated at the bottom of the boring. Grouting shall proceed in a continuous and expeditious manner by concurrently pulling the auger flights and pumping grout until the grout level is within two feet of the ground surface. Both the bottom of the tremie pipe and the base of the auger flights must remain submerged in grout while the well is grouted.

   After the grout has settled for 24 hours, the borehole must be checked for grout settlement, and if necessary, topped off with the appropriate grout mixture. The final level of the grout shall be within two feet of the ground surface. The top two feet of the borehole shall be abandoned by adding and compacting native soils.

8. Equipment used for well decommissioning shall be cleaned and decontaminated between decommissioning locations.

9. Upon completion of decommissioning activities, well decommissioning materials and equipment will be removed from the site and the site will be restored. Over-drilled well materials and cuttings shall be properly disposed.

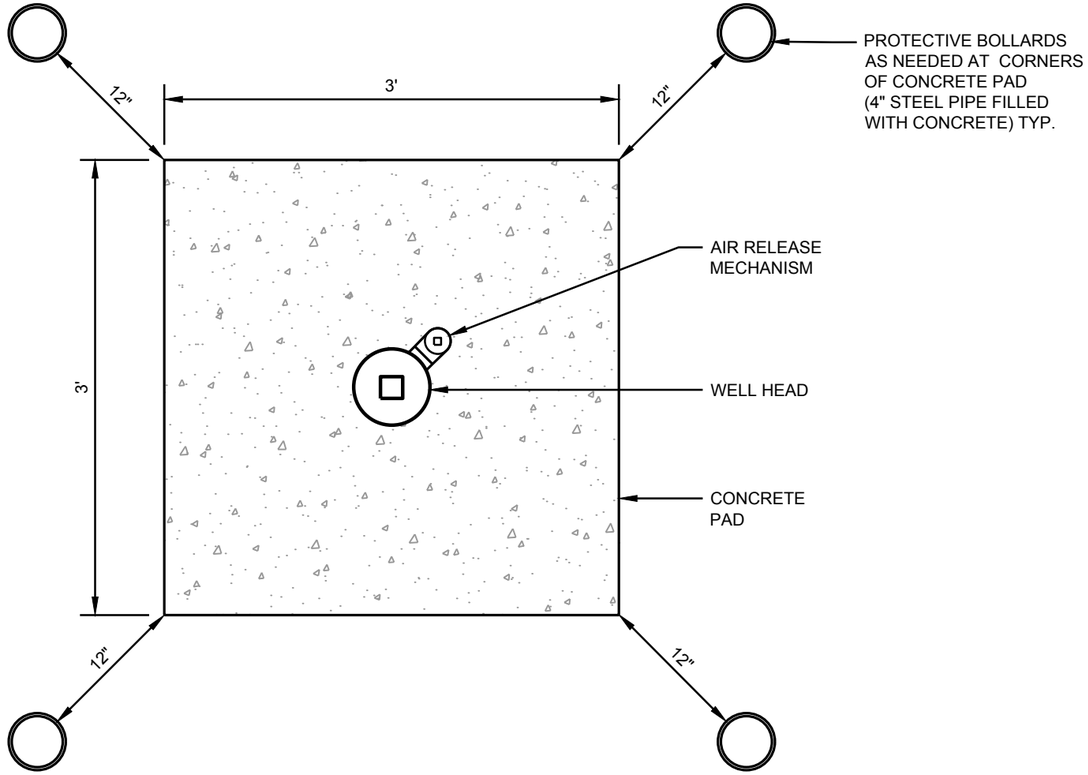
10. After the well has been decommissioned, a record must be prepared. The record must contain the following information, at a minimum:
    - Name and address of property owner;
    - Name, license or registration number of the contractor doing the work, name of the driller performing the work, and the signature of the representative;
    - Date work was completed;
    - Survey information including the county, township, range, section, and three quartiles, and the street address or fire number of the well or boring (for unincorporated areas);
    - A description of the geological material penetrated by the well (i.e., copy of the original boring log);
    - The original well or boring depth, and current well or boring depth;
    - The approximate date of construction;
    - The grout or sealing materials, type, quantities, and intervals;
    - The casing type, diameter, and depth, if present;
    - The screen or open hole depth interval, if present;
    - A description of any obstruction, if present;
    - A description of any deviations from the above procedures, or other unusual conditions encountered or actions taken; and
    - A statement as to whether or not all well materials were removed and if not a detailed explanation of the type of materials left in place and their approximate elevation, type, condition, etc.
11. Copies of the decommissioning record are to be forwarded to the site and the State agency if required.

4.1 Failure to remove all well materials

If for any reason the above decommissioning procedures fail to remove all well casing and screen materials, the well shall be permanently marked with a steel post and attached name plate containing the well identification. The name plate and/or site records shall contain, at a minimum, the following:

- Well Identification;
- Date of installation;
- Date of decommissioning;
- Survey coordinates; and
- Approximate elevation interval of in place well materials.

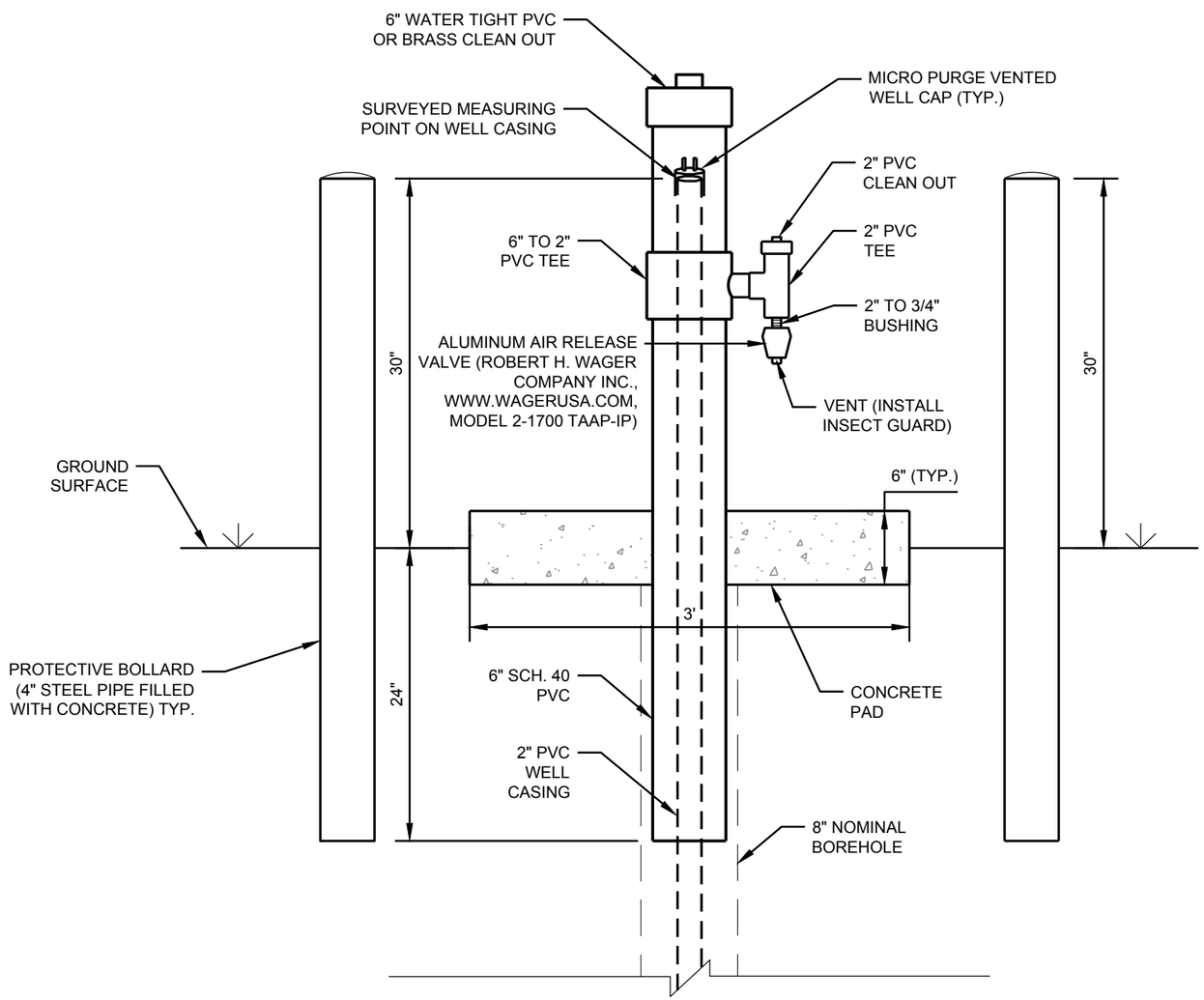
g:\projects\dominion\chesterfield power stn\073-6607 reymet road lf\environmental\groundwater monitoring plan\attachments\well decommissioning standard operating guidance.appiii.doc



PLAN VIEW

SCALE: 1" = 1'

NOTE: PROTECTIVE BOLLARDS TO BE INSTALLED AS NEEDED BASED ON SITE CONDITIONS TO PROTECT WELLHEAD INTEGRITY (AS DETERMINED BY DOMINION).



CROSS-SECTION VIEW

SCALE: 1" = 1'

Golder Associates
Richmond, Virginia

PROJECT
DOMINION
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VA

TITLE
MONITORING WELL DETAILS

PROJECT No.		15-32864
FILE No.		1532864A05
REV. 0	SCALE	AS SHOWN
DESIGN	MGW	06/29/16
CADD	BPG	06/29/16
CHECK		
REVIEW		

FIGURE 1

G:\Plan Production Data Files\Drawing Data Files\15-32864\A - Groundwater Map (UAP)\Active Drawings\1532864A05.dwg

WELL CONDITION SUMMARY

DATE:_____

Project Name_____ **Project No./Task No.**_____

Personnel _____ **Page**_____ **of** _____

Well ID	Protective Casing	Well Casing	Label	Lock	Pad Condition	Depth of Well (Feet)	General Turbidity	Comments/ Observations*
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	
	☐ OK ☐ Damaged	☐ OK ☐ Damaged	☐ OK ☐ Inadequate	☐ Yes ☐ No	☐ OK ☐ Damaged		☐ Clear ☐ Turbid	

* Note ponding water, weep holes, condition of surrounding area, including any disturbance of the ground since last inspection, evidence of contamination.

Signature:_____ Date:_____

WELL INSPECTION REPORT

FACILITY INFORMATION

Owner: _____ **Permit No.** _____

Location: _____ **Project No.** _____

INSPECTION

Inspection Date: _____ **Inspector Name:** _____

Time: _____ **Weather Conditions:** _____

MONITORING WELL CONDITIONS

Well ID: _____

Lock Condition: _____

Protective Casing Condition: _____

Pad Condition: _____

Pump Type: _____

Pump Serial No.: _____

Pump Condition: _____

Tubing Condition: _____

Sediment Accumulation in Well (describe): _____

Depth to Water (feet): _____

Depth to Bottom (feet): _____

Comments: _____

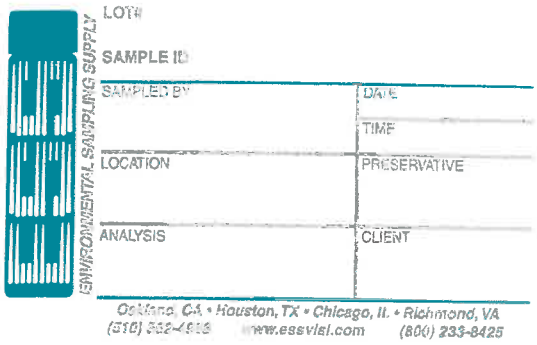
_____

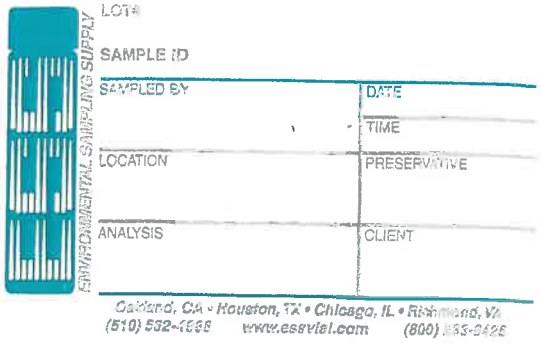
Signature: _____ **Date:** _____

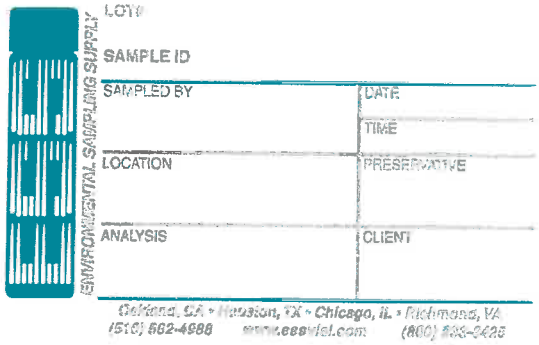
k:\reference\environmental\forms\waste management forms\annual well inspection form.doc

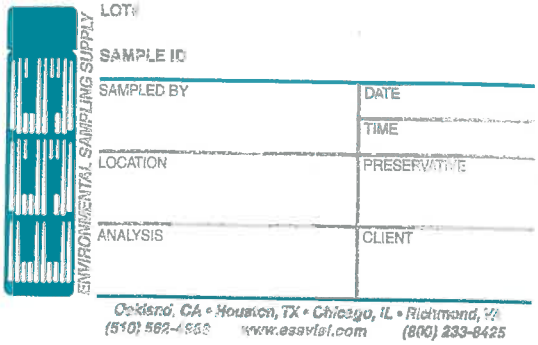
Appendix C

Example Chain-of-Custody Form
Sample Label
Chain-of-Custody Seal









ENCO

CUSTODY SEAL

Date: _____

Signature: _____

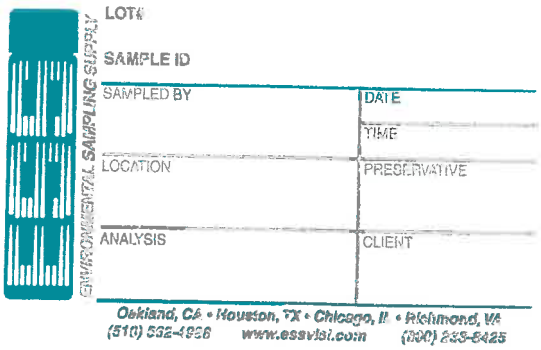
ENCO

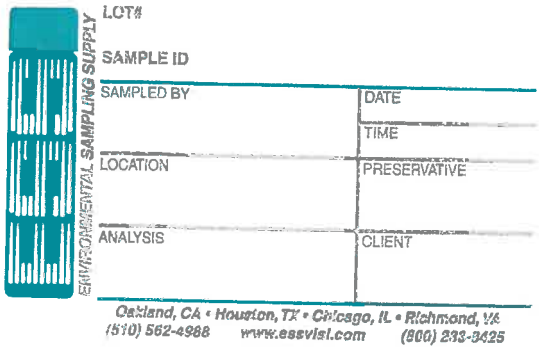
ENVIRONMENTAL CONSERVATION LABORATORIES, INC.

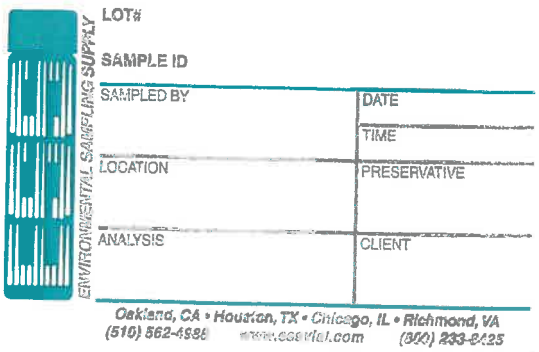
4810 Executive Park Ct., Ste 211 • Jacksonville, FL 32216-6069 • (904) 296-3007

10775 Central Port Drive • Orlando, FL 32824 • (407) 826-5314

102-A Woodwinds Industrial Court • Cary, NC 27511 • (919) 467-3090







ENCO

CUSTODY SEAL

Date: _____

Signature: _____

ENCO

ENVIRONMENTAL CONSERVATION LABORATORIES, INC.

4810 Executive Park Ct., Ste 211 • Jacksonville, FL 32216-6069 • (904) 296-3007

10775 Central Port Drive • Orlando, FL 32824 • (407) 826-5314

102-A Woodwinds Industrial Court • Cary, NC 27511 • (919) 467-3090

CHAIN OF CUSTODY

PAGE _____OF _____

CLIENT NAME:	PROJECT NAME:
CLIENT CONTACT:	SITE NAME:
CLIENT ADDRESS:	PROJECT NUMBER:
CLIENT PHONE NUMBER:	P.O. NUMBER:
CLIENT FAX NUMBER:	REGULATORY AUTHORITY:

Is sample for compliance reporting? YES NO	Is sample from a chlorinated supply? YES NO	PWS#
SAMPLER NAME (PRINT):	SAMPLER SIGNATURE:	**Turn Around Time:** **Day(s)**

							MATRIX						ANALYSIS							COMMENTS
CLIENT SAMPLE I.D.	Date Sampled	Time Sampled	Number of Containers	Grab	Composite	Field Filtered	Groundwater	Wastewater	Drinking Water	Soil	Solids	Other _____								PLEASE NOTE PRESERVATIVE(S)
1)																				
2)																				
3)																				
4)																				
5)																				
6)																				
7)																				
8)																				
9)																				
10)																				

RELINQUISHED:	DATE / TIME	RECEIVED:	DATE / TIME	**LAB USE ONLY** **COOLER TEMP ℃** _____
RELINQUISHED:	DATE / TIME	RECEIVED:	DATE / TIME	
RELINQUISHED:	DATE / TIME	RECEIVED:	DATE / TIME	

Appendix D

Groundwater Protection Standards

Groundwater Protection Standard Establishment
40 CFR Part 257 Subpart D

Chesterfield Power Station – Lower Ash Pond
Chester, Virginia

EPA's "*Disposal of Coal Combustion Residuals from Electric Utilities*" Final Rule, 40 CFR §257.95(d)(2), requires the owner or operator of an existing Coal Combustion Residuals (CCR) unit monitoring groundwater under the Assessment Monitoring Program to establish groundwater protection standards (GWPS) for all constituents detected pursuant to 40 CFR §257.95(b) or 40 CFR §257.95(d).

Initial Assessment Monitoring Program Appendix IV groundwater sampling and analysis was completed on March 23, 2018 in accordance with 40 CFR §257.95(b). Detected Appendix IV constituents included: arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, molybdenum, thallium, and radium 226 & 228 (combined). GWPS have been established for those detected Appendix IV constituents using the following methodology in accordance with 40 CFR §257.95(h):

1. For constituents for which a Maximum Contaminant Level (MCL) has been established, the MCL was used.
2. For constituents for which a health-based GWPS has been adopted under the August 29, 2018 Phase 1, Part 1 amendment to the CCR Rule, the health-based GWPS was used.
    a. The Commonwealth of Virginia adopted by reference the October 4, 2016 version of 40 CFR §257 into 9VAC20-81-800 of the Virginia Solid Waste Management Regulations. Amendments to 40 CFR Part 257 Subpart D after October 4, 2016 have not been incorporated into 9VAC20-81-800. Therefore, the health-based GWPS is not applicable to the Virginia CCR Rule under 9VAC20-81-800.
3. Under 9VAC20-81-800, for constituents for which an MCL has not been established, the background concentration for the constituent was used for GWPS.
4. For constituents for which the background level is higher than the MCL or health-based GWPS, the background concentration was used for GWPS.

Supporting data and calculations are included as an attachment to this memo. The following Table 1 summarizes groundwater protection standards for Chesterfield Power Station's Lower Ash Pond.

Attachments: Table 1 – CCR Rule Groundwater Protection Standards
Golder September 5, 2018 Proposed Groundwater Protection Standards

Table 1 – CCR Rule Groundwater Protection Standards – Chesterfield Power Station Lower Ash Pond

Detected Appendix IV Constituent	Units	Site-Specific Background Value	EPA MCL	CCR Rule Health-Based GWPS	CCR Rule GWPS	CCR Rule GWPS Source	Virginia CCR GWPS	Virginia CCR GWPS Source
Arsenic	µg/L	19.8	10	--	19.8	BKG	19.8	BKG
Barium	µg/L	318	2000	--	2000	MCL	2000	MCL
Beryllium	µg/L	QL (1)	4	--	4	MCL	4	MCL
Cadmium	µg/L	QL (1)	5	--	5	MCL	5	MCL
Chromium	µg/L	QL (5)	100	--	100	MCL	100	MCL
Cobalt	µg/L	7.40	--	6	7.40	BKG	7.40	BKG
Fluoride	µg/L	281	4000	--	4000	MCL	4000	MCL
Lead	µg/L	QL (1)	15*	15	15	CCR GWPS	QL (1)	BKG
Lithium	µg/L	QL (50)	--	40	40	CCR GWPS	QL (50)	BKG
Molybdenum	µg/L	QL (10)	--	100	100	CCR GWPS	QL (10)	BKG
Thallium	µg/L	QL (1)	2	--	2	MCL	2	MCL
Radium 226 & 228	pCi/L	1.55	5	--	5	MCL	5	MCL

Notes:

µg/L = Micrograms per liter
BKG = Site-Specific Background Value
CCR GWPS = Coal Combustion Residuals Rule health-based GWPS adopted under the Phase 1, Part 1 Amendment.
EPA = United States Environmental Protection Agency
GWPS = Groundwater Protection Standard
MCL = Maximum Contaminant Level
pCi/L = picocuries per liter
QL = Quantitation Limit; values in parentheses (1) represent highest laboratory QL for the constituent based on background data. Future QL values are subject to change; however, GWPS cannot be less than values in parentheses.
* = Listed MCL represents an EPA MCL action level

September 5, 2018

Reference No. 178975418.401

Kelly Hicks, P.G. Project Manager III
Dominion Energy
5000 Dominion Boulevard
Glen Allen, VA 23060

Via Email: kelly.a.hicks@dominionenergy.com

RE: PROPOSED GROUNDWATER PROTECTION STANDARDS
CHESTERFIELD POWER STATION LOWER ASH POND
CHESTERFIELD COUNTY, VIRGINIA

Dear Kelly:

Consistent with the provisions of Title 40 Code of Federal Regulations (CFR) Subpart 257.95(d)(2) of the Coal Combustion Residuals (CCR) Rule, Golder Associates Inc. (Golder) is providing the enclosed proposed Groundwater Protection Standard (GPS) for the Lower Ash Pond at the Dominion Chesterfield Power Station. The proposed GPS are for the Lower Ash Pond and are proposed for the Appendix IV constituents listed in 40 CFR 257 that were detected during the initial Assessment Monitoring Program Appendix IV sampling event. A summary of the proposed GPS is provided in Table 1. As presented, the proposed GPS are based on:

- Federal Maximum Contaminant Levels (MCLs) – for constituents for which an MCL has been established; or;
- Site-specific background values – for constituents for which an MCL has not been established or for constituents for which the site-specific background value is higher than the MCL; or;
- United States Environmental Protection Agency (EPA) risk-based Regional Screening Levels (RSLs) for Tapwater – for constituents for which an MCL has not been established, an RSL may be used.

The results of the supporting statistical evaluations are summarized in Table 2.

The selection of a statistical method was previously certified pursuant to the CCR rule [257.93(f)(6)] and posted the Certification in the Facility's operating record on October 17, 2017, pursuant to the CCR Rule [257.105(h)(4)]. Golder recommends that the MCL-based GPS be updated upon the EPA's promulgation of new or revised MCLs. The site-specific background-based GPS should be updated as needed based on changes in background water quality.

Golder Associates Inc.
2108 West Laburnum Ave., Suite 200
Richmond, Virginia, USA 23227

T: +1 804 358-7900 | F: +1 804 358-2900

Golder and the G logo are trademarks of Golder Associates Corporation

If you have any questions regarding the information presented herein, please do not hesitate to contact us.

Sincerely,

Golder Associates Inc.

Craig J. LaCosse
Senior Project Geologist

Michael G. Williams, C.P.G.
Principal and Senior Consultant

Cc: Martha Smith (Golder)

Attachments:

Table 1:	Proposed CCR Groundwater Protection Standards, CCR Rule Appendix IV Constituents, Lower Ash Pond, Chesterfield Power Station
Table 2:	Summary of Appendix IV Statistical Evaluations, Lower Ash Pond, Chesterfield Power Station
Attachment 1	Background Statistic Worksheets

https://golderassociates.sharepoint.com/sites/22463g/reports/cps - lap-uap-metals 2018/cps lap 2018/proposed gps/draft final/2018-09-05 cps lap ccr gps proposal.docx

Tables

Table 1
Proposed CCR Groundwater Protection Standards
CCR Rule Appendix IV Constituents
Lower Ash Pond
Chesterfield Power Station

CCR Appendix IV Consituent	Class	CAS RN	Units	Site-Specific Background Value	EPA MCL/RSL	Proposed CCR GPS	GPS Source
Arsenic	Metal	7440-38-2	µg/L	19.8	10	19.8	BKG
Barium	Metal	7440-39-3	µg/L	318	2,000	2,000	MCL
Beryllium	Metal	7440-41-7	µg/L	QL (1)	4	4	MCL
Cadmium	Metal	7440-43-9	µg/L	QL (1)	5	5	MCL
Chromium	Metal	7440-47-3	µg/L	QL (5)	100	100	MCL
Cobalt	Metal	7440-48-4	µg/L	7.4	[6]	7.4	BKG
Fluoride	Metal	16984-48-8	µg/L	281.4	4,000	4,000	MCL
Lead	Metal	7439-92-1	µg/L	QL (1)	15*	15*	MCL*
Lithium	Metal	7439-93-2	µg/L	QL (50)	[40]	50	BKG
Molybdenum	Metal	7439-98-7	µg/L	QL (10)	[100]	100	RSL
Thallium	Metal	7440-28-0	µg/L	QL (1)	2	2	MCL
Radium 226 & 228	Radionuclide	13982-63-3 / 15262-20-1	pCi/L	1.55	5	5	MCL

Notes:
µg/L = Microgram per liter
BKG = Site-specific Background Value
CAS RN = Chemical Abstracts Service Registry Number
CCR = Coal Combustion Residuals
EPA = United States Environmental Protection Agency
GPS = Groundwater Protection Standard
MCL = Maximum Contaminant Level
RSL = Regional Screening Level; RSLs are presented in brackets
pCi/L = picoCurie per liter
MDC = Minimum Detectable Concentration (sample specific)
QL = Laboratory quantitation limit (value shown in parentheses is a recent QL and is subject to change)
Note that quantitiation limit is subject to change with updated method detection limit studies
(1) = Indicated value represents recent quantitation limit
* = Listed MCL represents an EPA action level

Table 2
Summary of Appendix IV Statistical Evaluations
Lower Ash Pond
Chesterfield Power Station

Sample Identity	Date	Arsenic, Appendix IV ug/L	Barium, Appendix IV ug/L	Beryllium, Appendix IV ug/L	Cadmium, Appendix IV ug/L	Chromium, Appendix IV ug/L	Cobalt, Appendix IV ug/L	Fluoride, Appendix III & IV ug/L
MW-29U	10/07/2016	2.1 J	200	< 1.0 U	< 1.0 U	2.0 B	3.4	79 J
	11/16/2016	9.3	270	< 1.0 U	< 1.0 U	1.6 J	3.9	160 J
	01/09/2017	3.7 J	180	< 1.0 U	0.43 J	0.57 B	2.7	120
	02/20/2017	7.2	240	< 1.0 U	< 1.0 U	0.75 J	4.1	130
	04/03/2017	9.1	210	< 1.0 U	< 1.0 U	0.84 J+	6.9 J+	230 J+
	05/15/2017	13	280	< 1.0 U	0.33 J	< 2.0 U	4.4	190
	06/19/2017	17.8	318	< 1.0 U	0.90	1.4	3.8	220
	07/24/2017	14.6	275	< 1.0 U	< 0.80 U	1.8 J+	3.6	140
MW-35S	01/12/2017	< 5.0 U	48	< 1.0 U	0.34 J	1.3 B	5.4	24 B
	02/23/2017	< 5.0 U	42	< 1.0 U	< 1.0 U	0.34 B	3.8	29 B
	03/16/2017	0.41 J	42	< 1.0 U	< 1.0 U	< 2.0 U	3.6	42 B
	04/07/2017	0.51 J	41	< 1.0 U	< 1.0 U	0.38 J	3.0	27 J
	05/03/2017	< 5.0 U	28	< 1.0 U	< 1.0 U	< 2.0 U	1.7	< 50 U
	06/06/2017	< 5.0 U	40	< 1.0 U	< 1.0 U	< 2.0 U	1.9	28 J
	07/05/2017	< 1.0 U	43.0	< 1.0 U	< 0.80 U	1.2 J	0.94 J	< 100 U
	08/10/2017	< 1.0 U	38.4	< 1.0 U	< 0.80 U	< 5.0 U	0.82 J	< 100 U
Minimum		0.41	28	1.0	0.33	0.34	0.8	24
Maximum		17.80	318	1.0	1.00	5.00	6.9	230
n		16	16	16	16	16	16	16
Count Detects		10	16	0	4	11	16	13
Count Non-Detects		6	0	16	12	5	0	3
Mean of Data Set		6.23	143.46	1.0	0.84	1.57	3.37	104
Standard Deviation of Data Set		5.29	111.37	0.0	0.25	1.10	1.57	70
% Truncated		38%	0%	100%	75%	31%	0%	19%
Outliers		No	No	No	No	No	No	No
n (Outliers Removed)		16	16	16	16	16	16	16
% Truncated (Outliers Removed)		38%	0%	100%	75%	31%	0%	19%
Normality		Normal	Non-Normal	Non-Normal	Non-Normal	Normal	Normal	Normal
Mean & Std Adjustment		Kaplan Meier	Not Applicable	Not Applicable	Not Applicable	Kaplan Meier	Not Applicable	Kaplan Meier
Adjusted Mean of Data Set		5.233	Not Applicable	Not Applicable	Not Applicable	1.083	Not Applicable	95.19
Adjusted Standard Deviation of Data Set		5.665	Not Applicable	Not Applicable	Not Applicable	0.531	Not Applicable	72.54
Background Limit Type		UPL	NPTL	NPTL	NPTL	UPL	UPL	UPL
Parametric Critical Value		2.49	Not Applicable	Not Applicable	Not Applicable	2.49	2.49	2.49
Calculated Background Concentration		19.8	318	1 (QL)	1 (QL)	2.447	7.4	281.4
Level of Confidence		95%	95%	95%	95%	95%	95%	95%
Percent Coverage		95%	82.9%	82.9%	82.9%	95%	95%	95%
Is Calculated Background > QL		Yes	Yes	No --> will use QL (1.0)	No --> will use QL (1.0)	No --> will use QL (5.0)	Yes	Yes

Notes:

n - Number of Observations
ug/L - micrograms per liter
pCi/L - picocuries per liter
B - result is blank qualified
J+ - Estimated/bias high concentration
ND - Not Detected
Non-Parametric Percent Coverage for Data Sets - Table 17-4 in Appendix D of Unified Guidance
NTPL - Non-Parametric Tolerance Limit
Parametric Prediction Limit Critical Value (t-quantile)- Table 16-1 in Appendix D of Unified Guidance
Parametric Tolerance Limit Critical Value (tolerance factor)- Table 17-3 in Appendix D of Unified Guidance
QL = Laboratory quantitation limit = Reporting limit
U - Result below method detection limit / minimum detectable concentration
UPL - Upper Prediction Limit using K=4
NTPL - Non-Parametric Tolerance Limit

Check: CJL 9/4/18

Review: MGW 9/4/18

Table 2
Summary of Appendix IV Statistical Evaluations
Lower Ash Pond
Chesterfield Power Station

Sample Identity	Date	Lead, Appendix IV ug/L	Lithium, Appendix IV ug/L	Molybdenum, Appendix IV ug/L	Thallium, Appendix IV ug/L	Total Radium pCi/L
MW-29U	10/07/2016	0.51 B	< 50 U	1.0 J	< 1.0 U	0.909
	11/16/2016	0.79 J	< 50 U	1.1 J	< 1.0 U	1.00
	01/09/2017	< 1.0 U	0.48 B	0.74 J	< 1.0 U	0.709
	02/20/2017	0.19 B	0.51 J	1.2 B	< 1.0 U	1.24
	04/03/2017	0.28 J+	1.0 J+	1.1 J	< 1.0 U	0.476
	05/15/2017	0.47 J	< 8.0 U	1.9 J	< 1.0 U	0.693
	06/19/2017	< 0.10 U	0.41 J	6.4	< 0.10 U	0.542 U
	07/24/2017	< 1.0 U	< 25.0 U	5.0 J	< 1.0 U	1.53
MW-35S	01/12/2017	0.46 B	1.5 J	< 10 U	< 1.0 U	0.841
	02/23/2017	0.18 B	1.7 B	< 10 U	< 1.0 U	0.615
	03/16/2017	0.31 B	1.6 J	0.58 J	< 1.0 U	0.658
	04/07/2017	0.37 J	1.9 J	0.68 J	< 1.0 U	0.358
	05/03/2017	< 1.0 U	2.1 J	< 10 U	< 1.0 U	0.554
	06/06/2017	< 1.0 U	2.4 J	< 10 U	< 1.0 U	0.282 U
	07/05/2017	< 1.0 U	1.5 J	< 5.0 U	< 1.0 U	0.908 U
	08/10/2017	< 1.0 U	2.4 J	< 5.0 U	< 1.0 U	0.934 U
Minimum		0.10	0.41	0.58	0.1	0.282
Maximum		1.00	50	10.00	1.0	1.530
n		16	16	16	16	16
Count Detects		9	12	10	0	12
Count Non-Detects		7	4	6	16	4
Mean of Data Set		0.60	9.41	4.356	0.944	0.766
Standard Deviation of Data Set		0.35	16.94	3.848	0.225	0.323
% Truncated		44%	25%	38%	100%	25%
Outliers		No	Yes	No	No	No
n (Outliers Removed)		16	14	16	16	16
% Truncated (Outliers Removed)		44%	14%	38%	100%	25%
Normality		Normal	Normal	Log-Normal	Non-Normal	Normal
Mean & Std Adjustment		Kaplan Meier	Kaplan Meier	Kaplan Meier	Not Applicable	Kaplan Meier
Adjusted Mean of Data Set		0.366	1.458	0.266 (LN)	Not Applicable	0.711
Adjusted Standard Deviation of Data Set		0.192	0.685	0.732 (LN)	Not Applicable	0.328
Background Limit Type		UPL	UPL	UTL	NPTL	UPL
Parametric Critical Value		2.49	2.533	2.524	Not Applicable	2.49
Calculated Background Concentration		0.858	3.254	8.28	1 (QL)	1.552
Level of Confidence		95%	95%	95%	95%	95%
Percent Coverage		95%	95%	95%	82.9%	95%
Is Calculated Background > QL		No --> will use QL (1.0)	No --> will use QL (50.0)	No --> will use QL (10.0)	No --> will use QL (1.0)	Yes

Notes:

n - Number of Observations
ug/L - micrograms per liter
pCi/L - picocuries per liter
B - result is blank qualified
J+ - Estimated/bias high concentration
ND - Not Detected
Non-Parametric Percent Coverage for Data Sets - Table 17-4 in Appendix D of Unified Guidance
NTPL - Non-Parametric Tolerance Limit
Parametric Prediction Limit Critical Value (t-quantile)- Table 16-1 in Appendix D of Unified Guidance
Parametric Tolerance Limit Critical Value (tolerance factor)- Table 17-3 in Appendix D of Unified Guidance
QL = Laboratory quantitation limit = Reporting limit
U - Result below method detection limit / minimum detectable concentration
UPL - Upper Prediction Limit using K=4
NTPL - Non-Parametric Tolerance Limit

Check: CJL 9/4/18

Review: MGW 9/4/18

Attachment 1

Background Statistic Worksheets

Arsenic, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	12		
Number of Detects	10	Number of Non-Detects	6
Number of Distinct Detects	10	Number of Distinct Non-Detects	2
Minimum Detect	0.41	Minimum Non-Detect	1
Maximum Detect	17.8	Maximum Non-Detect	5
Variance Detected	37.18	Percent Non-Detects	37.5%
Mean Detected	7.772	SD Detected	6.098
Mean of Detected Logged Data	1.502	SD of Detected Logged Data	1.364

Dixon's Outlier Test for Arsenic, Appendix IV

Total N = 16
Number NDs = 6
Number Detects = 10
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 17.8 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.277

For 10% significance level, 17.8 is not an outlier.
For 5% significance level, 17.8 is not an outlier.
For 1% significance level, 17.8 is not an outlier.

2. Data Value 0.41 is a Potential Outlier (Lower Tail)?

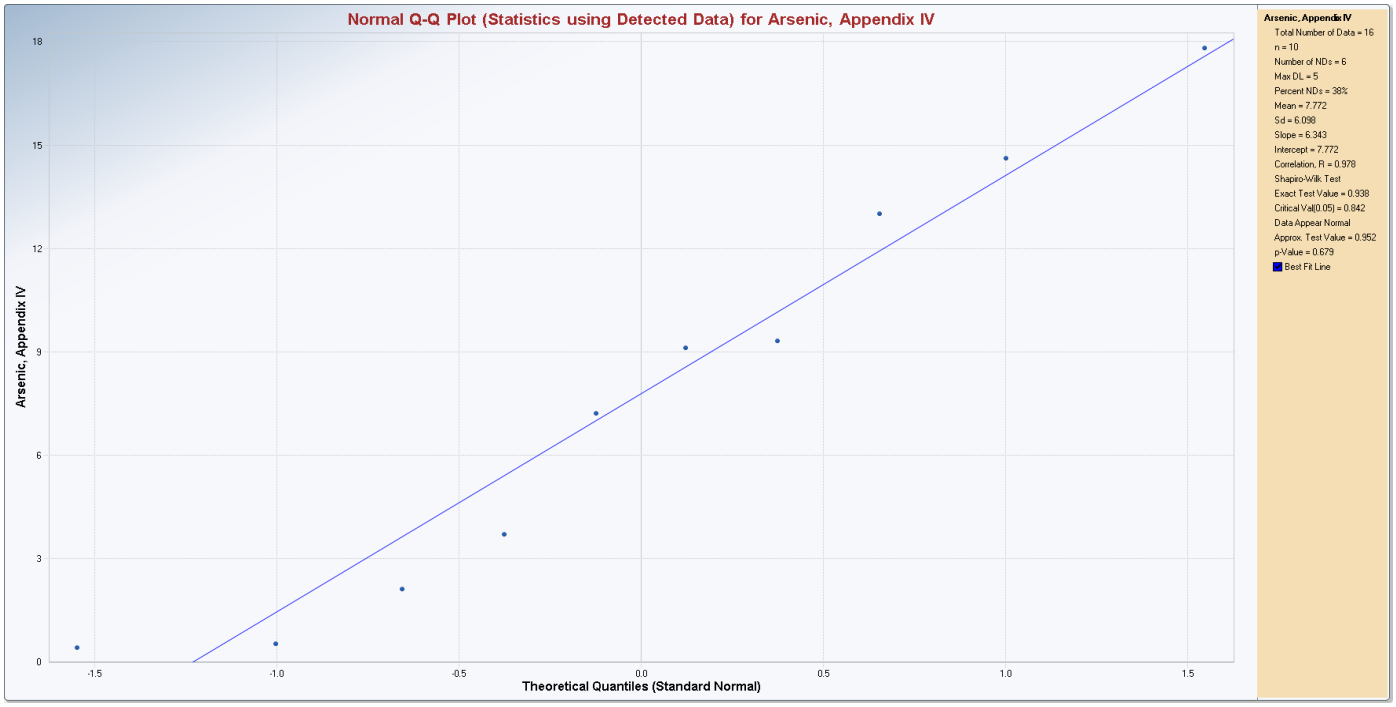
Test Statistic: 0.007

For 10% significance level, 0.41 is not an outlier.
For 5% significance level, 0.41 is not an outlier.
For 1% significance level, 0.41 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Arsenic, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	5.233	SD	5.665
95% UTL95% Coverage	19.53	95% KM UPL (t)	15.47
95% KM UPL for Next 4 Observations	19.77	95% KM UPL for Mean of Next 4 Observations	10.79

Barium, Appendix IV

General Statistics

Total Number of Observations	16	Number of Distinct Observations	15
Minimum	28	First Quartile	41.75
Second Largest	280	Median	114
Maximum	318	Third Quartile	247.5
Mean	143.5	SD	111.4
Coefficient of Variation	0.776	Skewness	0.261
Mean of logged Data	4.589	SD of logged Data	0.948

Dixon's Outlier Test for Barium, Appendix IV

Total N = 16
Number NDs = 0
Number Detects = 16
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 318 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.155

For 10% significance level, 318 is not an outlier.
For 5% significance level, 318 is not an outlier.
For 1% significance level, 318 is not an outlier.

2. Data Value 28 is a Potential Outlier (Lower Tail)?

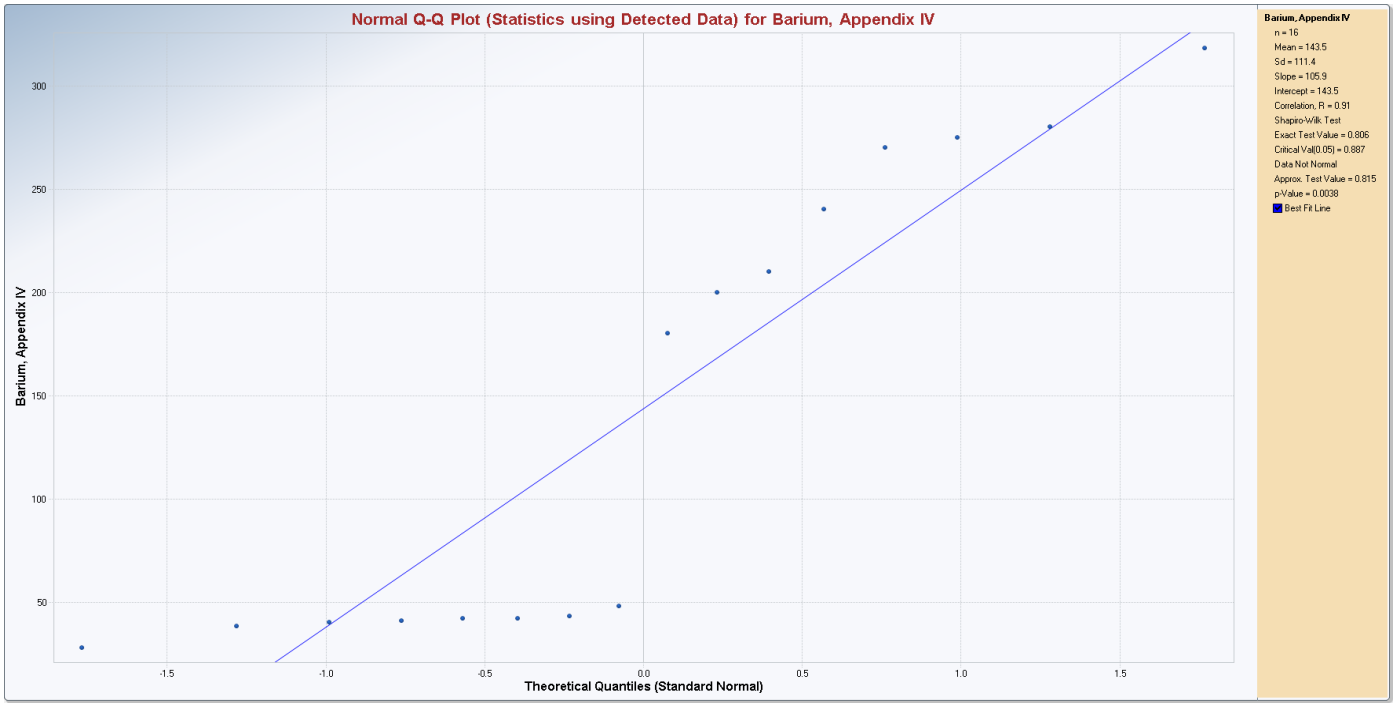
Test Statistic: 0.049

For 10% significance level, 28 is not an outlier.
For 5% significance level, 28 is not an outlier.
For 1% significance level, 28 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Barium, Appendix IV

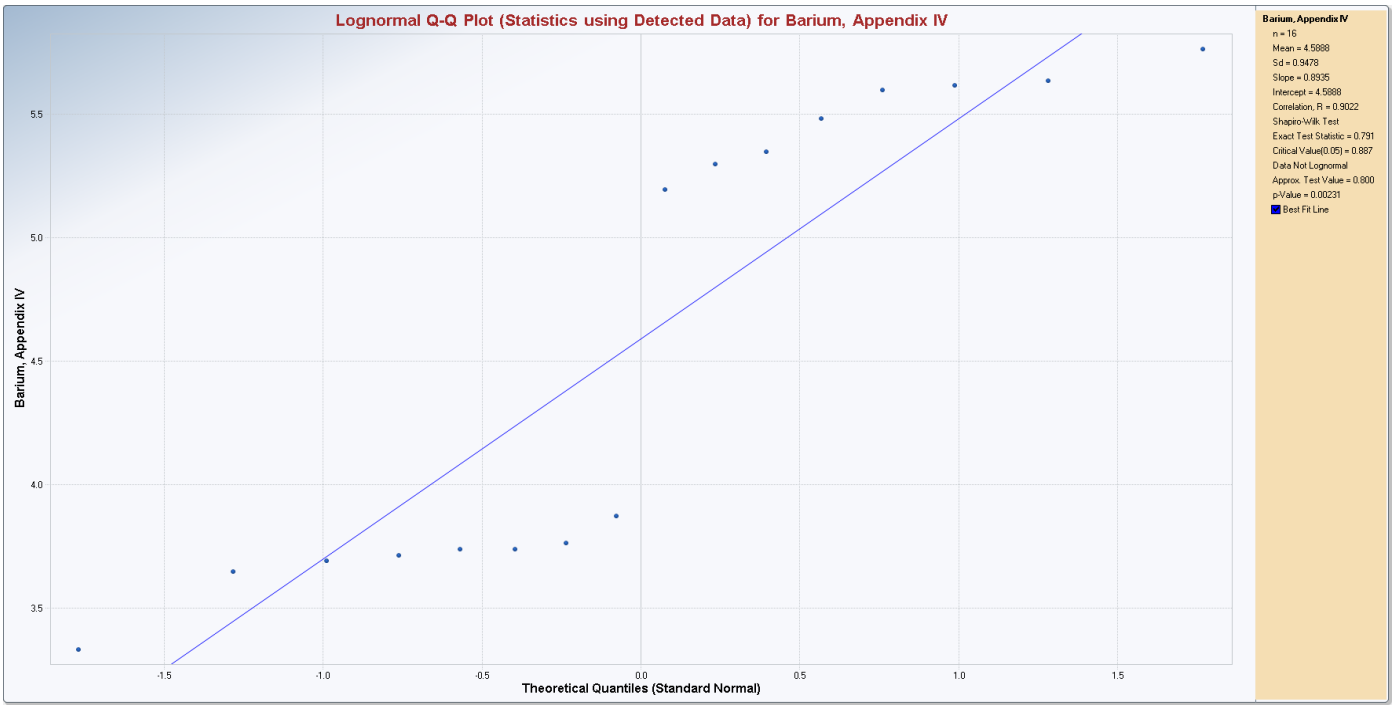


Normal GOF Test

Shapiro Wilk Test Statistic	0.806	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Barium, Appendix IV



Lognormal GOF Test

Shapiro Wilk Test Statistic	0.791	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

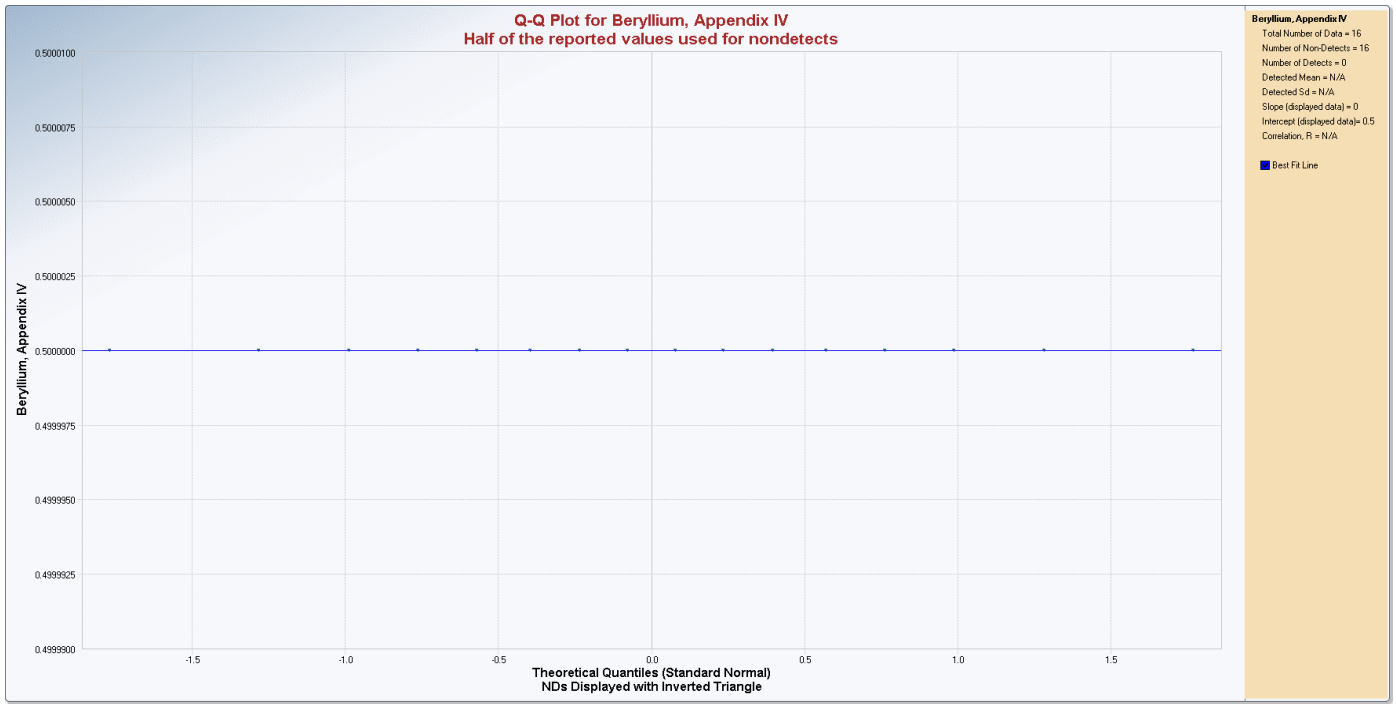
Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	16	95% UTL with 95% Coverage	318
Approximate f	0.842	Confidence Coefficient (CC) achieved by UTL	0.56
95% Percentile Bootstrap UTL with 95% Coverage	318	95% BCA Bootstrap UTL with 95% Coverage	318

Beryllium, Appendix IV

General Statistics

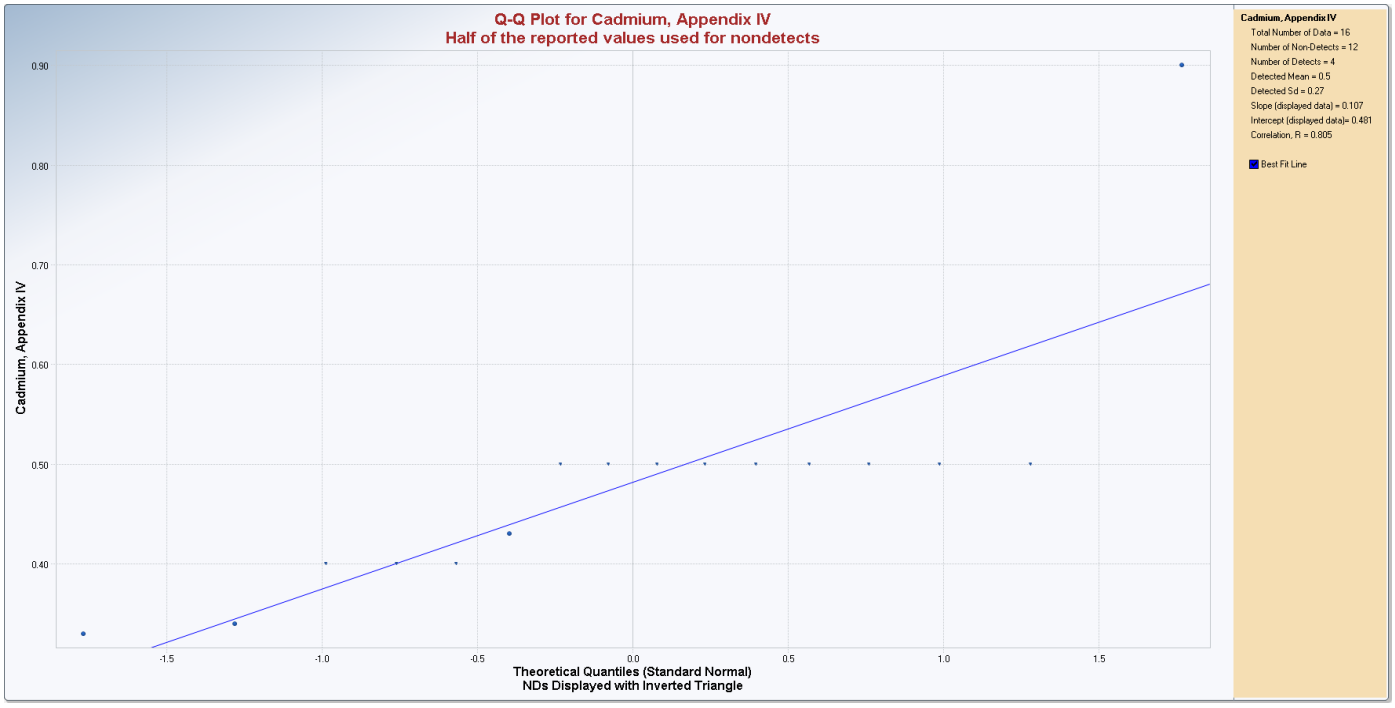
Total Number of Observations	16		
Number of Distinct Observations	1		
Number of Detects	0	Number of Non-Detects	16
Number of Distinct Detects	0	Number of Distinct Non-Detects	1
Minimum Detect	N/A	Minimum Non-Detect	1
Maximum Detect	N/A	Maximum Non-Detect	1
Variance Detected	N/A	Percent Non-Detects	100%
Mean Detected	N/A	SD Detected	N/A
Mean of Detected Logged Data	N/A	SD of Detected Logged Data	N/A



Cadmium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	6		
Number of Detects	4	Number of Non-Detects	12
Number of Distinct Detects	4	Number of Distinct Non-Detects	2
Minimum Detect	0.33	Minimum Non-Detect	0.8
Maximum Detect	0.9	Maximum Non-Detect	1
Variance Detected	0.0731	Percent Non-Detects	75%
Mean Detected	0.5	SD Detected	0.27
Mean of Detected Logged Data	-0.784	SD of Detected Logged Data	0.468



Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	16	95% UTL with95% Coverage	1
Approximate f	0.842	Confidence Coefficient (CC) achieved by UTL	0.56
95% UPL	1	95% USL	1

Chromium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	12		
Number of Detects	11	Number of Non-Detects	5
Number of Distinct Detects	11	Number of Distinct Non-Detects	2
Minimum Detect	0.34	Minimum Non-Detect	2
Maximum Detect	2	Maximum Non-Detect	5
Variance Detected	0.326	Percent Non-Detects	31.25%
Mean Detected	1.107	SD Detected	0.571
Mean of Detected Logged Data	-0.049	SD of Detected Logged Data	0.614

Dixon's Outlier Test for Chromium, Appendix IV

Total N = 16
Number NDs = 5
Number Detects = 11
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 2.5 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.363

For 10% significance level, 2.5 is not an outlier.
For 5% significance level, 2.5 is not an outlier.
For 1% significance level, 2.5 is not an outlier.

2. Data Value 0.34 is a Potential Outlier (Lower Tail)?

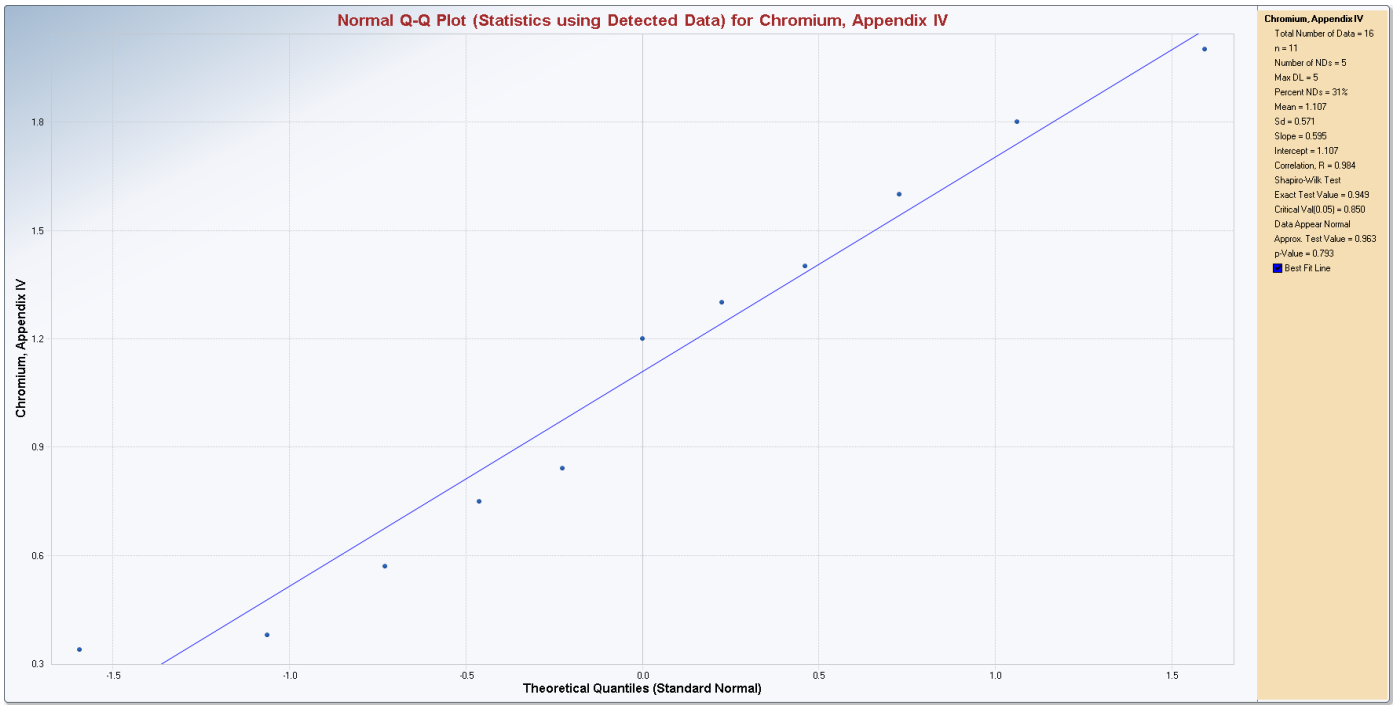
Test Statistic: 0.158

For 10% significance level, 0.34 is not an outlier.
For 5% significance level, 0.34 is not an outlier.
For 1% significance level, 0.34 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Chromium, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	1.083	SD	0.531
95% UTL95% Coverage	2.424	95% KM UPL (t)	2.043
95% KM UPL for Next 4 Observations	2.447	95% KM UPL for Mean of Next 4 Observations	1.604

Cobalt, Appendix IV

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
Minimum	0.82	First Quartile	2.5
Second Largest	5.4	Median	3.6
Maximum	6.9	Third Quartile	3.95
Mean	3.373	SD	1.568
Coefficient of Variation	0.465	Skewness	0.292
Mean of logged Data	1.083	SD of logged Data	0.584

Dixon's Outlier Test for Cobalt, Appendix IV

Total N = 16
Number NDs = 0
Number Detects = 16
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 6.9 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.481

For 10% significance level, 6.9 is an outlier.
For 5% significance level, 6.9 is not an outlier.
For 1% significance level, 6.9 is not an outlier.

2. Data Value 0.82 is a Potential Outlier (Lower Tail)?

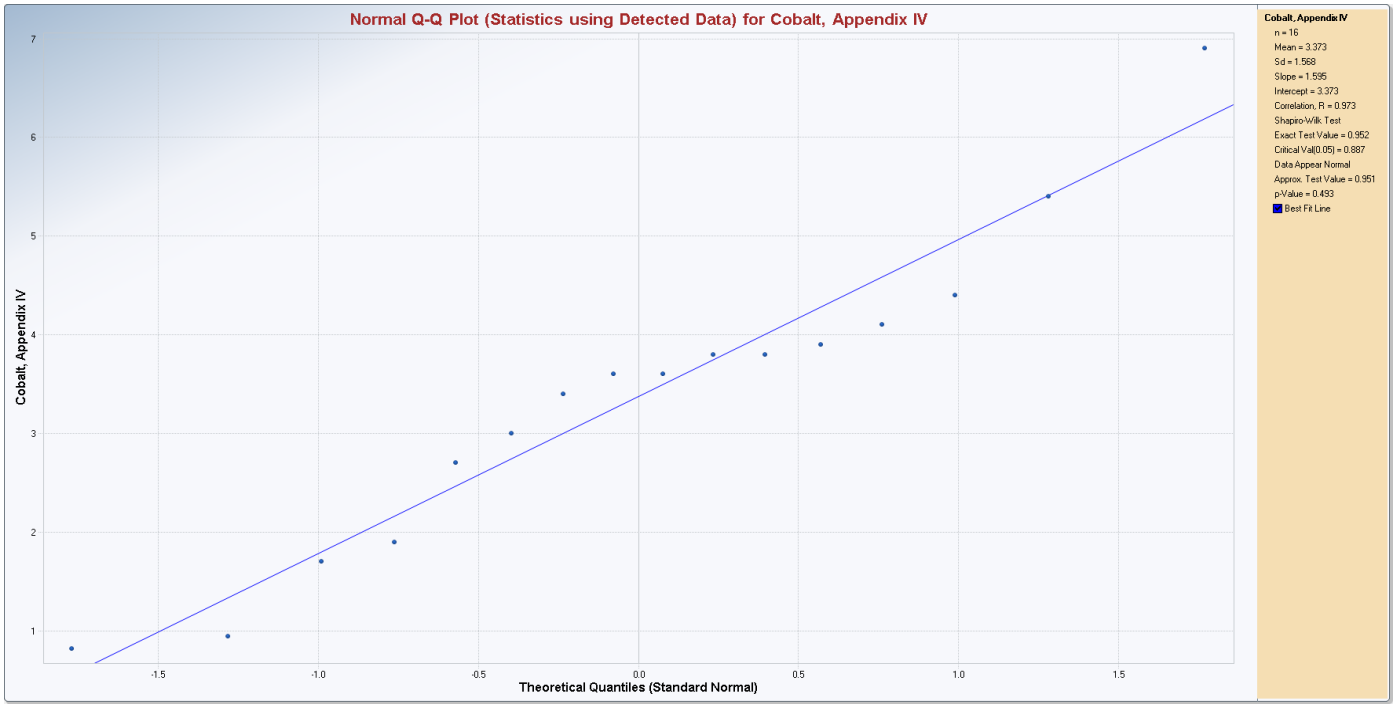
Test Statistic: 0.246

For 10% significance level, 0.82 is not an outlier.
For 5% significance level, 0.82 is not an outlier.
For 1% significance level, 0.82 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Cobalt, Appendix IV



Normal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data Normal at 5% Significance Level	

Data Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with	95% Coverage	7.33		90% Percentile (z)	5.382
	95% UPL (t)	6.206		95% Percentile (z)	5.952
	95% UPL for Next 4 Observations	7.397		99% Percentile (z)	7.02
	95% UPL for Mean of 4 Observations	4.909		95% USL	7.203

Fluoride, Appendix III & IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	15		
Number of Detects	13	Number of Non-Detects	3
Number of Distinct Detects	13	Number of Distinct Non-Detects	2
Minimum Detect	24	Minimum Non-Detect	50
Maximum Detect	230	Maximum Non-Detect	100
Variance Detected	5829	Percent Non-Detects	18.75%
Mean Detected	109.2	SD Detected	76.35
Mean of Detected Logged Data	4.387	SD of Detected Logged Data	0.878

Dixon's Outlier Test for Fluoride, Appendix III & IV

Total N = 16
Number NDs = 3
Number Detects = 13
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 230 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.197

For 10% significance level, 230 is not an outlier.
For 5% significance level, 230 is not an outlier.
For 1% significance level, 230 is not an outlier.

2. Data Value 24 is a Potential Outlier (Lower Tail)?

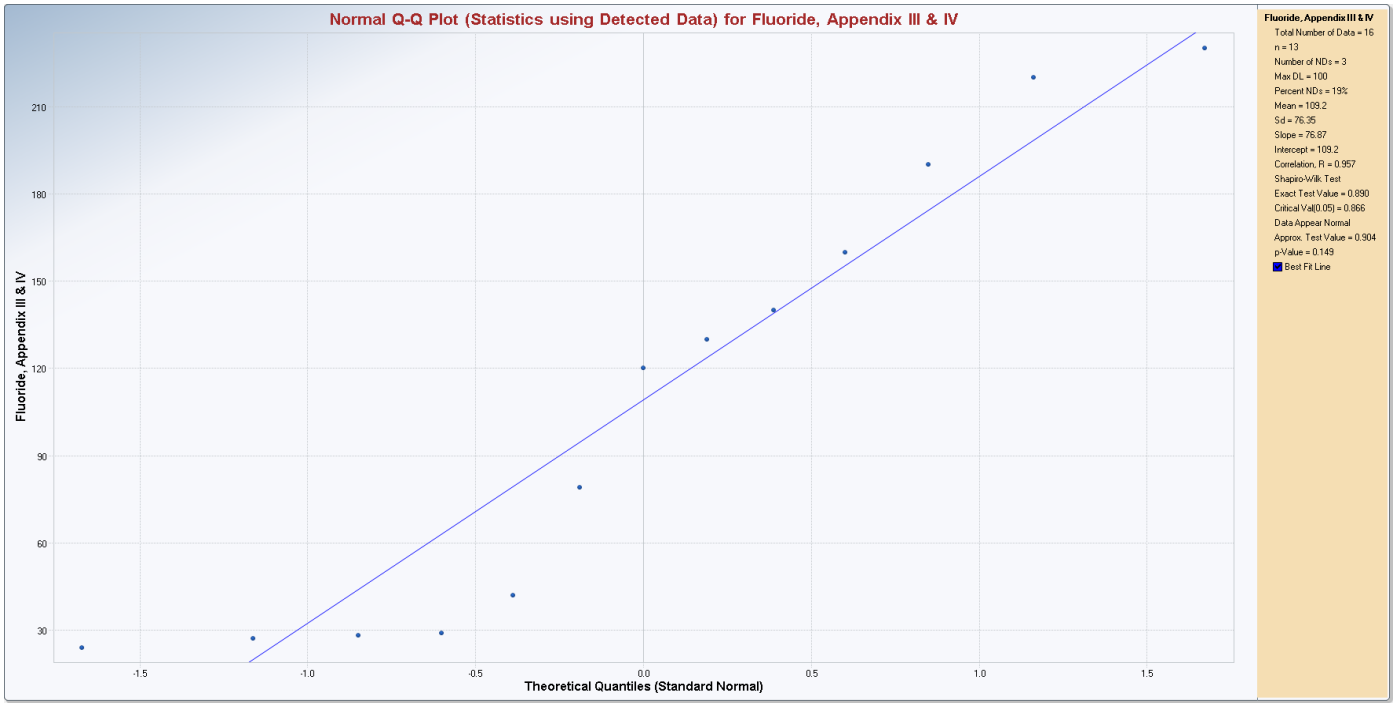
Test Statistic: 0.018

For 10% significance level, 24 is not an outlier.
For 5% significance level, 24 is not an outlier.
For 1% significance level, 24 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Fluoride, Appendix III & IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.89	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	95.19	SD	72.54
95% UTL95% Coverage	278.3	95% KM UPL (t)	226.3
95% KM UPL for Next 4 Observations	281.4	95% KM UPL for Mean of Next 4 Observations	166.3

Lead, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	11		
Number of Detects	9	Number of Non-Detects	7
Number of Distinct Detects	9	Number of Distinct Non-Detects	2
Minimum Detect	0.18	Minimum Non-Detect	0.1
Maximum Detect	0.79	Maximum Non-Detect	1
Variance Detected	0.0361	Percent Non-Detects	43.75%
Mean Detected	0.396	SD Detected	0.19
Mean of Detected Logged Data	-1.028	SD of Detected Logged Data	0.48

Dixon's Outlier Test for Lead, Appendix IV

Total N = 16
Number NDs = 7
Number Detects = 9
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 0.79 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.483

For 10% significance level, 0.79 is an outlier.
For 5% significance level, 0.79 is not an outlier.
For 1% significance level, 0.79 is not an outlier.

2. Data Value 0.05 is a Potential Outlier (Lower Tail)?

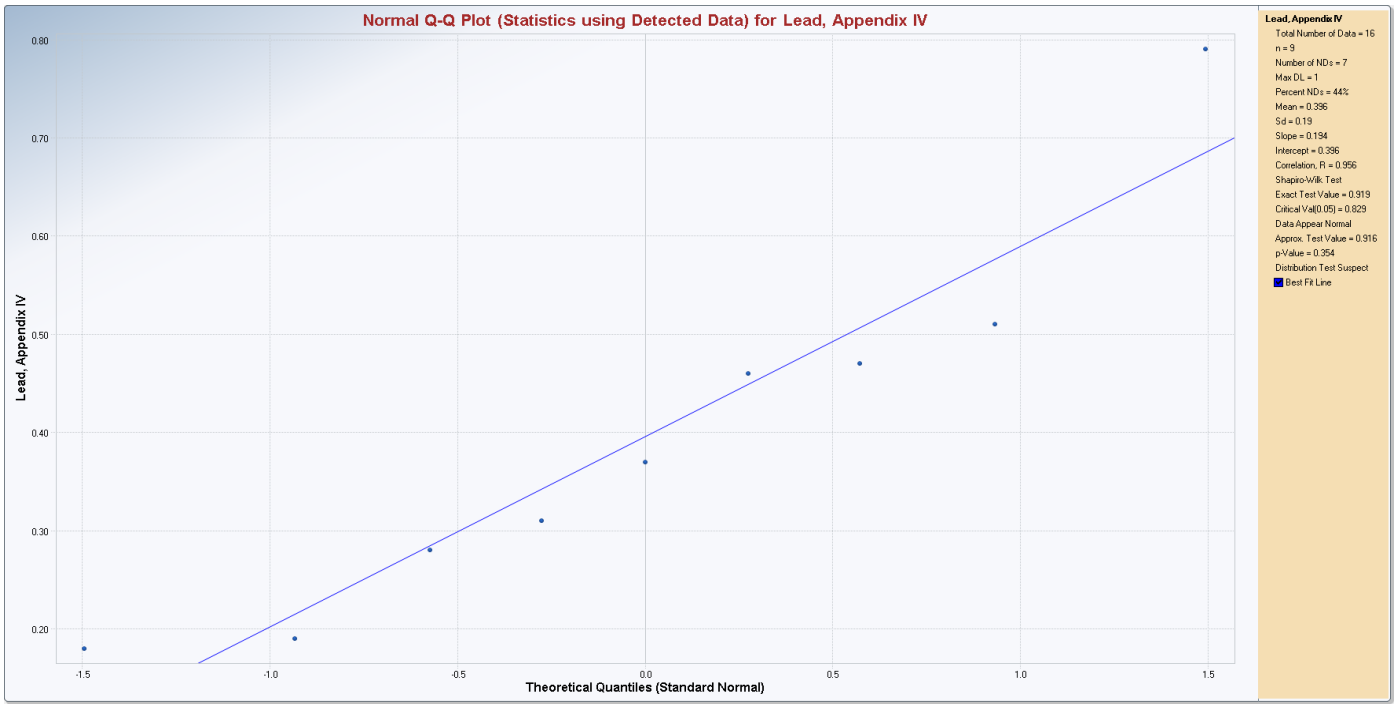
Test Statistic: 0.311

For 10% significance level, 0.05 is not an outlier.
For 5% significance level, 0.05 is not an outlier.
For 1% significance level, 0.05 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Lead, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	0.366	SD	0.192
95% UTL95% Coverage	0.85	95% KM UPL (t)	0.712
95% KM UPL for Next 4 Observations	0.858	95% KM UPL for Mean of Next 4 Observations	0.554

Lithium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	13		
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	10	Number of Distinct Non-Detects	3
Minimum Detect	0.41	Minimum Non-Detect	8
Maximum Detect	2.4	Maximum Non-Detect	50
Variance Detected	0.512	Percent Non-Detects	25%
Mean Detected	1.458	SD Detected	0.715
Mean of Detected Logged Data	0.221	SD of Detected Logged Data	0.642

Dixon's Outlier Test for Lithium, Appendix IV

Total N = 16
Number NDs = 4
Number Detects = 12
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 25 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.510

For 10% significance level, 25 is an outlier.
For 5% significance level, 25 is an outlier.
For 1% significance level, 25 is not an outlier.

2. Data Value 0.41 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.008

For 10% significance level, 0.41 is not an outlier.
For 5% significance level, 0.41 is not an outlier.
For 1% significance level, 0.41 is not an outlier.

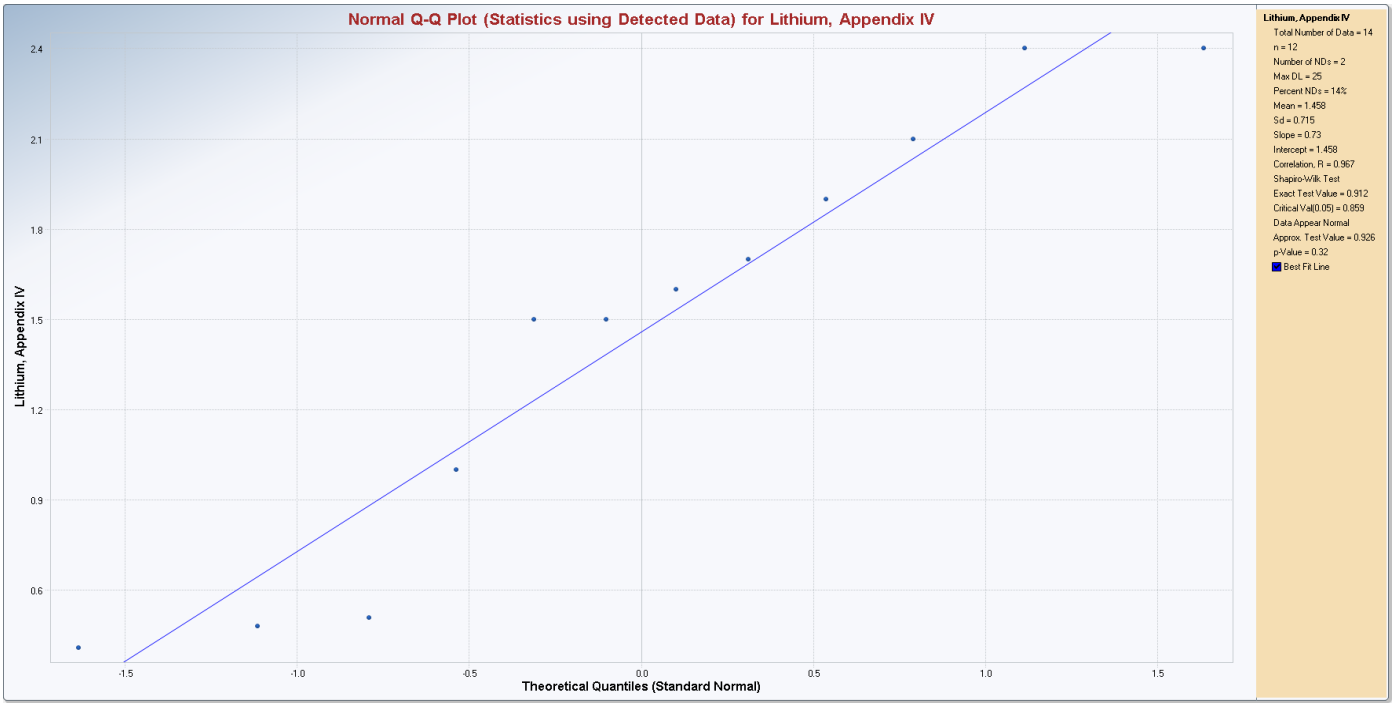
Lithium, Appendix IV

General Statistics - Outliers Removed

Total Number of Observations	14		
Number of Distinct Observations	12		
Number of Detects	12	Number of Non-Detects	2
Number of Distinct Detects	10	Number of Distinct Non-Detects	2
Minimum Detect	0.41	Minimum Non-Detect	8
Maximum Detect	2.4	Maximum Non-Detect	25
Variance Detected	0.512	Percent Non-Detects	14.29%
Mean Detected	1.458	SD Detected	0.715
Mean of Detected Logged Data	0.221	SD of Detected Logged Data	0.642

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.614	d2max (for USL)	2.372



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	1.458	SD	0.685
95% UTL95% Coverage	3.248	95% KM UPL (t)	2.714
95% KM UPL for Next 4 Observations	3.254	95% KM UPL for Mean of Next 4 Observations	2.146

Molybdenum, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	10		
Number of Detects	10	Number of Non-Detects	6
Number of Distinct Detects	9	Number of Distinct Non-Detects	2
Minimum Detect	0.58	Minimum Non-Detect	5
Maximum Detect	6.4	Maximum Non-Detect	10
Variance Detected	4.107	Percent Non-Detects	37.5%
Mean Detected	1.97	SD Detected	2.027
Mean of Detected Logged Data	0.325	SD of Detected Logged Data	0.815

Dixon's Outlier Test for Molybdenum, Appendix IV

Total N = 16
Number NDs = 6
Number Detects = 10
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 6.4 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.247

For 10% significance level, 6.4 is not an outlier.
For 5% significance level, 6.4 is not an outlier.
For 1% significance level, 6.4 is not an outlier.

2. Data Value 0.58 is a Potential Outlier (Lower Tail)?

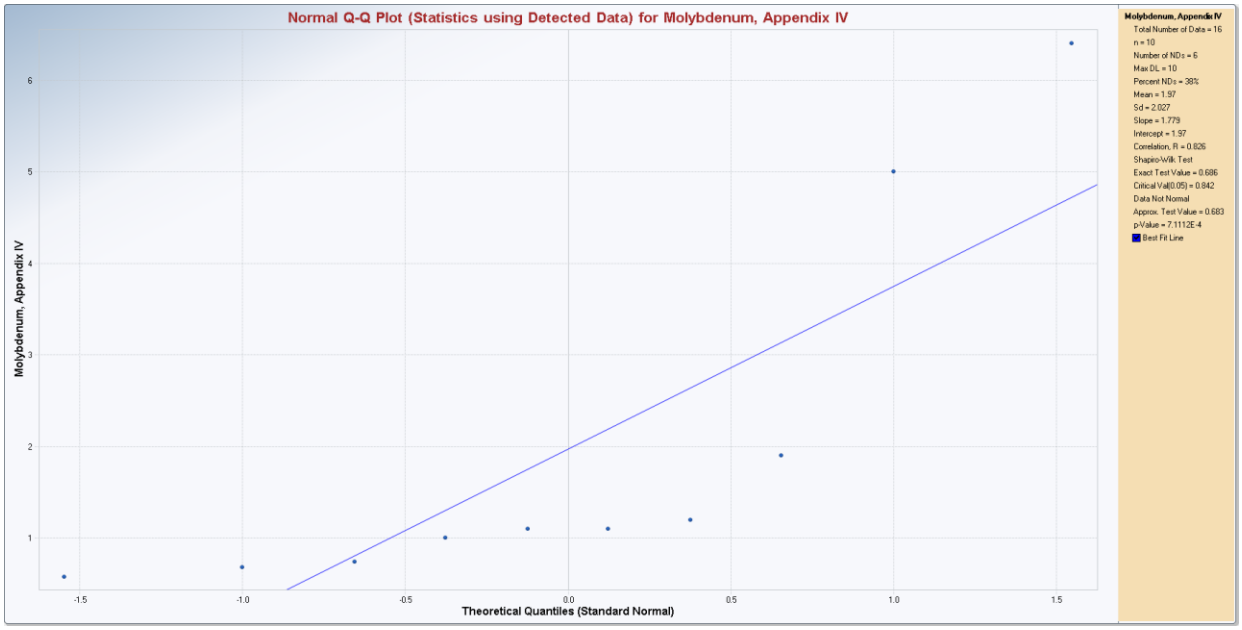
Test Statistic: 0.036

For 10% significance level, 0.58 is not an outlier.
For 5% significance level, 0.58 is not an outlier.
For 1% significance level, 0.58 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Molybdenum, Appendix IV

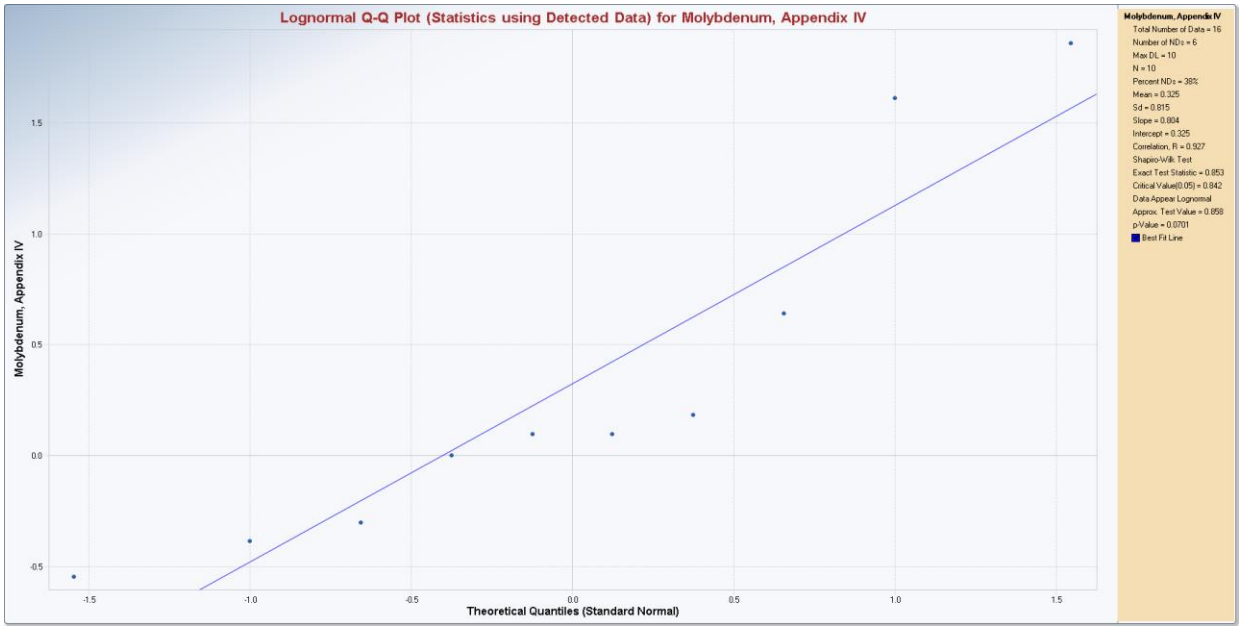


Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.686	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Molybdenum, Appendix IV



Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.853	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

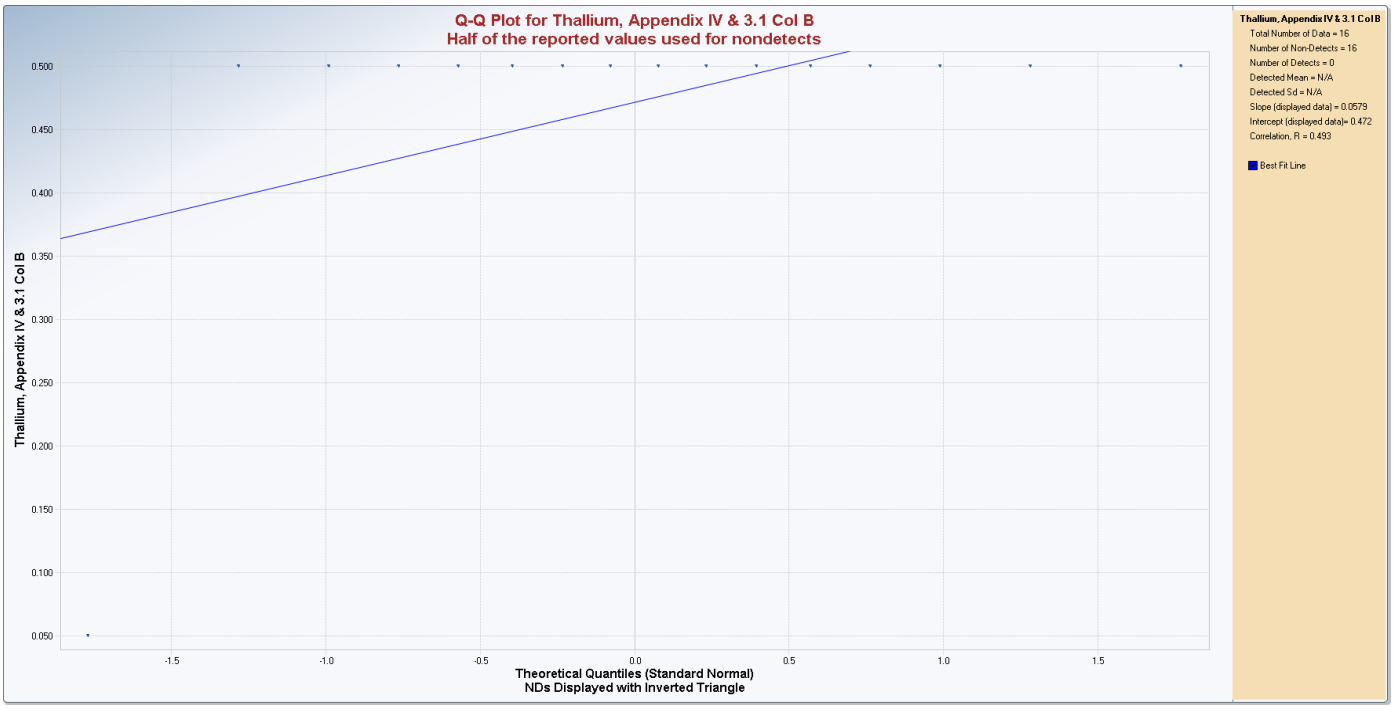
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	0.266 (LN)	95% KM UTL (Lognormal)95% Coverage	8.286 ug/L
KM SD of Logged Data	0.732 (LN)	95% KM UPL (Lognormal)	4.901
95% KM Percentile Lognormal (z)	4.352	95% KM USL (Lognormal)	7.81

Thallium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	2		
Number of Detects	0	Number of Non-Detects	16
Number of Distinct Detects	0	Number of Distinct Non-Detects	2
Minimum Detect	N/A	Minimum Non-Detect	0.1
Maximum Detect	N/A	Maximum Non-Detect	1
Variance Detected	N/A	Percent Non-Detects	100%
Mean Detected	N/A	SD Detected	N/A
Mean of Detected Logged Data	N/A	SD of Detected Logged Data	N/A



Total Radium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	16		
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	12	Number of Distinct Non-Detects	4
Minimum Detect	0.358	Minimum Non-Detect	0.282
Maximum Detect	1.53	Maximum Non-Detect	0.934
Variance Detected	0.11	Percent Non-Detects	25%
Mean Detected	0.799	SD Detected	0.332
Mean of Detected Logged Data	-0.3	SD of Detected Logged Data	0.405

Dixon's Outlier Test for Radium 226 + 228

Total N = 16
Number NDs = 4
Number Detects = 12
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 1.53 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.452

For 10% significance level, 1.53 is not an outlier.
For 5% significance level, 1.53 is not an outlier.
For 1% significance level, 1.53 is not an outlier.

2. Data Value 0.141 is a Potential Outlier (Lower Tail)?

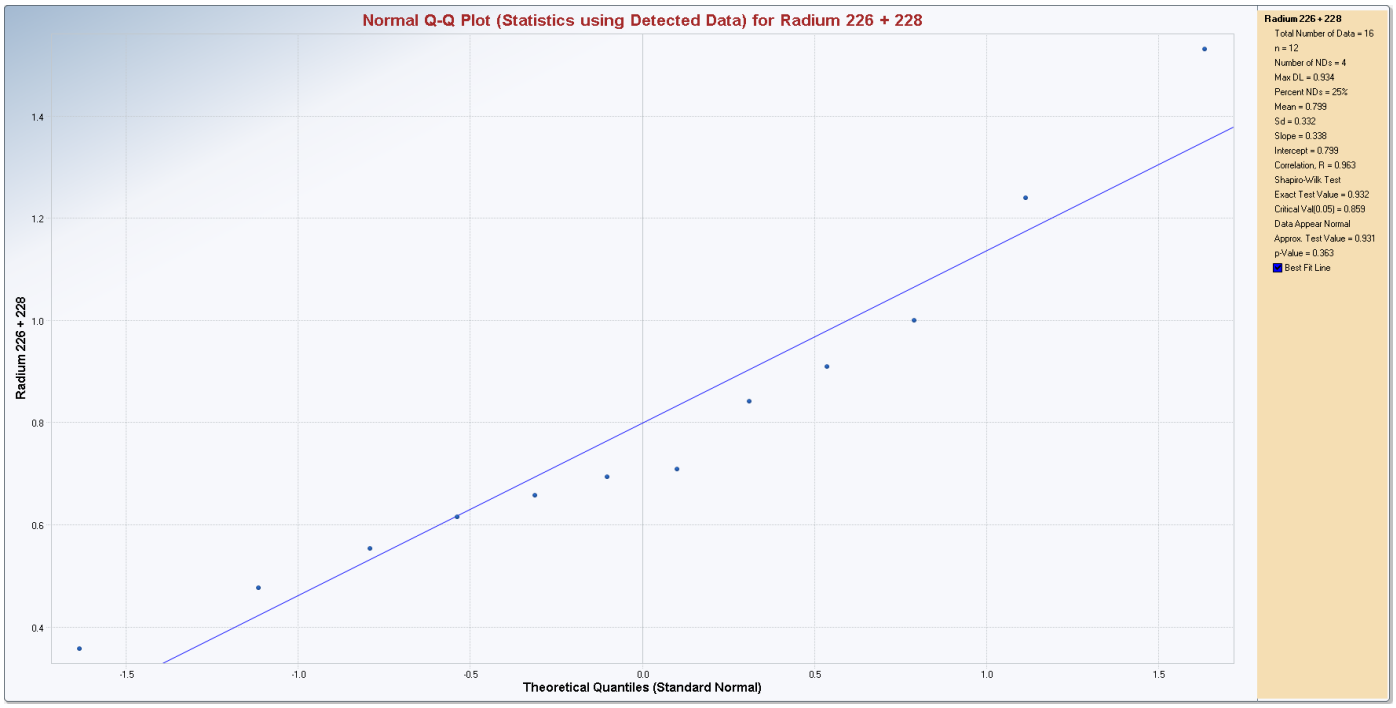
Test Statistic: 0.253

For 10% significance level, 0.141 is not an outlier.
For 5% significance level, 0.141 is not an outlier.
For 1% significance level, 0.141 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Total Radium, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level	

Data Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.711	KM SD	0.328
95% UTL95% Coverage	1.538	95% KM UPL (t)	1.303
95% KM UPL for Next 4 Observations	1.552	95% KM UPL for Mean of Next 4 Observations	1.032

Groundwater Protection Standard Establishment
40 CFR Part 257 Subpart D

Chesterfield Power Station – Upper Ash Pond
Chester, Virginia

EPA's "*Disposal of Coal Combustion Residuals from Electric Utilities*" Final Rule, 40 CFR §257.95(d)(2), requires the owner or operator of an existing Coal Combustion Residuals (CCR) unit monitoring groundwater under the Assessment Monitoring Program to establish groundwater protection standards (GWPS) for all constituents detected pursuant to 40 CFR §257.95(b) or 40 CFR §257.95(d).

Initial Assessment Monitoring Program Appendix IV groundwater sampling and analysis was completed on May 7, 2018 in accordance with 40 CFR §257.95(b). Detected Appendix IV constituents included: arsenic, barium, beryllium, cobalt, fluoride, lead, lithium, molybdenum, thallium, and radium 226 & 228 (combined). GWPS have been established for those detected Appendix IV constituents using the following methodology in accordance with 40 CFR §257.95(h):

1. For constituents for which a Maximum Contaminant Level (MCL) has been established, the MCL was used.
2. For constituents for which a health-based GWPS has been adopted under the August 29, 2018 Phase 1, Part 1 amendment to the CCR Rule, the health-based GWPS was used.
    a. The Commonwealth of Virginia adopted by reference the October 4, 2016 version of 40 CFR §257 into 9VAC20-81-800 of the Virginia Solid Waste Management Regulations. Amendments to 40 CFR Part 257 Subpart D after October 4, 2016 have not been incorporated into 9VAC20-81-800. Therefore, the health-based GWPS is not applicable to the Virginia CCR Rule under 9VAC20-81-800.
3. Under 9VAC20-81-800, for constituents for which an MCL has not been established, the background concentration for the constituent was used for GWPS.
4. For constituents for which the background level is higher than the MCL or health-based GWPS, the background concentration was used for GWPS.

Supporting data and calculations are included as an attachment to this memo. Table 1 summarizes groundwater protection standards for Chesterfield Power Station's Upper Ash Pond – Columbia Aquifer and Table 2 summarizes the groundwater protection standards for the Potomac Aquifer.

Attachments: Table 1 – CCR Rule Groundwater Protection Standards, Columbia Aquifer
Table 2 – CCR Rule Groundwater Protection Standards, Potomac Aquifer
Golder November 1, 2018 Proposed Groundwater Protection Standards

November 1, 2018

Table 1 – CCR Rule Groundwater Protection Standards, Columbia Aquifer – Chesterfield Power Station Upper Ash Pond

Detected Appendix IV Constituent	Units	Site-Specific Background Value	EPA MCL	CCR Rule Health-Based GWPS	CCR Rule GWPS	CCR Rule GWPS Source	Virginia CCR GWPS	Virginia CCR GWPS Source
Arsenic	µg/L	19.8	10	--	19.8	BKG	19.8	BKG
Barium	µg/L	318	2000	--	2000	MCL	2000	MCL
Beryllium	µg/L	QL (1)	4	--	4	MCL	4	MCL
Cobalt	µg/L	7.40	--	6	7.40	BKG	7.40	BKG
Fluoride	µg/L	281	4000	--	4000	MCL	4000	MCL
Lead	µg/L	QL (1)	15*	15	15	CCR GWPS	QL (1)	BKG
Lithium	µg/L	QL (50)	--	40	40	CCR GWPS	QL (50)	BKG
Molybdenum	µg/L	QL (10)	--	100	100	CCR GWPS	QL (10)	BKG
Thallium	µg/L	QL (1)	2	--	2	MCL	2	MCL
Radium 226 & 228	pCi/L	1.55	5	--	5	MCL	5	MCL

Notes:

µg/L = Micrograms per liter
BKG = Site-Specific Background Value
CCR GWPS = Coal Combustion Residuals Rule health-based GWPS adopted under the Phase 1, Part 1 Amendment.
EPA = United States Environmental Protection Agency
GWPS = Groundwater Protection Standard
MCL = Maximum Contaminant Level
pCi/L = picocuries per liter
QL = Quantitation Limit; values in parentheses (1) represent highest laboratory QL for the constituent based on background data. Future QL values are subject to change; however, GWPS cannot be less than values in parentheses.
* = Listed MCL represents an EPA MCL action level

Table 2 – CCR Rule Groundwater Protection Standards, Potomac Aquifer – Chesterfield Power Station Upper Ash Pond

Detected Appendix IV Constituent	Units	Site-Specific Background Value	EPA MCL	CCR Rule Health-Based GWPS	CCR Rule GWPS	CCR Rule GWPS Source	Virginia CCR GWPS	Virginia CCR GWPS Source
Arsenic	µg/L	17.8	10	--	17.8	BKG	17.8	BKG
Barium	µg/L	318	2000	--	2000	MCL	2000	MCL
Beryllium	µg/L	QL (1)	4	--	4	MCL	4	MCL
Cobalt	µg/L	6.90	--	6	6.90	BKG	6.90	BKG
Fluoride	µg/L	313	4000	--	4000	MCL	4000	MCL
Lead	µg/L	QL (1)	15*	15	15	CCR GWPS	QL (1)	BKG
Lithium	µg/L	QL (50)	--	40	40	CCR GWPS	QL (50)	BKG
Molybdenum	µg/L	QL (10)	--	100	100	CCR GWPS	QL (10)	BKG
Thallium	µg/L	QL (1)	2	--	2	MCL	2	MCL
Radium 226 & 228	pCi/L	1.88	5	--	5	MCL	5	MCL

Notes:

µg/L = Micrograms per liter
BKG = Site-Specific Background Value
CCR GWPS = Coal Combustion Residuals Rule health-based GWPS adopted under the Phase 1, Part 1 Amendment.
EPA = United States Environmental Protection Agency
GWPS = Groundwater Protection Standard
MCL = Maximum Contaminant Level
pCi/L = picocuries per liter
QL = Quantitation Limit; values in parentheses (1) represent highest laboratory QL for the constituent based on background data. Future QL values are subject to change; however, GWPS cannot be less than values in parentheses.
* = Listed MCL represents an EPA MCL action level

November 1, 2018

Reference No. 178975418.402

Kelly Hicks, P.G. Project Manager III
Dominion Energy
5000 Dominion Boulevard
Glen Allen, VA 23060

Via Email: kelly.a.hicks@dominionenergy.com

RE: PROPOSED GROUNDWATER PROTECTION STANDARDS
CHESTERFIELD POWER STATION UPPER ASH POND
CHESTERFIELD COUNTY, VIRGINIA

Dear Kelly:

Consistent with the provisions of Title 40 Code of Federal Regulations (CFR) Subpart 257.95(d)(2) of the Coal Combustion Residuals (CCR) Rule, Golder Associates Inc. (Golder) is providing the enclosed proposed Groundwater Protection Standard (GPS) for the Upper Ash Pond at the Dominion Chesterfield Power Station. The proposed GPS are for the Upper Ash Pond and are proposed for the Appendix IV constituents listed in 40 CFR 257 that were detected during the initial Assessment Monitoring Program Appendix IV sampling event. Summaries of the proposed GPS for the Upper Ash Pond upper Columbia Aquifer and the lower Potomac Aquifer are presented in Table 1 and Table 2, respectively. The Upper Ash Pond Columbia Aquifer groundwater monitoring network includes upgradient wells MW-29U and MW-35S and downgradient wells MW-1, MW-2, MW-3, MW-5, MW-8R, MW-9R, MW-11, MW-12, MW-13, MW-15, MW-16, MW-17S, MW-B31, and MW-B32. The Upper Ash Pond Potomac Aquifer groundwater monitoring network includes upgradient wells MW-30U and MW-35D and downgradient wells MW-1D, MW-4, MW-6, MW-7, MW-10, MW-14, and MW-16D. As presented, the proposed GPS are based on:

- Federal Maximum Contaminant Levels (MCLs) – for constituents for which an MCL has been established; or;
- Site-specific background values – for constituents for which an MCL has not been established or for constituents for which the site-specific background value is higher than the MCL; or;
- United States Environmental Protection Agency (EPA) risk-based Regional Screening Levels (RSLs) for Tapwater – for constituents for which an MCL has not been established, an RSL may be used.

The results of the supporting statistical evaluations are summarized in Tables 3 and 4.

The selection of a statistical method was previously certified pursuant to the CCR rule [257.93(f)(6)] and posted the Certification in the Facility's operating record on October 17, 2017, pursuant to the CCR Rule [257.105(h)(4)]. Golder recommends that the MCL-based GPS be updated upon the EPA's promulgation of new or revised MCLs. The site-specific background-based GPS should be updated as needed based on changes in background water quality.

Golder and the G logo are trademarks of Golder Associates Corporation

If you have any questions regarding the information presented herein, please do not hesitate to contact us.

Sincerely,

Golder Associates Inc.

for: Craig J. LaCosse
Senior Project Geologist

Michael G. Williams, C.P.G.
Principal and Senior Hydrogeologist

Attachments:	Table 1	Proposed CCR Groundwater Protection Standards CCR Rule Appendix IV Constituents, Columbia Aquifer, Upper Ash Pond, Chesterfield Power Station
	Table 2	Proposed CCR Groundwater Protection Standards CCR Rule Appendix IV Constituents, Potomac Aquifer, Upper Ash Pond, Chesterfield Power Station
	Table 3	Summary of Appendix IV Statistical Evaluations, Columbia Aquifer, Upper Ash Pond, Chesterfield Power Station
	Table 4	Summary of Appendix IV Statistical Evaluations, Potomac Aquifer, Upper Ash Pond, Chesterfield Power Station
	Attachment 1	Background Statistic Worksheets – Columbia Aquifer
	Attachment 2	Background Statistic Worksheets – Potomac Aquifer

https://golderassociates.sharepoint.com/sites/22463g/reports/cps - lap-uap-metals 2018/cps uap 2018/proposed gps/draft final/2018-11-01 cps uap gps proposal.docx

Tables

Table 1
Proposed CCR Groundwater Protection Standards
CCR Rule Appendix IV Constituents
Columbia Aquifer, Upper Ash Pond
Chesterfield Power Station

CCR Appendix IV Consituent	Class	CAS RN	Units	Site-Specific Background Value	ACL/RSL	EPA MCL/RSL	Proposed CCR GPS	GPS Source
Arsenic	Metal	7440-38-2	µg/L	19.8	0.052	10	19.8	BKG
Barium	Metal	7440-39-3	µg/L	318	3,800	2,000	2,000	MCL
Beryllium	Metal	7440-41-7	µg/L	QL (1)	25	4	4	MCL
Cobalt	Metal	7440-48-4	µg/L	7.4	6	[6]	7.4	BKG
Fluoride	Metal	16984-48-8	µg/L	281.4	800	4,000	4,000	MCL
Lead	Metal	7439-92-1	µg/L	QL (1)	15	15*	15*	MCL*
Lithium	Metal	7439-93-2	µg/L	QL (50)	40	[40]	50	BKG
Molybdenum	Metal	7439-98-7	µg/L	QL (10)	100	[100]	100	RSL
Thallium	Metal	7440-28-0	µg/L	QL (1)	0.2	2	2	MCL
Radium 226 & 228	Radionuclide	13982-63-3 / 15262-20-1	pCi/L	1.55	−−	5	5	MCL

Notes:
µg/L = Microgram per liter
BKG = Site-specific Background Value
CAS RN = Chemical Abstracts Service Registry Number
CCR = Coal Combustion Residuals
EPA = United States Environmental Protection Agency
GPS = Groundwater Protection Standard
MCL = Maximum Contaminant Level
RSL = Regional Screening Level; RSLs are presented in brackets
pCi/L = picoCurie per liter
MDC = Minimum Detectable Concentration (sample specific)
QL = Laboratory quantitation limit (value shown in parentheses is a recent QL and is subject to change)
Note that quantitiation limit is subject to change with updated method detection limit studies
(1) = Indicated value represents recent quantitation limit
* = Listed MCL represents an EPA action level

Table 2
Proposed CCR Groundwater Protection Standards
CCR Rule Appendix IV Constituents
Potomac Aquifer, Upper Ash Pond
Chesterfield Power Station

CCR Appendix IV Consituent	Class	CAS RN	Units	Site-Specific Background Value	EPA MCL/RSL	Proposed CCR GPS	GPS Source
Arsenic	Metal	7440-38-2	µg/L	17.8	10	17.8	BKG
Barium	Metal	7440-39-3	µg/L	318	2,000	2,000	MCL
Beryllium	Metal	7440-41-7	µg/L	QL (1)	4	4	MCL
Cobalt	Metal	7440-48-4	µg/L	6.9	[6]	6.9	BKG
Fluoride	Metal	16984-48-8	µg/L	313.2	4,000	4,000	MCL
Lead	Metal	7439-92-1	µg/L	QL (1)	15*	15*	MCL*
Lithium	Metal	7439-93-2	µg/L	QL (50)	[40]	50	BKG
Molybdenum	Metal	7439-98-7	µg/L	QL (10)	[100]	100	RSL
Thallium	Metal	7440-28-0	µg/L	QL (1)	2	2	MCL
Radium 226 & 228	Radionuclide	13982-63-3 / 15262-20-1	pCi/L	1.88	5	5	MCL

Notes:
µg/L = Microgram per liter
BKG = Site-specific Background Value
CAS RN = Chemical Abstracts Service Registry Number
CCR = Coal Combustion Residuals
EPA = United States Environmental Protection Agency
GPS = Groundwater Protection Standard
MCL = Maximum Contaminant Level
RSL = Regional Screening Level; RSLs are presented in brackets
pCi/L = picoCurie per liter
MDC = Minimum Detectable Concentration (sample specific)
QL = Laboratory quantitation limit (value shown in parentheses is a recent QL and is subject to change)
Note that quantitiation limit is subject to change with updated method detection limit studies
(1) = Indicated value represents recent quantitation limit
* = Listed MCL represents an EPA action level

Table 3
Summary of Appendix IV Statistical Evaluations
Columbia Aquifer, Upper Ash Pond
Chesterfield Power Station

		Arsenic, Appendix IV	Barium, Appendix IV	Beryllium, Appendix IV	Cobalt, Appendix IV	Fluoride, Appendix III & IV	Lead, Appendix IV	Lithium, Appendix IV	Molybdenum, Appendix IV	Thallium, Appendix IV	Total Radium
Sample Identity	**Date**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**pCi/L**
MW-29U	10/07/2016	2.1 J	200	< 1.0 U	3.4	79 J	0.51 B	*< 50 U*	1.0 J	< 1.0 U	0.909
	11/16/2016	9.3	270	< 1.0 U	3.9	160 J	0.79 J	*< 50 U*	1.1 J	< 1.0 U	1.00
	01/09/2017	3.7 J	180	< 1.0 U	2.7	120	< 1.0 U	0.48 B	0.74 J	< 1.0 U	0.709
	02/20/2017	7.2	240	< 1.0 U	4.1	130	0.19 B	0.51 J	1.2 B	< 1.0 U	1.24
	04/03/2017	9.1	210	< 1.0 U	6.9 J+	230 J+	0.28 J+	1.0 J+	1.1 J	< 1.0 U	0.476
	05/15/2017	13	280	< 1.0 U	4.4	190	0.47 J	< 8.0 U	1.9 J	< 1.0 U	0.693
	06/19/2017	17.8	318	< 1.0 U	3.8	220	< 0.10 U	0.41 J	6.4	< 0.10 U	0.542 U
	07/24/2017	14.6	275	< 1.0 U	3.6	140	< 1.0 U	< 25.0 U	5.0 J	< 1.0 U	1.53
MW-35S	01/12/2017	< 5.0 U	48	< 1.0 U	5.4	24 B	0.46 B	1.5 J	< 10 U	< 1.0 U	0.841
	02/23/2017	< 5.0 U	42	< 1.0 U	3.8	29 B	0.18 B	1.7 B	< 10 U	< 1.0 U	0.615
	03/16/2017	0.41 J	42	< 1.0 U	3.6	42 B	0.31 B	1.6 J	0.58 J	< 1.0 U	0.658
	04/07/2017	0.51 J	41	< 1.0 U	3.0	27 J	0.37 J	1.9 J	0.68 J	< 1.0 U	0.358
	05/03/2017	< 5.0 U	28	< 1.0 U	1.7	< 50 U	< 1.0 U	2.1 J	< 10 U	< 1.0 U	0.554
	06/06/2017	< 5.0 U	40	< 1.0 U	1.9	28 J	< 1.0 U	2.4 J	< 10 U	< 1.0 U	0.282 U
	07/05/2017	< 1.0 U	43.0	< 1.0 U	0.94 J	< 100 U	< 1.0 U	1.5 J	< 5.0 U	< 1.0 U	0.908 U
	08/10/2017	< 1.0 U	38.4	< 1.0 U	0.82 J	< 100 U	< 1.0 U	2.4 J	< 5.0 U	< 1.0 U	0.934 U
Minimum		0.41	28	1.0	0.8	24	0.10	0.41	0.58	0.1	0.282
Maximum		17.80	318	1.0	6.9	230	1.00	50	10.00	1.0	1.530
n		16	16	16	16	16	16	16	16	16	16
Count Detects		10	16	0	16	13	9	12	10	0	12
Count Non-Detects		6	0	16	0	3	7	4	6	16	4
Mean of Data Set		6.23	143.46	1.0	3.37	104	0.60	9.41	4.356	0.944	0.766
Standard Deviation of Data Set		5.29	111.37	0.0	1.57	70	0.35	16.94	3.848	0.225	0.323
% Truncated		38%	0%	100%	0%	19%	44%	25%	38%	100%	25%
Outliers		No	No	No	No	No	No	Yes	No	No	No
n (Outliers Removed)		16	16	16	16	16	16	14	16	16	16
% Truncated (Outliers Removed)		38%	0%	100%	0%	19%	44%	14%	38%	100%	25%
Normality		Normal	Non-Normal	Non-Normal	Normal	Normal	Normal	Normal	Log-Normal	Non-Normal	Normal
Mean & Std Adjustment		Kaplan Meier	Not Applicable	Not Applicable	Not Applicable	Kaplan Meier	Kaplan Meier	Kaplan Meier	Kaplan Meier	Not Applicable	Kaplan Meier
Adjusted Mean of Data Set		5.233	Not Applicable	Not Applicable	Not Applicable	95.19	0.366	1.458	0.266 (LN)	Not Applicable	0.711
Adjusted Standard Deviation of Data		5.665	Not Applicable	Not Applicable	Not Applicable	72.54	0.192	0.685	0.732 (LN)	Not Applicable	0.328
Background Limit Type		UPL	NPTL	NPTL	UPL	UPL	UPL	UPL	UTL	NPTL	UPL
Parametric Critical Value		2.49	Not Applicable	Not Applicable	2.49	2.49	2.49	2.533	2.524	Not Applicable	2.49
Calculated Background Concentration		19.8	318	1 (QL)	7.4	281.4	0.858	3.254	8.28	1 (QL)	1.552
Level of Confidence		95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Percent Coverage		95%	82.9%	82.9%	95%	95%	95%	95%	95%	82.9%	95%
Is Calculated Background > QL		Yes	Yes	No --> will use QL (1.0)	Yes	Yes	No --> will use QL (1.0)	No --> will use QL (50.0)	No --> will use QL (10.0)	No --> will use QL (1.0)	Yes

Notes:

n - Number of Observations
ug/L - micrograms per liter
pCi/L - picocuries per liter
B - result is blank qualified
J+ - Estimated/bias high concentration
U - Result below method detection limit / minimum detectable concentration
QL = Laboratory quantitation limit = Reporting limit
Non-Parametric Percent Coverage for Data Sets - Table 17-4 in Appendix D of Unified Guidance
Parametric Prediction Limit Critical Value (t-quantile)- Table 16-1 in Appendix D of Unified Guidance
Parametric Tolerance Limit Critical Value (tolerance factor)- Table 17-3 in Appendix D of Unified Guidance
Values in Itlaics identified as statistical outliers. Values not removed since results were verified.
NTPL - Non-Parametric Tolerance Limit
UPL - Upper Prediction Limit using K=4
UTL - Upper Tolerance Limit

Check: CJL 9/4/18

Review: MGW 9/4/18

Table 4
Summary of Appendix IV Statistical Evaluations
Potomac Aquifer, Upper Ash Pond
Chesterfield Power Station

		Arsenic, Appendix IV	Barium, Appendix IV	Beryllium, Appendix IV	Cobalt, Appendix IV	Fluoride, Appendix IV	Lead, Appendix IV	Lithium, Appendix IV	Molybdenum, Appendix IV	Thallium, Appendix IV	Total Radium, Appendix IV
Sample Identity	**Date**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**pci/l**
MW-29U	10/7/2016	2.1 J	200	< 1.0 U	3.4	79 J	0.51 B	*< 50 U*	1.0 J	< 1.0 U	0.909
	11/16/2016	*9.3*	270	< 1.0 U	3.9	160 J	0.79 J	*< 50 U*	1.1 J	< 1.0 U	1.00
	1/9/2017	3.7 J	180	< 1.0 U	2.7	120	< 1.0 U	0.48 B	0.74 J	< 1.0 U	0.709
	2/20/2017	*7.2*	240	< 1.0 U	4.1	130	0.19 B	0.51 J	1.2 B	< 1.0 U	1.24
	4/3/2017	*9.1*	210	< 1.0 U	6.9 J+	230 J+	0.28 J+	1.0 J+	1.1 J	< 1.0 U	0.476
	5/15/2017	*13*	280	< 1.0 U	4.4	190	0.47 J	< 8.0 U	1.9 J	< 1.0 U	0.693
	6/19/2017	*17.8*	318	< 1.0 U	3.8	220	< 0.10 U	0.41 J	6.4	< 0.10 U	0.542 U
	7/24/2017	*14.6*	275	< 1.0 U	3.6	140	< 1.0 U	< 25.0 U	5.0 J	< 1.0 U	1.53
MW-30U	10/7/2016	0.62 J	73	< 1.0 U	0.24 J	28 B	0.24 B	9.7 J	0.60 J	< 1.0 U	0.627
	11/16/2016	0.67 J	74	< 1.0 U	0.20 J	110 J	< 1.0 U	11 J	0.61 J	< 1.0 U	0.924
	1/9/2017	< 5.0 U	68	< 1.0 U	< 1.0 U	130	< 1.0 U	10	< 10 U	< 1.0 U	0.582
	2/20/2017	0.77 B	80	< 1.0 U	0.13 B	140	0.24 B	11	< 10 U	< 1.0 U	0.463 U
	4/3/2017	0.84 J	77	< 1.0 U	0.33 J+	130	0.58 J+	11	0.61 J	< 1.0 U	0.688
	5/15/2017	< 5.0 U	80	< 1.0 U	< 1.0 U	120	< 1.0 U	9.9	< 10 U	< 1.0 U	1.31
	6/19/2017	0.22	68.2	< 1.0 U	0.040 J	100	0.093 J	10.7	< 5.0 U	< 0.10 U	1.26 U
	7/24/2017	< 1.0 U	64.8	< 1.0 U	< 1.0 U	58 J	< 1.0 U	8.8 J	< 5.0 U	< 1.0 U	0.603 U
MW-35D	1/12/2017	0.63 J	46	< 1.0 U	0.36 J	220	0.79 B	13	2.2 B	< 1.0 U	0.911
	2/23/2017	0.37 J	44	< 1.0 U	0.14 J	250	0.20 B	12	1.4 J	< 1.0 U	0.245 U
	3/16/2017	0.58 J	43	< 1.0 U	0.41 B	200	0.51 B	12	1.3 J	< 1.0 U	0.367
	4/7/2017	< 5.0 U	43	< 1.0 U	0.14 J	260	0.21 J	12	0.66 J	< 1.0 U	0.709
	5/3/2017	< 5.0 U	41	< 1.0 U	0.37 J+	260	0.48 J	12	1.2 J	< 1.0 U	0.638
	6/6/2017	< 5.0 U	44	< 1.0 U	0.64 J	240	< 1.0 U	13	< 10 U	< 1.0 U	0.505 U
	7/5/2017	< 1.0 U	42.8	< 1.0 U	0.10 J	130	< 1.0 U	12.4 J	< 5.0 U	< 1.0 U	1.51
	8/10/2017	< 1.0 U	41.2	< 1.0 U	< 1.0 U	160	< 1.0 U	12.3 J	< 5.0 U	< 1.0 U	0.659 U
MW-35S	1/13/2017	< 5.0 U	48	< 1.0 U	5.4	24 B	0.46 B	1.5 J	< 10 U	< 1.0 U	0.841
	2/23/2017	< 5.0 U	42	< 1.0 U	3.8	29 B	0.18 B	1.7 B	< 10 U	< 1.0 U	0.615
	3/16/2017	0.41 J	42	< 1.0 U	3.6	42 B	0.31 B	1.6 J	0.58 J	< 1.0 U	0.658
	4/7/2017	0.51 J	41	< 1.0 U	3.0	27 J	0.37 J	1.9 J	0.68 J	< 1.0 U	0.358
	5/3/2017	< 5.0 U	28	< 1.0 U	1.7	< 50 U	< 1.0 U	2.1 J	< 10 U	< 1.0 U	0.554
	6/6/2017	< 5.0 U	40	< 1.0 U	1.9	28 J	< 1.0 U	2.4 J	< 10 U	< 1.0 U	0.282 U
	7/5/2017	< 1.0 U	43.0	< 1.0 U	0.94 J	< 100 U	< 1.0 U	1.5 J	< 5.0 U	< 1.0 U	0.908 U
	8/10/2017	< 1.0 U	38.4	< 1.0 U	0.82 J	< 100 U	< 1.0 U	2.4 J	< 5.0 U	< 1.0 U	0.934 U
Minimum		0.22	28.0	1.0	0.04	24	0.09	0.4	0.58	0.10	0.245
Maximum		17.80	318.0	1.0	6.90	260	1.00	50.0	10.00	1.00	1.530
n		32	32	32	32	32	32	32	32	32	32
Count Detects		18	32	0	28	29	18	28	18	0	22
Count Non-Detects		14	0	32	4	3	14	4	14	32	10
Mean of Data Set		4.14	100.8	1.0	1.91	131	0.63	10.4	4.32	0.94	0.758
Standard Deviation of Data Set		4.49	89.5	0.0	1.86	75	0.35	11.9	3.77	0.22	0.331
% Truncated		44%	0%	100%	13%	9%	44%	13%	44%	100%	31%
Outliers		Yes	No	No	No	No	No	Yes	No	No	No
n (Outliers Removed)		26	32	32	32	32	32	30	32	32	32
% Truncated (Outliers Removed)		54%	0%	100%	13%	9%	44%	7%	44%	100%	31%
Normality		Non-Normal	Non-Normal	Non-Normal	Non-Normal	Normal	Normal	Non-Normal	Non-Normal	Non-Normal	Log-Normal
Mean & Std Adjustment		Not Applicable	Not Applicable	Not Applicable	Not Applicable	Kaplan Meier	Kaplan Meier	Not Applicable	Not Applicable	Not Applicable	Kaplan Meier
Adjusted Mean of Data Set		Not Applicable	Not Applicable	Not Applicable	Not Applicable	126.9	0.368	Not Applicable	Not Applicable	Not Applicable	-0.514 (LN)
Adjusted Standard Deviation of		Not Applicable	Not Applicable	Not Applicable	Not Applicable	77.89	0.204	Not Applicable	Not Applicable	Not Applicable	0.523 (LN)
Background Limit Type		NPTL	NPTL	NPTL	NPTL	UPL	UPL	NPTL	NPTL	NPTL	UTL
Parametric Critical Value		Not Applicable	Not Applicable	Not Applicable	Not Applicable	2.356	2.356	Not Applicable	Not Applicable	Not Applicable	2.198
Calculated Background		17.8	318	1 (QL)	6.9	313.2	0.86	50 (QL)	6.4	1 (QL)	1.88
Level of Confidence		95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Percent Coverage		89%	91.2%	91.2%	91.2%	95%	95%	90.5%	91.2%	91.2%	95%
Is Calculated Background > QL		Yes	Yes	No --> will use QL (1.0)	Yes	Yes	No --> will use QL (1.0)	No --> will use QL (50)	No --> will use QL (10)	No --> will use QL (1.0)	Yes

Notes:

n - Number of Observations
ug/L - micrograms per liter
pCi/L - picocuries per liter
B - result is blank qualified
J+ - Estimated/bias high concentration
U - Result below method detection limit / minimum detectable concentration
QL = Laboratory quantitation limit = Reporting limit
Non-Parametric Percent Coverage for Data Sets - Table 17-4 in Appendix D of Unified Guidance
Parametric Prediction Limit Critical Value (t-quantile)- Table 16-1 in Appendix D of Unified Guidance
Parametric Tolerance Limit Critical Value (tolerance factor)- Table 17-3 in Appendix D of Unified Guidance
Values in Itlaics identified as statistical outliers. Values not removed since results were verified.
NTPL - Non-Parametric Tolerance Limit
UPL - Upper Prediction Limit using K=4
UTL - Upper Tolerance Limit

Check: CJL 9/4/18

Review: MGW 9/4/18

Attachment 1

Background Statistic Worksheets – Columbia Aquifer

Arsenic, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	12		
Number of Detects	10	Number of Non-Detects	6
Number of Distinct Detects	10	Number of Distinct Non-Detects	2
Minimum Detect	0.41	Minimum Non-Detect	1
Maximum Detect	17.8	Maximum Non-Detect	5
Variance Detected	37.18	Percent Non-Detects	37.5%
Mean Detected	7.772	SD Detected	6.098
Mean of Detected Logged Data	1.502	SD of Detected Logged Data	1.364

Dixon's Outlier Test for Arsenic, Appendix IV

Total N = 16
Number NDs = 6
Number Detects = 10
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 17.8 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.277

For 10% significance level, 17.8 is not an outlier.
For 5% significance level, 17.8 is not an outlier.
For 1% significance level, 17.8 is not an outlier.

2. Data Value 0.41 is a Potential Outlier (Lower Tail)?

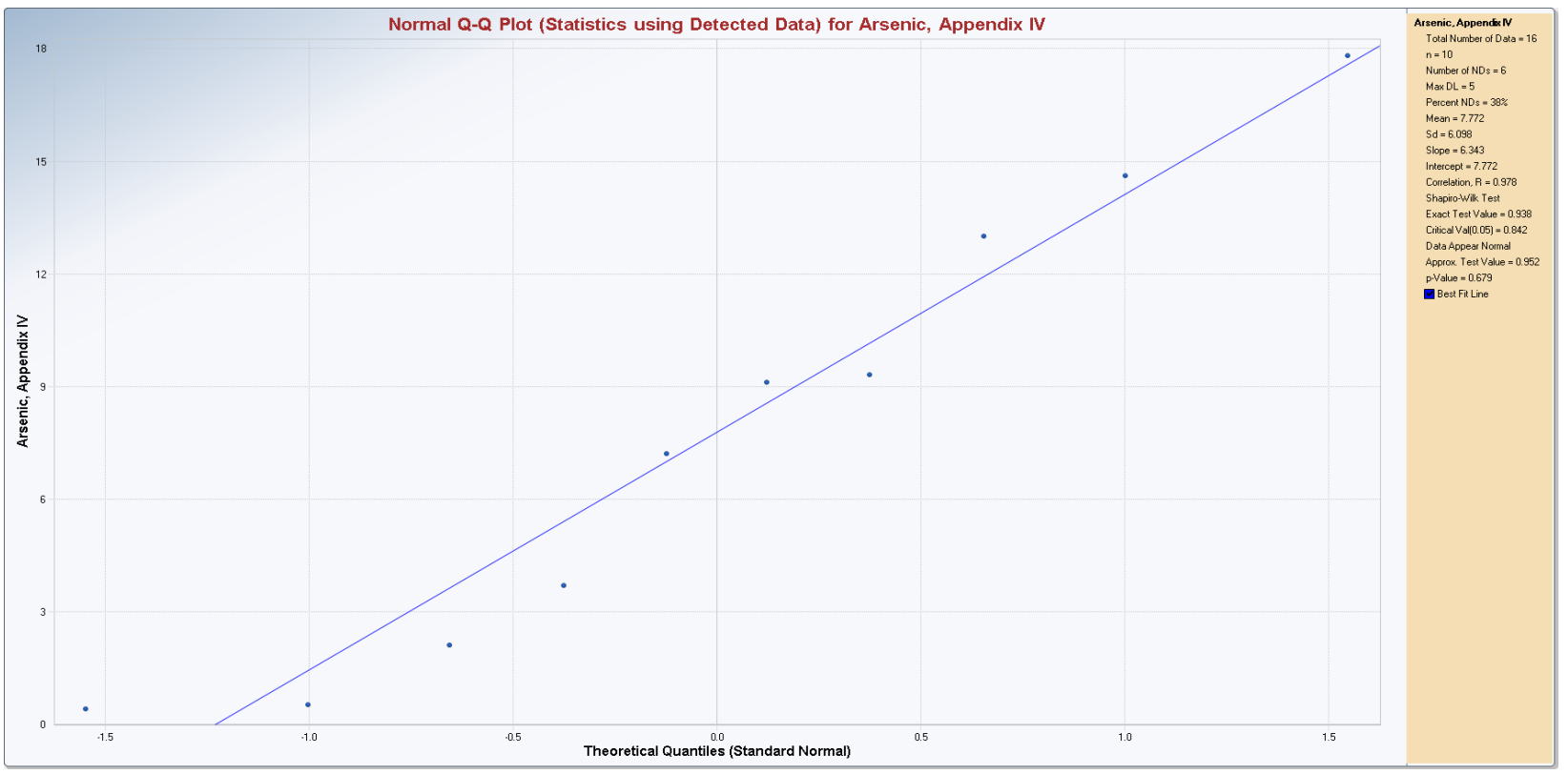
Test Statistic: 0.007

For 10% significance level, 0.41 is not an outlier.
For 5% significance level, 0.41 is not an outlier.
For 1% significance level, 0.41 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Arsenic, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	5.233	SD	5.665
95% UTL95% Coverage	19.53	95% KM UPL (t)	15.47
95% KM UPL for Next 4 Observations	19.77	95% KM UPL for Mean of Next 4 Observations	10.79

Barium, Appendix IV

General Statistics

Total Number of Observations	16	Number of Distinct Observations	15
Minimum	28	First Quartile	41.75
Second Largest	280	Median	114
Maximum	318	Third Quartile	247.5
Mean	143.5	SD	111.4
Coefficient of Variation	0.776	Skewness	0.261
Mean of logged Data	4.589	SD of logged Data	0.948

Dixon's Outlier Test for Barium, Appendix IV

Total N = 16
Number NDs = 0
Number Detects = 16
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 318 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.155

For 10% significance level, 318 is not an outlier.
For 5% significance level, 318 is not an outlier.
For 1% significance level, 318 is not an outlier.

2. Data Value 28 is a Potential Outlier (Lower Tail)?

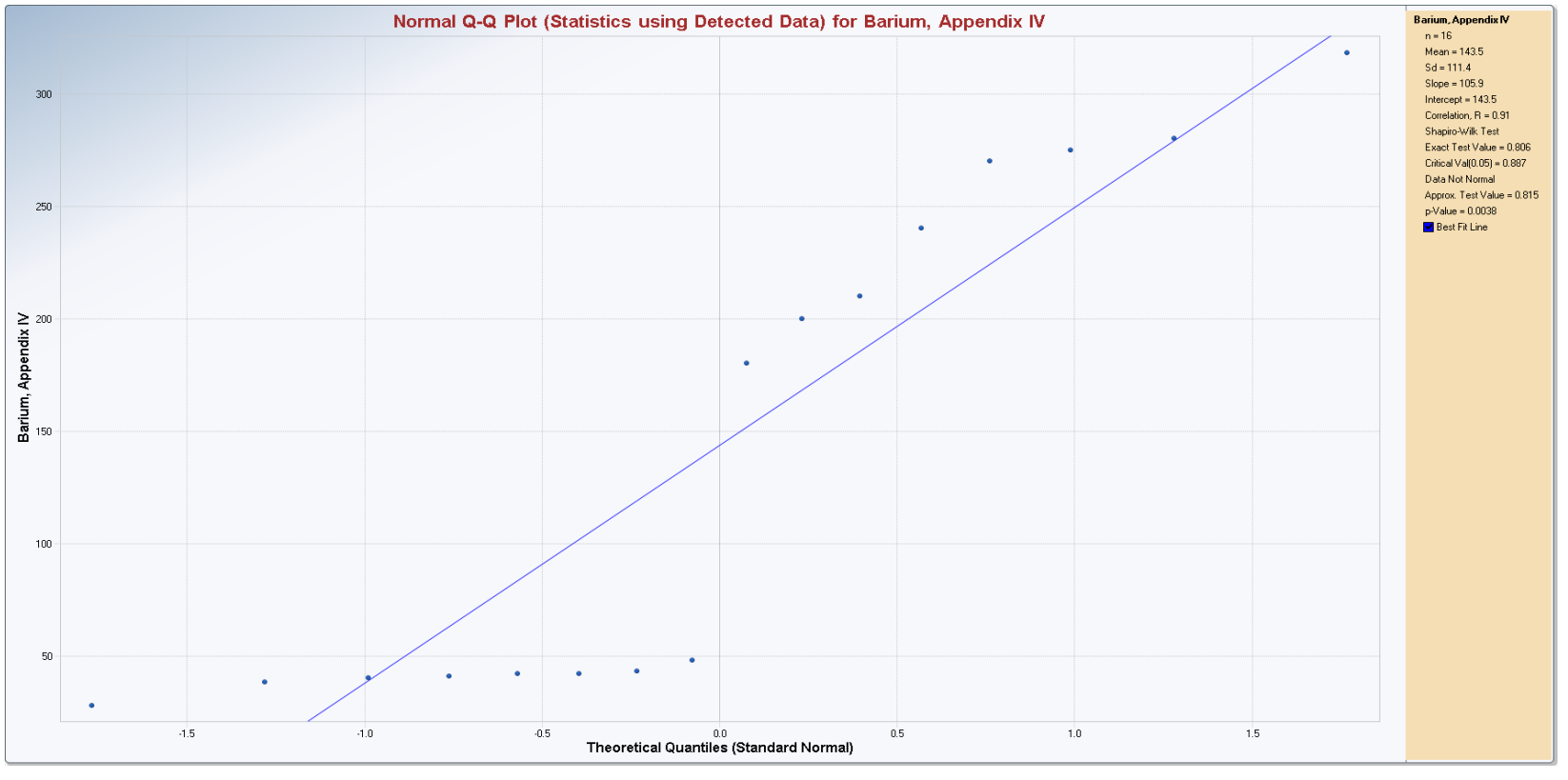
Test Statistic: 0.049

For 10% significance level, 28 is not an outlier.
For 5% significance level, 28 is not an outlier.
For 1% significance level, 28 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Barium, Appendix IV

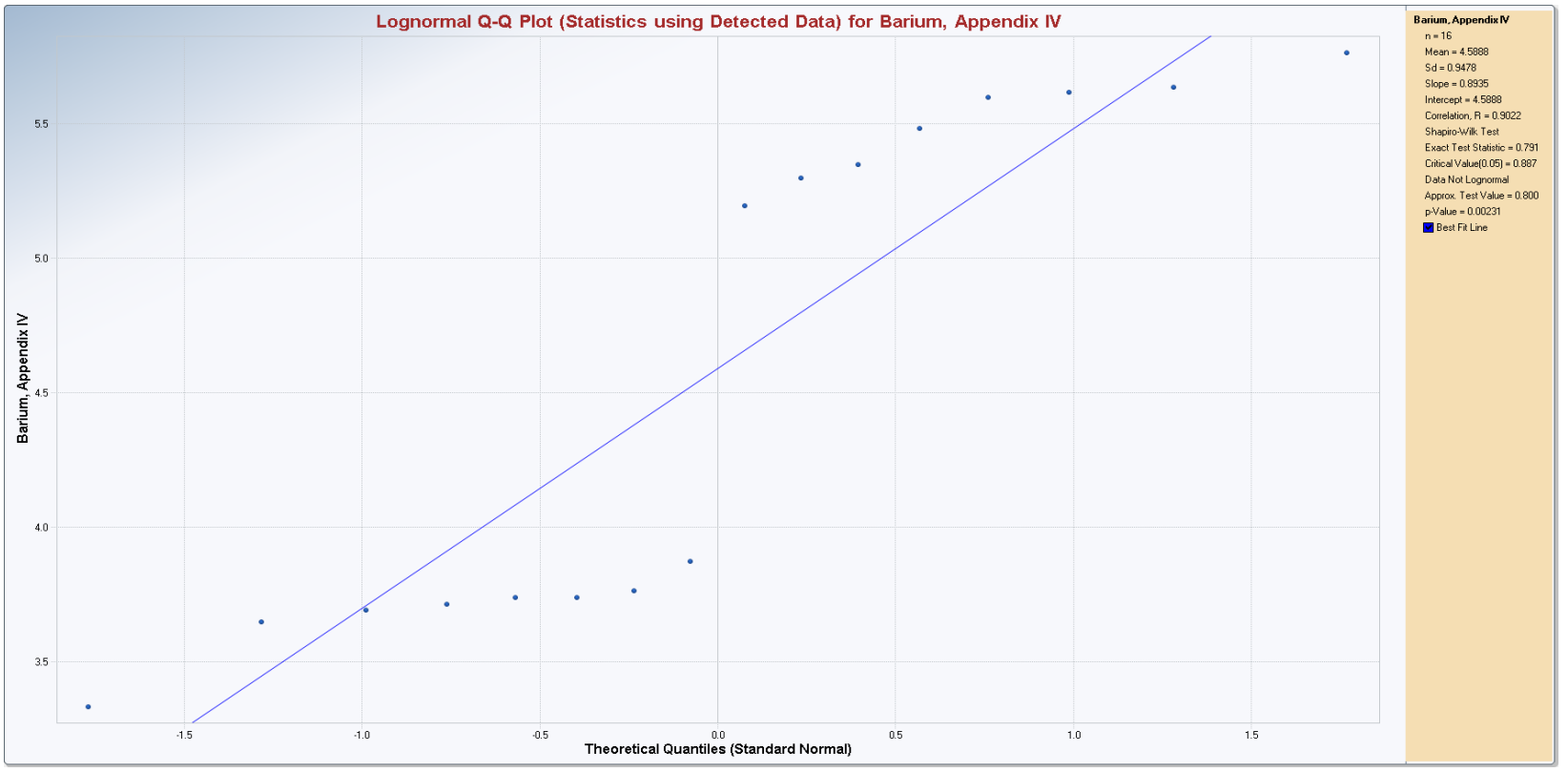


Normal GOF Test

Shapiro Wilk Test Statistic	0.806	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Barium, Appendix IV



Lognormal GOF Test

Shapiro Wilk Test Statistic	0.791	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

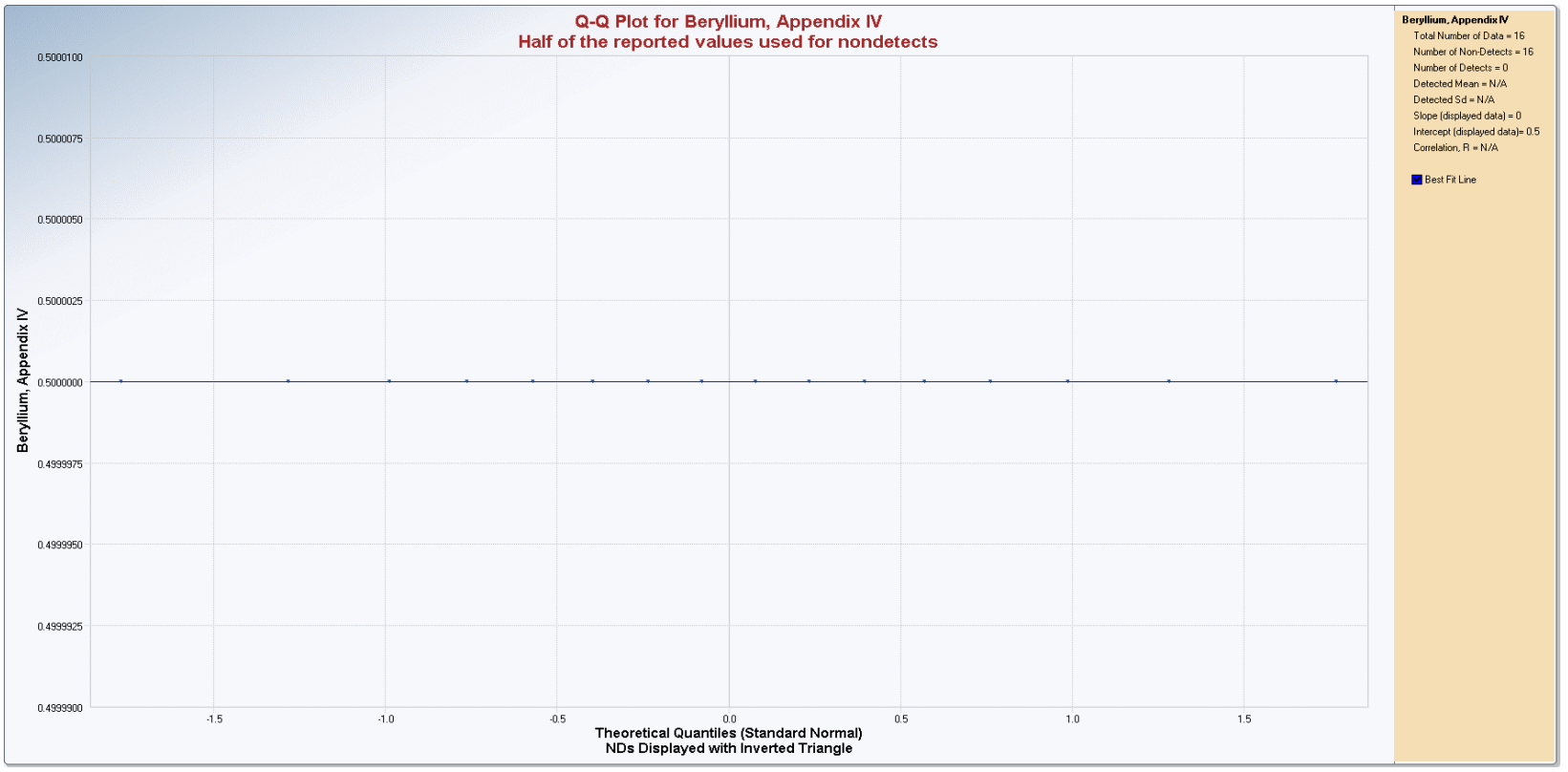
Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	16	95% UTL with 95% Coverage	318
Approximate f	0.842	Confidence Coefficient (CC) achieved by UTL	0.56
95% Percentile Bootstrap UTL with 95% Coverage	318	95% BCA Bootstrap UTL with 95% Coverage	318

Beryllium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	1		
Number of Detects	0	Number of Non-Detects	16
Number of Distinct Detects	0	Number of Distinct Non-Detects	1
Minimum Detect	N/A	Minimum Non-Detect	1
Maximum Detect	N/A	Maximum Non-Detect	1
Variance Detected	N/A	Percent Non-Detects	100%
Mean Detected	N/A	SD Detected	N/A
Mean of Detected Logged Data	N/A	SD of Detected Logged Data	N/A



Cobalt, Appendix IV

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
Minimum	0.82	First Quartile	2.5
Second Largest	5.4	Median	3.6
Maximum	6.9	Third Quartile	3.95
Mean	3.373	SD	1.568
Coefficient of Variation	0.465	Skewness	0.292
Mean of logged Data	1.083	SD of logged Data	0.584

Dixon's Outlier Test for Cobalt, Appendix IV

Total N = 16

Number NDs = 0

Number Detects = 16

Number Data (n) = 16

10% critical value: 0.454

5% critical value: 0.507

1% critical value: 0.595

Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 6.9 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.481

For 10% significance level, 6.9 is an outlier.

For 5% significance level, 6.9 is not an outlier.

For 1% significance level, 6.9 is not an outlier.

2. Data Value 0.82 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.246

For 10% significance level, 0.82 is not an outlier.

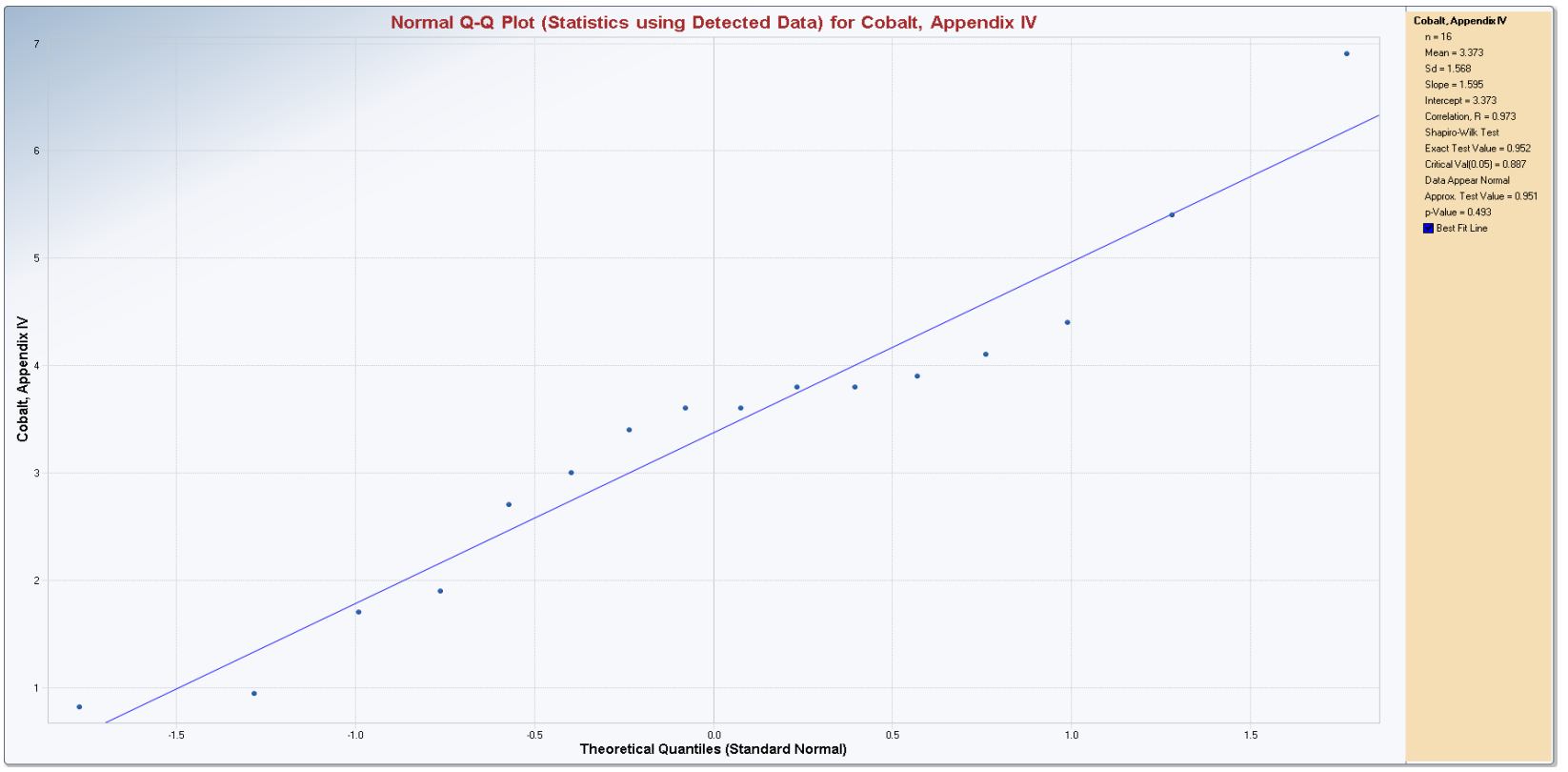
For 5% significance level, 0.82 is not an outlier.

For 1% significance level, 0.82 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Cobalt, Appendix IV



Normal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data Normal at 5% Significance Level

Data Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with	95% Coverage	7.33	90% Percentile (z)	5.382
	95% UPL (t)	6.206	95% Percentile (z)	5.952
	95% UPL for Next 4 Observations	7.397	99% Percentile (z)	7.02
	95% UPL for Mean of 4 Observations	4.909	95% USL	7.203

Fluoride, Appendix III & IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	15		
Number of Detects	13	Number of Non-Detects	3
Number of Distinct Detects	13	Number of Distinct Non-Detects	2
Minimum Detect	24	Minimum Non-Detect	50
Maximum Detect	230	Maximum Non-Detect	100
Variance Detected	5829	Percent Non-Detects	18.75%
Mean Detected	109.2	SD Detected	76.35
Mean of Detected Logged Data	4.387	SD of Detected Logged Data	0.878

Dixon's Outlier Test for Fluoride, Appendix III & IV

Total N = 16
Number NDs = 3
Number Detects = 13
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 230 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.197

For 10% significance level, 230 is not an outlier.
For 5% significance level, 230 is not an outlier.
For 1% significance level, 230 is not an outlier.

2. Data Value 24 is a Potential Outlier (Lower Tail)?

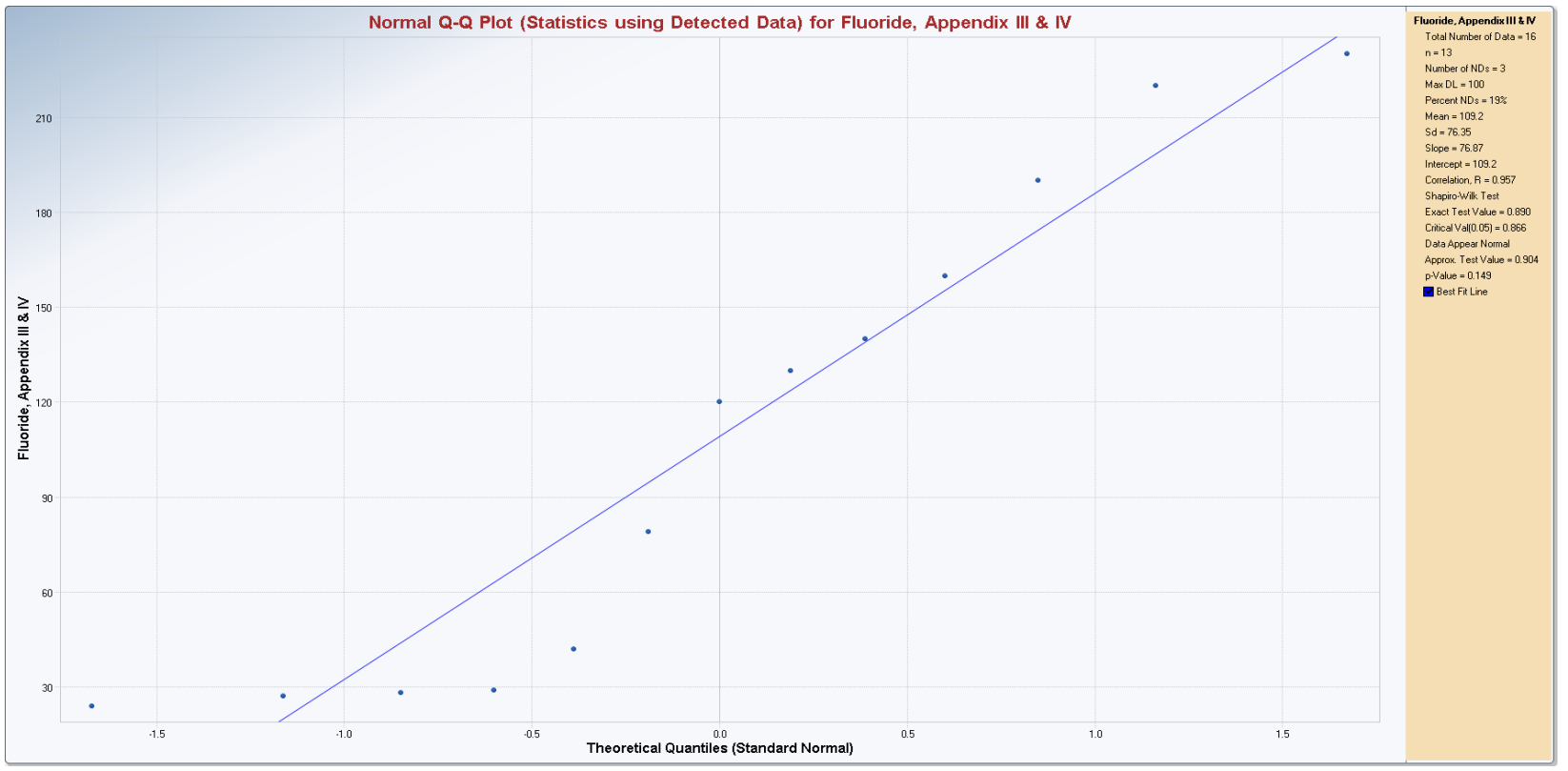
Test Statistic: 0.018

For 10% significance level, 24 is not an outlier.
For 5% significance level, 24 is not an outlier.
For 1% significance level, 24 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Fluoride, Appendix III & IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.89	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	95.19	SD	72.54
95% UTL95% Coverage	278.3	95% KM UPL (t)	226.3
95% KM UPL for Next 4 Observations	281.4	95% KM UPL for Mean of Next 4 Observations	166.3

Lead, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	11		
Number of Detects	9	Number of Non-Detects	7
Number of Distinct Detects	9	Number of Distinct Non-Detects	2
Minimum Detect	0.18	Minimum Non-Detect	0.1
Maximum Detect	0.79	Maximum Non-Detect	1
Variance Detected	0.0361	Percent Non-Detects	43.75%
Mean Detected	0.396	SD Detected	0.19
Mean of Detected Logged Data	-1.028	SD of Detected Logged Data	0.48

Dixon's Outlier Test for Lead, Appendix IV

Total N = 16

Number NDs = 7

Number Detects = 9

Number Data (n) = 16

10% critical value: 0.454

5% critical value: 0.507

1% critical value: 0.595

Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 0.79 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.483

For 10% significance level, 0.79 is an outlier.

For 5% significance level, 0.79 is not an outlier.

For 1% significance level, 0.79 is not an outlier.

2. Data Value 0.05 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.311

For 10% significance level, 0.05 is not an outlier.

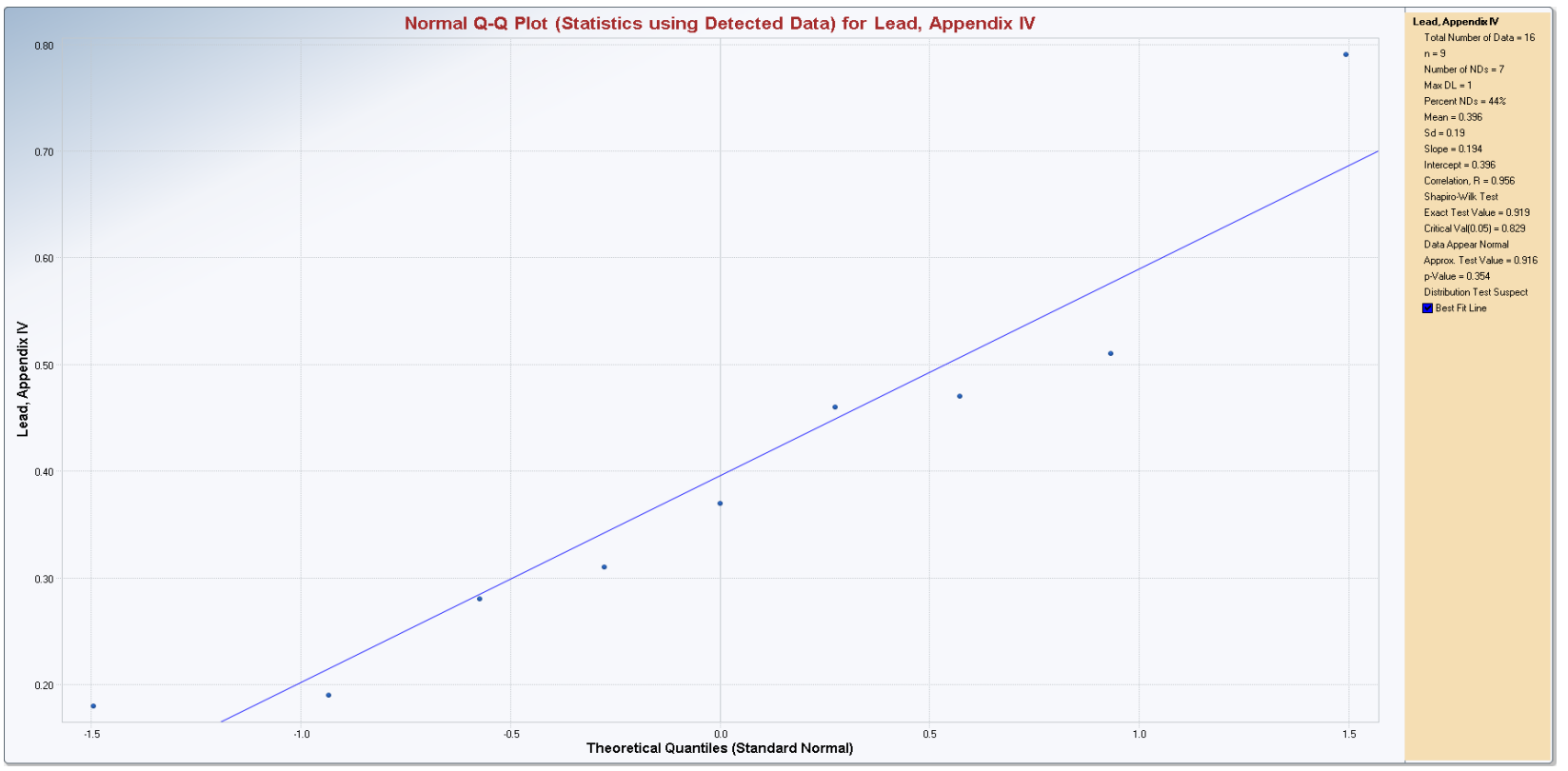
For 5% significance level, 0.05 is not an outlier.

For 1% significance level, 0.05 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Lead, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	0.366	SD	0.192
95% UTL95% Coverage	0.85	95% KM UPL (t)	0.712
95% KM UPL for Next 4 Observations	0.858	95% KM UPL for Mean of Next 4 Observations	0.554

Lithium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	13		
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	10	Number of Distinct Non-Detects	3
Minimum Detect	0.41	Minimum Non-Detect	8
Maximum Detect	2.4	Maximum Non-Detect	50
Variance Detected	0.512	Percent Non-Detects	25%
Mean Detected	1.458	SD Detected	0.715
Mean of Detected Logged Data	0.221	SD of Detected Logged Data	0.642

Dixon's Outlier Test for Lithium, Appendix IV

Total N = 16

Number NDs = 4

Number Detects = 12

Number Data (n) = 16

10% critical value: 0.454

5% critical value: 0.507

1% critical value: 0.595

Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 25 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.510

For 10% significance level, 25 is an outlier.

For 5% significance level, 25 is an outlier.

For 1% significance level, 25 is not an outlier.

2. Data Value 0.41 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.008

For 10% significance level, 0.41 is not an outlier.

For 5% significance level, 0.41 is not an outlier.

For 1% significance level, 0.41 is not an outlier.

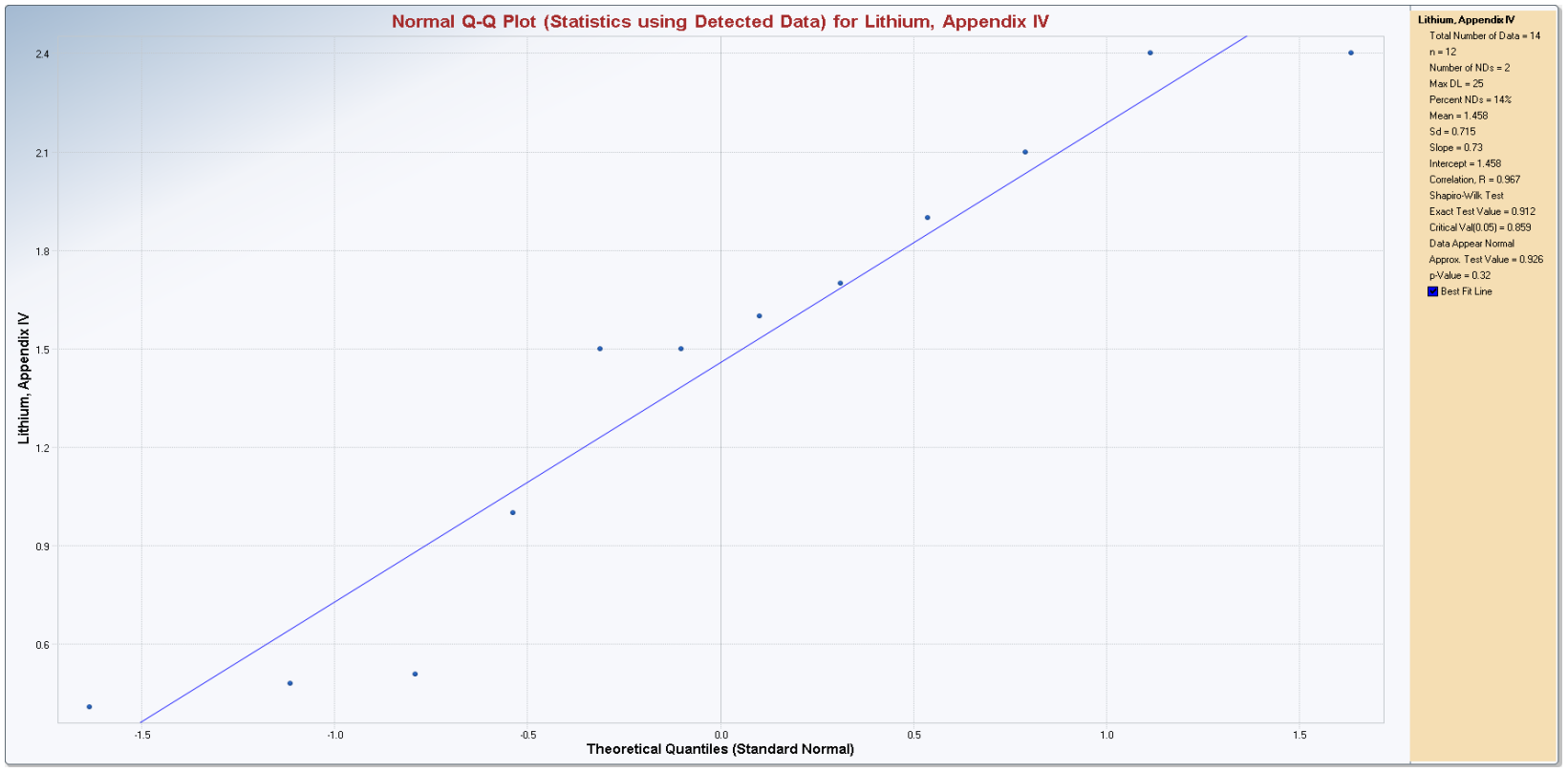
Lithium, Appendix IV

General Statistics - Outliers Removed

Total Number of Observations	14		
Number of Distinct Observations	12		
Number of Detects	12	Number of Non-Detects	2
Number of Distinct Detects	10	Number of Distinct Non-Detects	2
Minimum Detect	0.41	Minimum Non-Detect	8
Maximum Detect	2.4	Maximum Non-Detect	25
Variance Detected	0.512	Percent Non-Detects	14.29%
Mean Detected	1.458	SD Detected	0.715
Mean of Detected Logged Data	0.221	SD of Detected Logged Data	0.642

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.614	d2max (for USL)	2.372



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

Mean	1.458	SD	0.685
95% UTL95% Coverage	3.248	95% KM UPL (t)	2.714
95% KM UPL for Next 4 Observations	3.254	95% KM UPL for Mean of Next 4 Observations	2.146

Molybdenum, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	10		
Number of Detects	10	Number of Non-Detects	6
Number of Distinct Detects	9	Number of Distinct Non-Detects	2
Minimum Detect	0.58	Minimum Non-Detect	5
Maximum Detect	6.4	Maximum Non-Detect	10
Variance Detected	4.107	Percent Non-Detects	37.5%
Mean Detected	1.97	SD Detected	2.027
Mean of Detected Logged Data	0.325	SD of Detected Logged Data	0.815

Dixon's Outlier Test for Molybdenum, Appendix IV

Total N = 16
Number NDs = 6
Number Detects = 10
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 6.4 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.247

For 10% significance level, 6.4 is not an outlier.
For 5% significance level, 6.4 is not an outlier.
For 1% significance level, 6.4 is not an outlier.

2. Data Value 0.58 is a Potential Outlier (Lower Tail)?

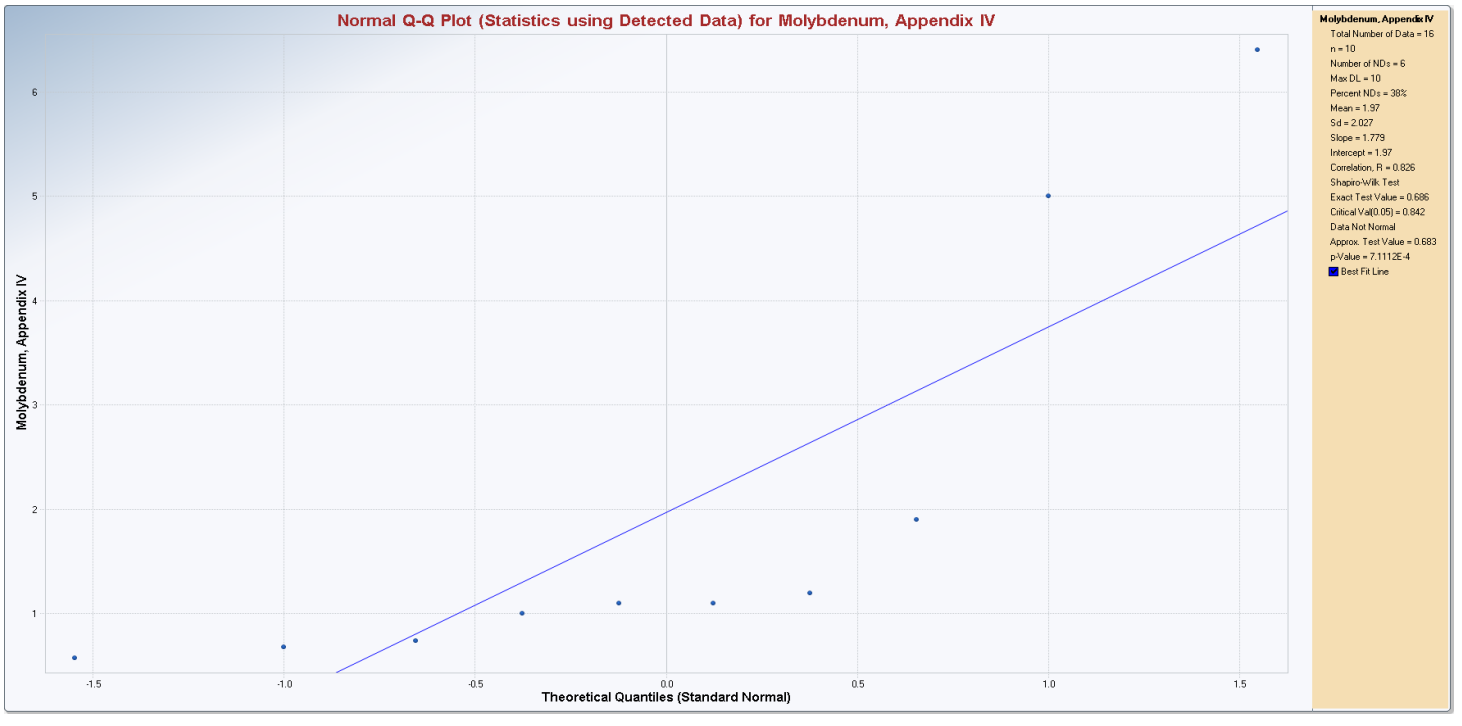
Test Statistic: 0.036

For 10% significance level, 0.58 is not an outlier.
For 5% significance level, 0.58 is not an outlier.
For 1% significance level, 0.58 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Molybdenum, Appendix IV

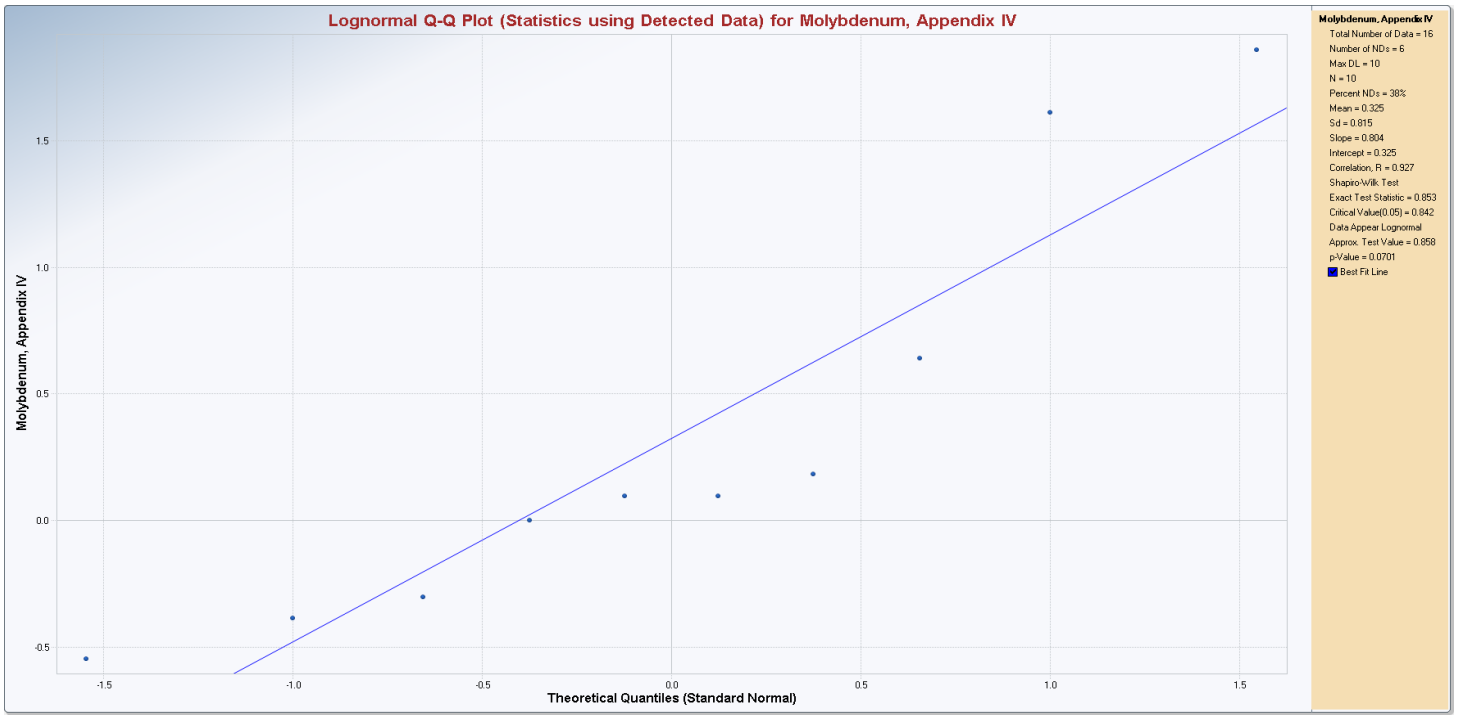


Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.686	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Molybdenum, Appendix IV



Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.853	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

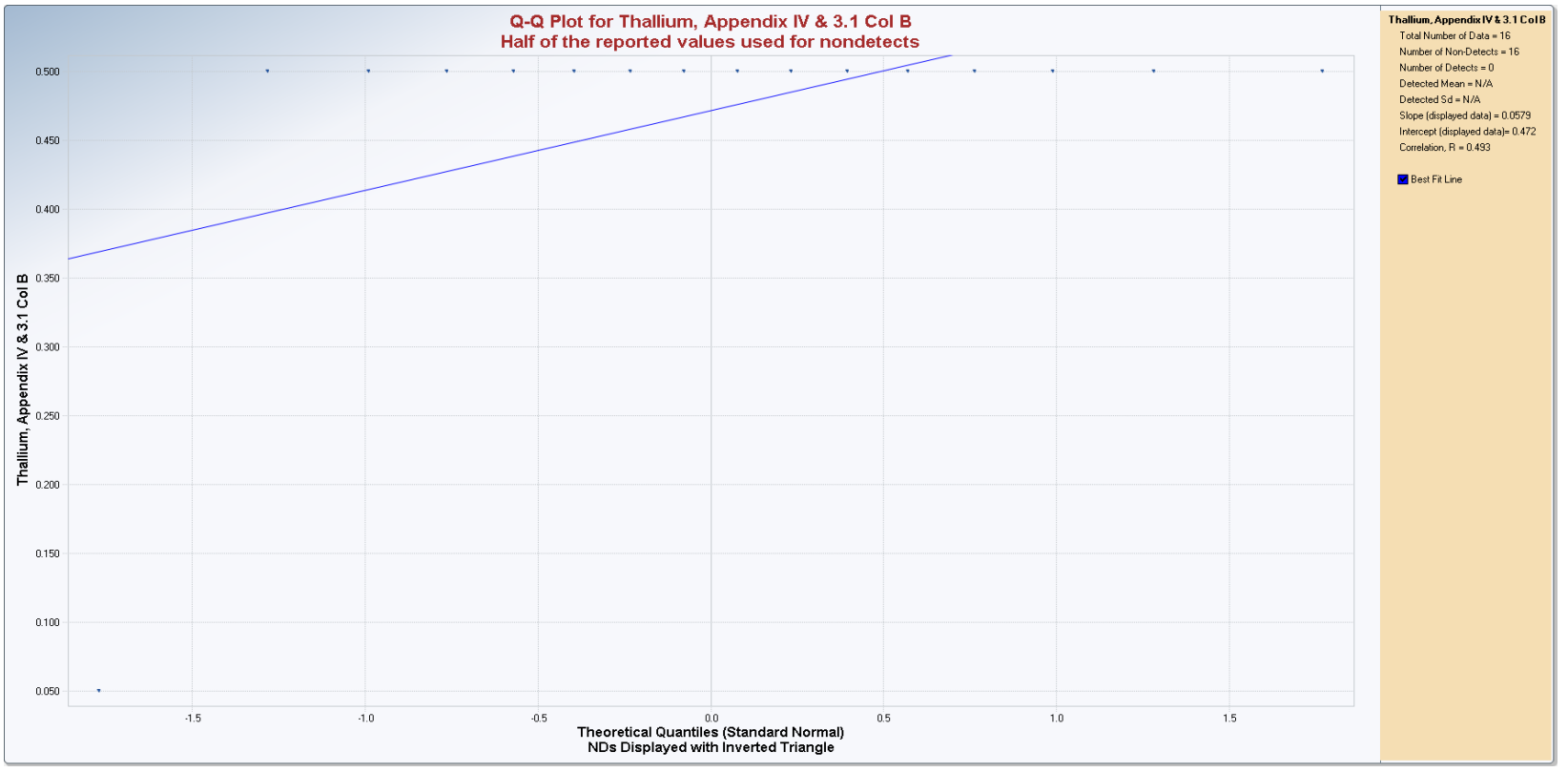
Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	0.266 (LN)	95% KM UTL (Lognormal)95% Coverage	8.286 ug/L
KM SD of Logged Data	0.732 (LN)	95% KM UPL (Lognormal)	4.901
95% KM Percentile Lognormal (z)	4.352	95% KM USL (Lognormal)	7.81

Thallium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	2		
Number of Detects	0	Number of Non-Detects	16
Number of Distinct Detects	0	Number of Distinct Non-Detects	2
Minimum Detect	N/A	Minimum Non-Detect	0.1
Maximum Detect	N/A	Maximum Non-Detect	1
Variance Detected	N/A	Percent Non-Detects	100%
Mean Detected	N/A	SD Detected	N/A
Mean of Detected Logged Data	N/A	SD of Detected Logged Data	N/A



Total Radium, Appendix IV

General Statistics

Total Number of Observations	16		
Number of Distinct Observations	16		
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	12	Number of Distinct Non-Detects	4
Minimum Detect	0.358	Minimum Non-Detect	0.282
Maximum Detect	1.53	Maximum Non-Detect	0.934
Variance Detected	0.11	Percent Non-Detects	25%
Mean Detected	0.799	SD Detected	0.332
Mean of Detected Logged Data	-0.3	SD of Detected Logged Data	0.405

Dixon's Outlier Test for Radium 226 + 228

Total N = 16
Number NDs = 4
Number Detects = 12
Number Data (n) = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 1.53 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.452

For 10% significance level, 1.53 is not an outlier.
For 5% significance level, 1.53 is not an outlier.
For 1% significance level, 1.53 is not an outlier.

2. Data Value 0.141 is a Potential Outlier (Lower Tail)?

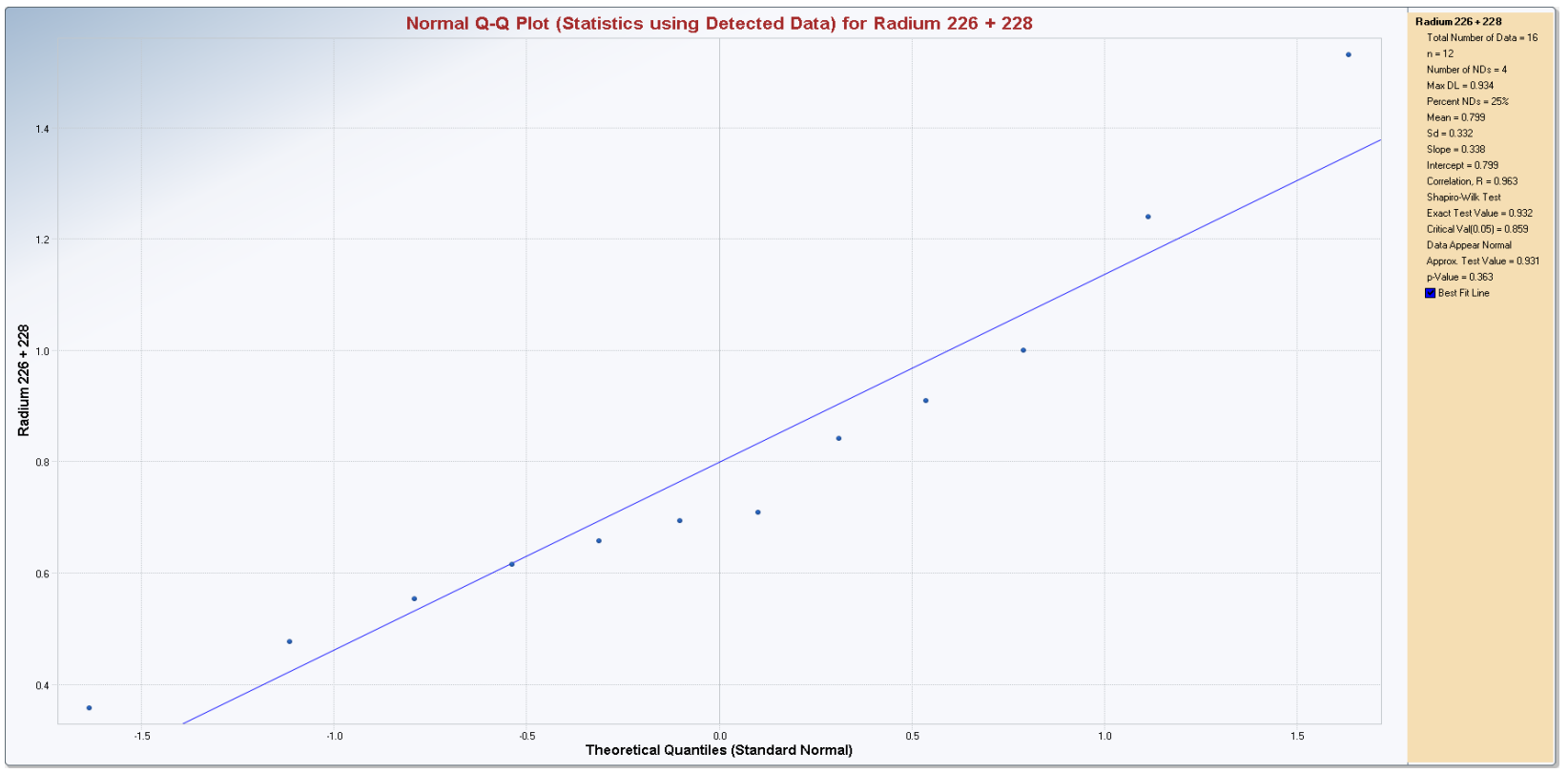
Test Statistic: 0.253

For 10% significance level, 0.141 is not an outlier.
For 5% significance level, 0.141 is not an outlier.
For 1% significance level, 0.141 is not an outlier.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Total Radium, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level

Data Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.711	KM SD	0.328
95% UTL95% Coverage	1.538	95% KM UPL (t)	1.303
95% KM UPL for Next 4 Observations	1.552	95% KM UPL for Mean of Next 4 Observations	1.032

Attachment 2

Background Statistic Worksheets – Potomac Aquifer

General Statistics

Total Number of Observations	32		
Number of Distinct Observations	20		
Number of Detects	18	Number of Non-Detects	14
Number of Distinct Detects	18	Number of Distinct Non-Detects	2
Minimum Detect	0.22	Minimum Non-Detect	1
Maximum Detect	17.8	Maximum Non-Detect	5
Variance Detected	33.2	Percent Non-Detects	43.75%
Mean Detected	4.579	SD Detected	5.762
Mean of Detected Logged Data	0.566	SD of Detected Logged Data	1.492

Rosner's Outlier Test for 7 Outliers in Arsenic, Appendix IV

Total N	**32**
Number NDs	**14**
Number Detects	**32**
Mean with NDs=DL/2	**3.357**
SD with NDs=DL/2	**4.539**
Number of data	**32**
Number of suspected outliers	**7**
NDs replaced with half value.	

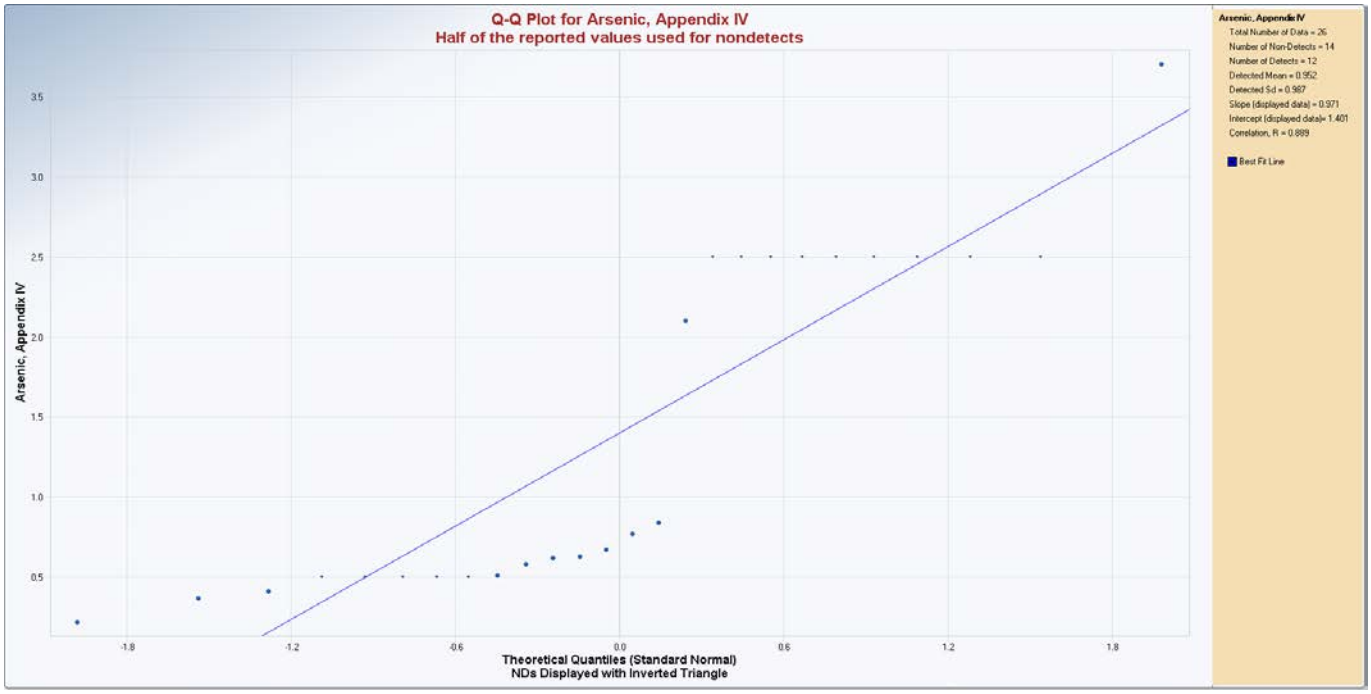
#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	3.357	4.467	17.8	7	3.233	2.94	3.27
2	2.891	3.756	14.6	8	3.117	2.92	3.25
3	2.501	3.116	13	4	3.369	2.91	3.24
4	2.139	2.446	9.3	6	2.927	2.89	3.22
5	1.883	2.059	9.1	3	3.505	2.88	3.2
6	1.616	1.525	7.2	2	3.662	2.86	3.178
7	1.401	1.059	3.7	1	2.17	2.84	3.156

For 5% significance level, there are 6 Potential Outliers

17.8, 14.6, 13, 9.3, 9.1, 7.2

General Statistics - Outliers Removed

Total Number of Observations	26	Number of Missing Observations	38
Number of Distinct Observations	14		
Number of Detects	12	Number of Non-Detects	14
Number of Distinct Detects	12	Number of Distinct Non-Detects	2
Minimum Detect	0.22	Minimum Non-Detect	1
Maximum Detect	3.7	Maximum Non-Detect	5
Variance Detected	0.974	Percent Non-Detects	53.85%
Mean Detected	0.952	SD Detected	0.987
Mean of Detected Logged Data	-0.362	SD of Detected Logged Data	0.752



Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	26	95% UTL with95% Coverage	5
Approx, f used to compute achieved CC	1.368	Approximate Actual Confidence Coefficient achieved by UTL	0.736
Approximate Sample Size needed to achieve specified CC	59	95% UPL	5
95% USL	5	95% KM Chebyshev UPL	4.476

Barium, Appendix IV

General Statistics

Total Number of Observations	32	Number of Distinct Observations	26
Minimum	28	First Quartile	42.6
Second Largest	280	Median	56.4
Maximum	318	Third Quartile	105
Mean	100.8	SD	89.47
Coefficient of Variation	0.888	Skewness	1.348
Mean of logged Data	4.308	SD of logged Data	0.744

Rosner's Outlier Test for 2 Outliers in Barium, Appendix IV

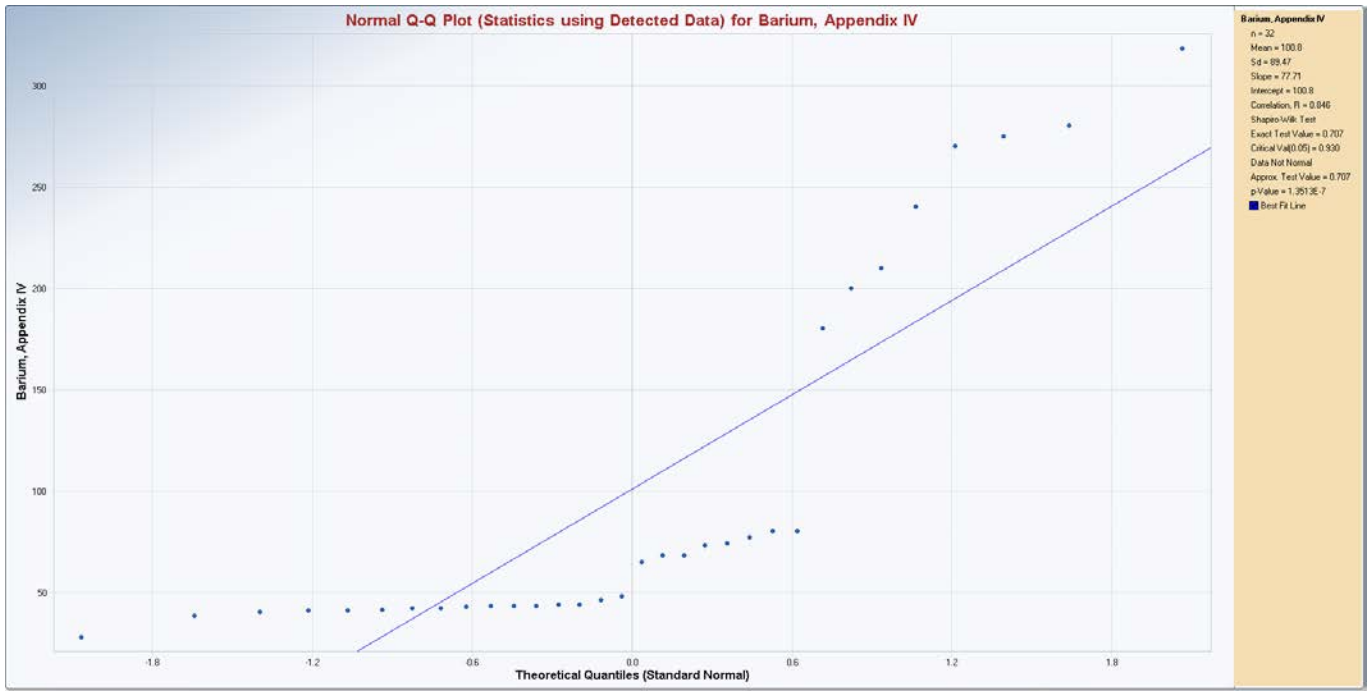
Total N	**32**
Number NDs	**0**
Number Detects	**32**
Mean with NDs=DL/2	**100.8**
SD with NDs=DL/2	**89.47**
Number of data	**32**
Number of suspected outliers	**2**
NDs replaced with half value.	

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	100.8	88.06	318	7	2.466	2.94	3.27
2	93.79	81.54	280	4	2.284	2.92	3.25

For 5% Significance Level, there are no Potential Outliers

Critical Values for Background Threshold Values (BTVs)

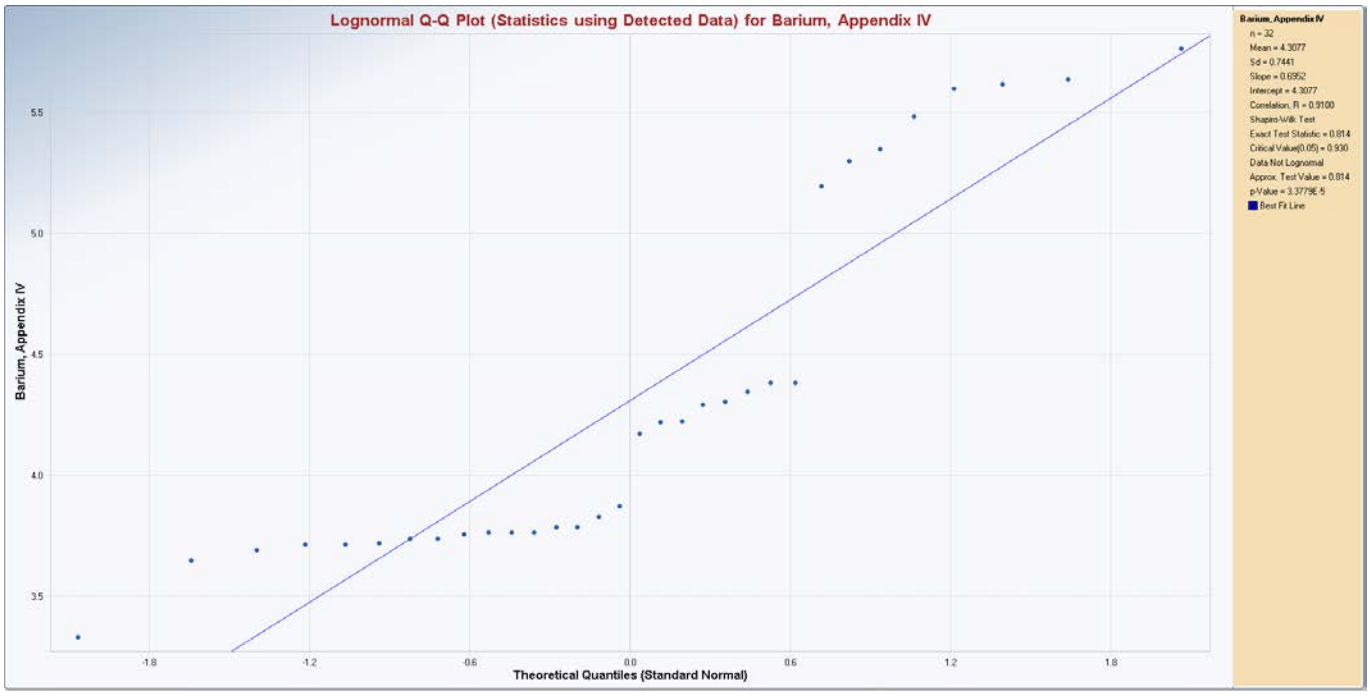
Tolerance Factor K (For UTL)	2.198	d2max (for USL)	2.773



Normal GOF Test

Shapiro Wilk Test Statistic	0.707	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level



Lognormal GOF Test

Shapiro Wilk Test Statistic	0.814	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.93	Data Not Lognormal at 5% Significance Level	

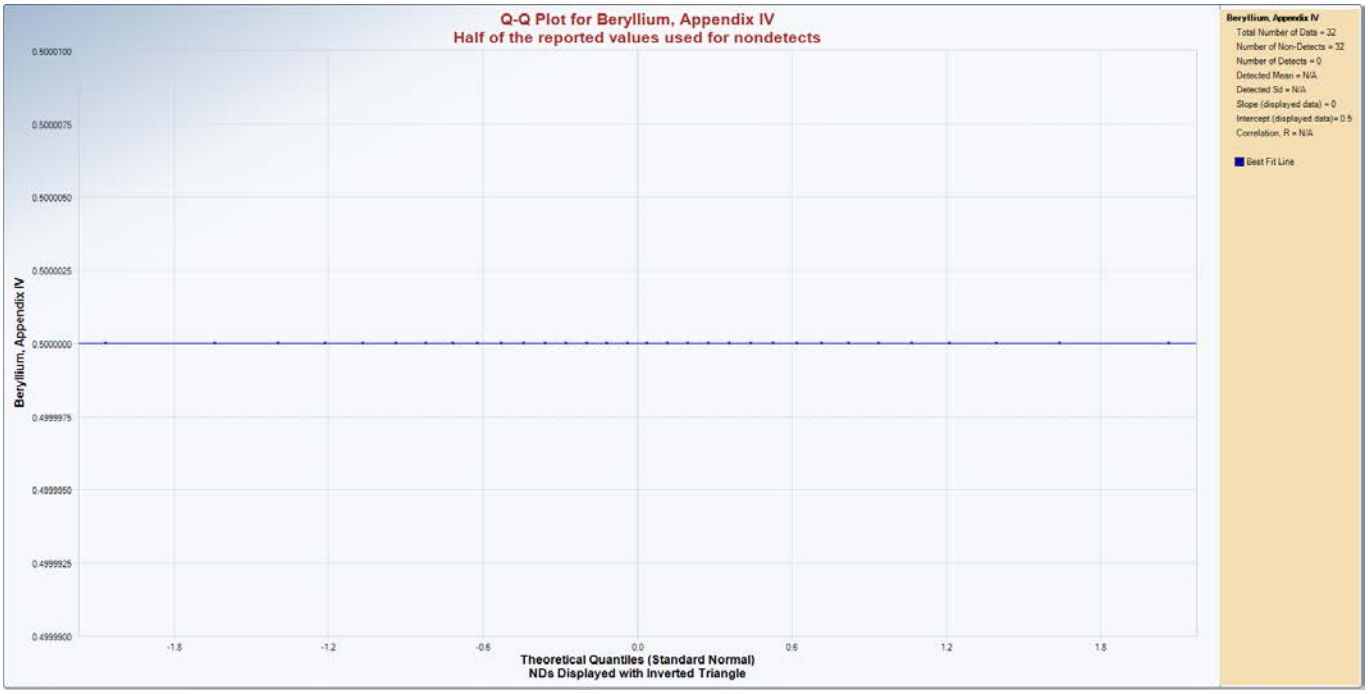
Data Not Lognormal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	32	95% UTL with 95% Coverage	318
Approx, f used to compute achieved CC	1.684	Approximate Actual Confidence Coefficient achieved by UTL	0.806
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	318	95% BCA Bootstrap UTL with 95% Coverage	318
95% UPL	293.3	90% Percentile	267
		95% Percentile	277.3
		99% Percentile	306.2

General Statistics

Total Number of Observations	32		
Number of Distinct Observations	1		
Number of Detects	0	Number of Non-Detects	32
Number of Distinct Detects	0	Number of Distinct Non-Detects	1
Minimum Detect	N/A	Minimum Non-Detect	1
Maximum Detect	N/A	Maximum Non-Detect	1
Variance Detected	N/A	Percent Non-Detects	100%
Mean Detected	N/A	SD Detected	N/A
Mean of Detected Logged Data	N/A	SD of Detected Logged Data	N/A



General Statistics

Total Number of Observations	32		
Number of Distinct Observations	26		
Number of Detects	28	Number of Non-Detects	4
Number of Distinct Detects	25	Number of Distinct Non-Detects	1
Minimum Detect	0.04	Minimum Non-Detect	1
Maximum Detect	6.9	Maximum Non-Detect	1
Variance Detected	3.841	Percent Non-Detects	12.5%
Mean Detected	2.038	SD Detected	1.96
Mean of Detected Logged Data	-0.0593	SD of Detected Logged Data	1.494

Rosner's Outlier Test for 2 Outliers in Cobalt, Appendix IV

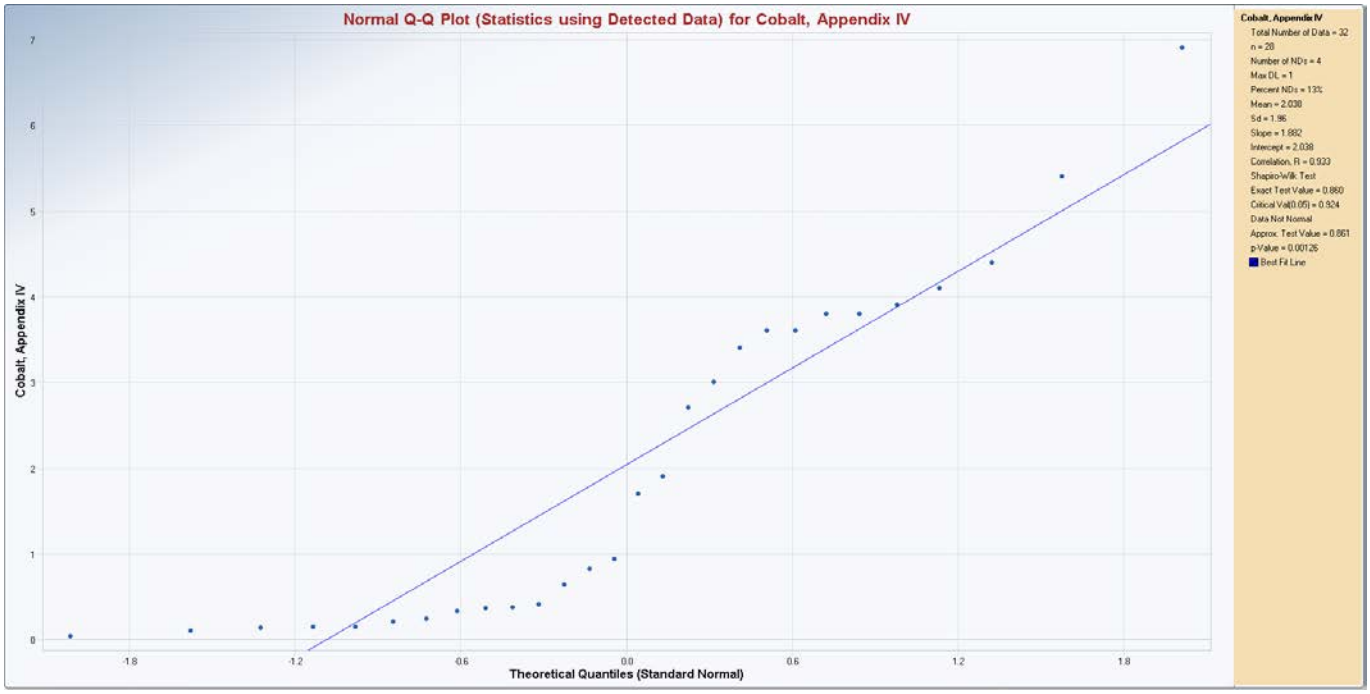
Total N	**32**
Number NDs	**4**
Number Detects	**32**
Mean with NDs=DL/2	**1.846**
SD with NDs=DL/2	**1.901**
Number of data	**32**
Number of suspected outliers	**2**
NDs replaced with half value.	

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	1.846	1.871	6.9	3	2.702	2.94	3.27
2	1.683	1.689	5.4	25	2.201	2.92	3.25

For 5% Significance Level, there are no Potential Outliers

Critical Values for Background Threshold Values (BTVs)

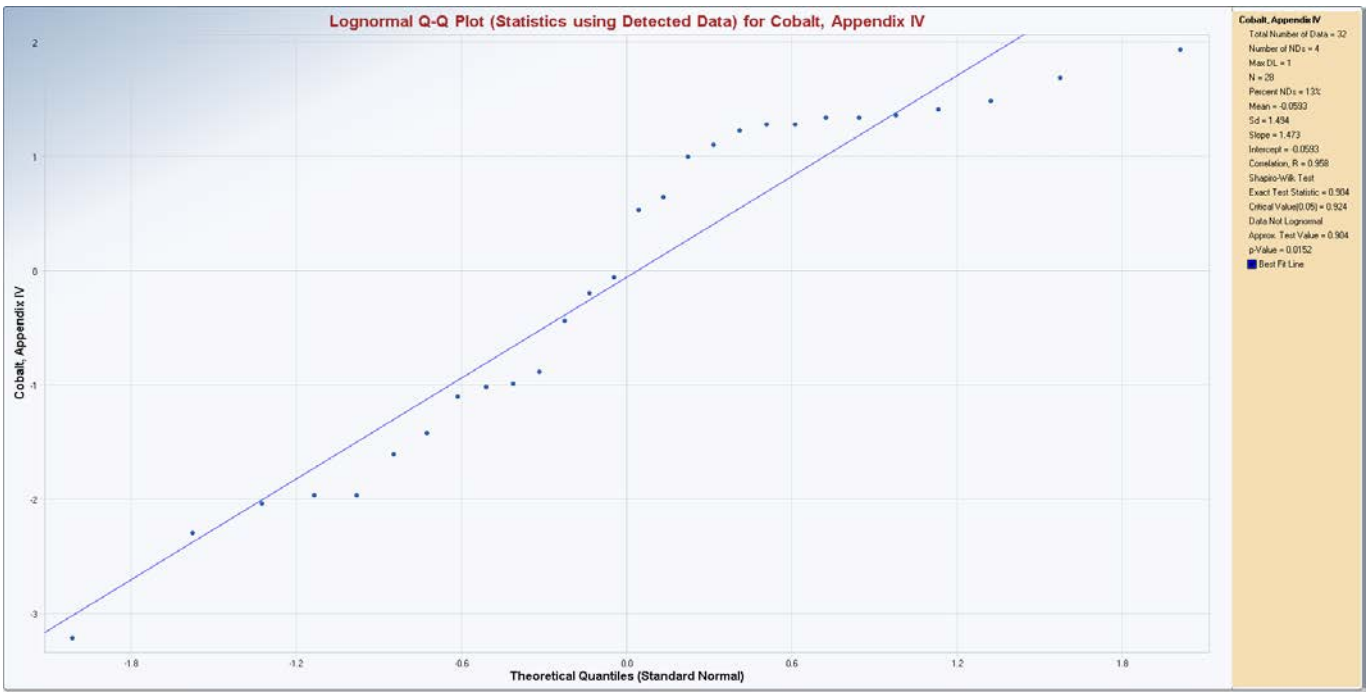
Tolerance Factor K (For UTL)	2.198	d2max (for USL)	2.773



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.86	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level



Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.904	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	32	95% UTL with95% Coverage	6.9
Approx, f used to compute achieved CC	1.684	Approximate Actual Confidence Coefficient achieved by UTL	0.806
Approximate Sample Size needed to achieve specified CC	59	95% UPL	5.925

General Statistics

Total Number of Observations	32		
Number of Distinct Observations	21		
Number of Detects	29	Number of Non-Detects	3
Number of Distinct Detects	20	Number of Distinct Non-Detects	2
Minimum Detect	24	Minimum Non-Detect	50
Maximum Detect	260	Maximum Non-Detect	100
Variance Detected	5918	Percent Non-Detects	9.375%
Mean Detected	136.4	SD Detected	76.93
Mean of Detected Logged Data	4.688	SD of Detected Logged Data	0.773

Rosner's Outlier Test for 2 Outliers in Fluoride, Appendix III & IV

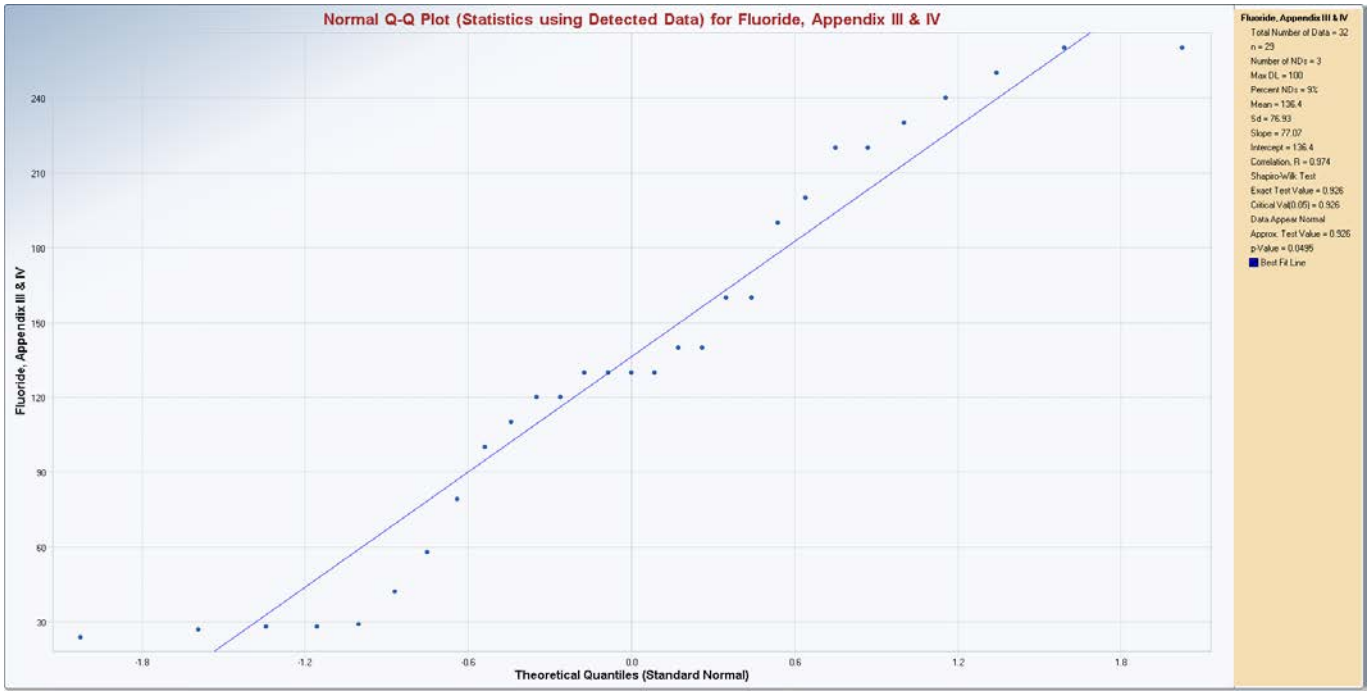
Total N	**32**
Number NDs	**3**
Number Detects	**32**
Mean with NDs=DL/2	**127.5**
SD with NDs=DL/2	**78.39**
Number of data	**32**
Number of suspected outliers	**2**
NDs replaced with half value.	

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	127.5	77.16	260	20	1.717	2.94	3.27
2	123.2	75.8	260	21	1.804	2.92	3.25

For 5% Significance Level, there are no Potential Outliers

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.198	d2max (for USL)	2.773



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.926	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.926	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	126.9	KM SD	77.89
95% UTL95% Coverage	297.2	95% KM UPL (t)	261
95% KM UPL for Next 4 Observations	313.2	95% KM UPL for Mean of Next 4 Observations	196.9
90% KM Percentile (z)	226.7	95% KM Percentile (z)	255
99% KM Percentile (z)	308.1	95% KM USL	342.9

General Statistics

Total Number of Observations	32		
Number of Distinct Observations	17		
Number of Detects	18	Number of Non-Detects	14
Number of Distinct Detects	15	Number of Distinct Non-Detects	2
Minimum Detect	0.093	Minimum Non-Detect	0.1
Maximum Detect	0.79	Maximum Non-Detect	1
Variance Detected	0.0417	Percent Non-Detects	43.75%
Mean Detected	0.384	SD Detected	0.204
Mean of Detected Logged Data	-1.102	SD of Detected Logged Data	0.573

Rosner's Outlier Test for 2 Outliers in Lead, Appendix IV

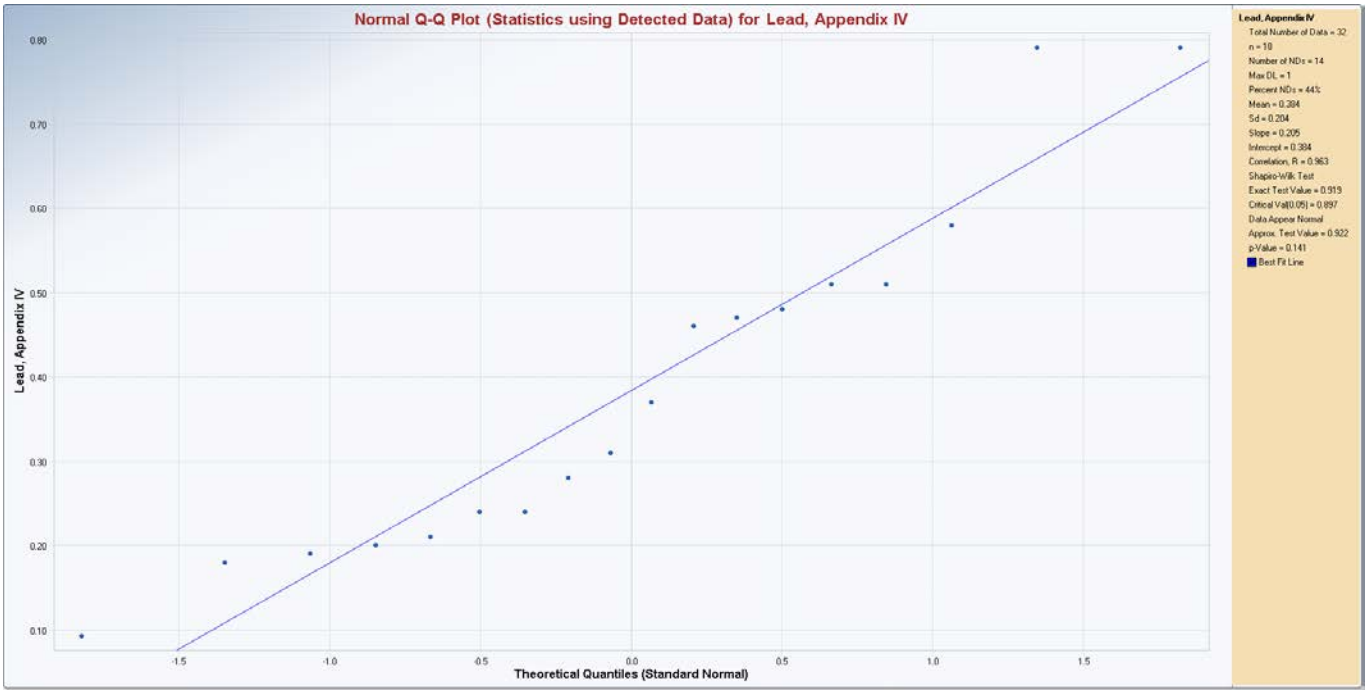
Total N	**32**
Number NDs	**14**
Number Detects	**32**
Mean with NDs=DL/2	**0.42**
SD with NDs=DL/2	**0.175**
Number of data	**32**
Number of suspected outliers	**2**
NDs replaced with half value.	

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.42	0.173	0.05	7	2.147	2.94	3.27
2	0.432	0.164	0.79	6	2.176	2.92	3.25

For 5% Significance Level, there are no Potential Outliers

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.198	d2max (for USL)	2.773



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.368	KM SD	0.204
95% UTL95% Coverage	0.814	95% KM UPL (t)	0.719
95% KM UPL for Next 4 Observations	0.855	95% KM UPL for Mean of Next 4 Observations	0.551
90% KM Percentile (z)	0.629	95% KM Percentile (z)	0.703
99% KM Percentile (z)	0.842	95% KM USL	0.933

Lithium, Appendix IV

General Statistics

Total Number of Observations	32		
Number of Distinct Observations	23		
Number of Detects	28	Number of Non-Detects	4
Number of Distinct Detects	20	Number of Distinct Non-Detects	3
Minimum Detect	0.41	Minimum Non-Detect	8
Maximum Detect	13	Maximum Non-Detect	50
Variance Detected	25.66	Percent Non-Detects	12.5%
Mean Detected	7.082	SD Detected	5.066
Mean of Detected Logged Data	1.477	SD of Detected Logged Data	1.184

Rosner's Outlier Test for 3 Outliers in Lithium, Appendix IV

Total N	**32**
Number NDs	**4**
Number Detects	**32**
Mean with NDs=DL/2	**8.275**
SD with NDs=DL/2	**6.546**
Number of data	**32**
Number of suspected outliers	**3**
NDs replaced with half value.	

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	8.275	6.443	25	5	2.596	2.94	3.27
2	7.735	5.886	25	6	2.933	2.92	3.25
3	7.16	5.022	0.41	7	1.344	2.91	3.24

For 5% significance level, there are 2 Potential Outliers

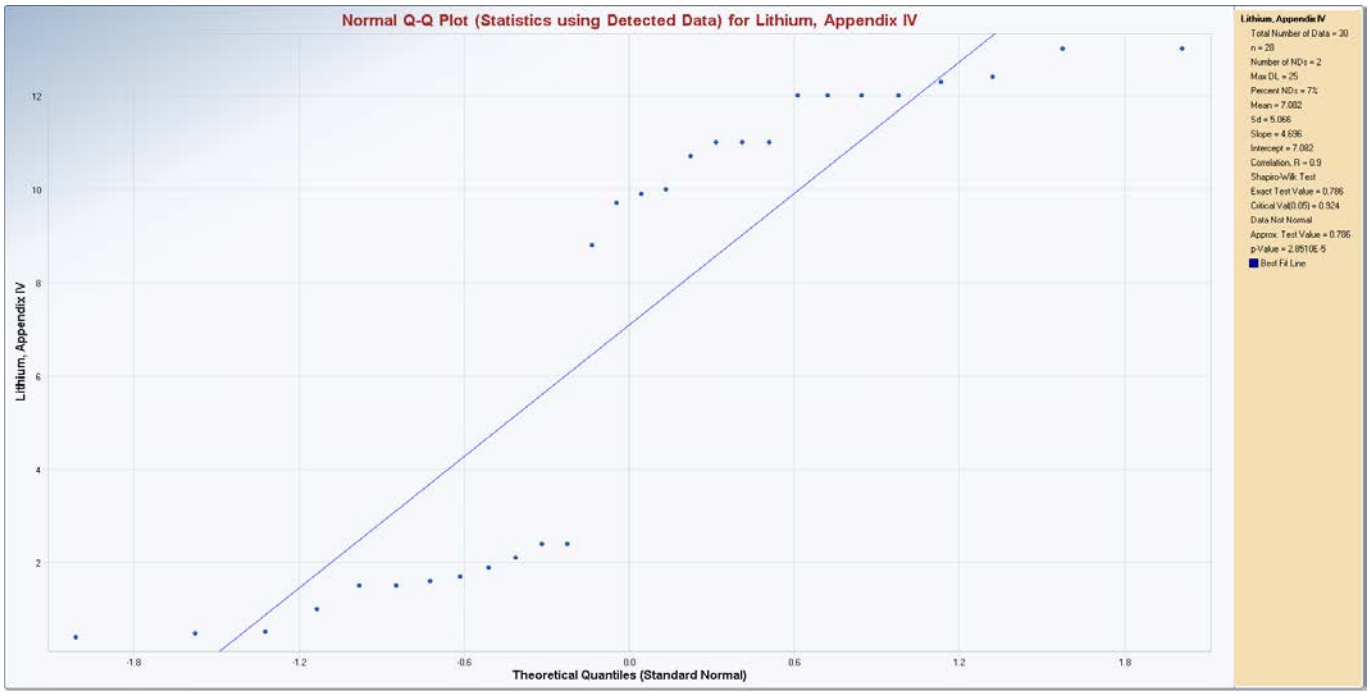
25, 25

General Statistics - Outliers Removed

Total Number of Observations	30		
Number of Distinct Observations	22		
Number of Detects	28	Number of Non-Detects	2
Number of Distinct Detects	20	Number of Distinct Non-Detects	2
Minimum Detect	0.41	Minimum Non-Detect	8
Maximum Detect	13	Maximum Non-Detect	25
Variance Detected	25.66	Percent Non-Detects	6.667%
Mean Detected	7.082	SD Detected	5.066
Mean of Detected Logged Data	1.477	SD of Detected Logged Data	1.184

Critical Values for Background Threshold Values (BTVs)

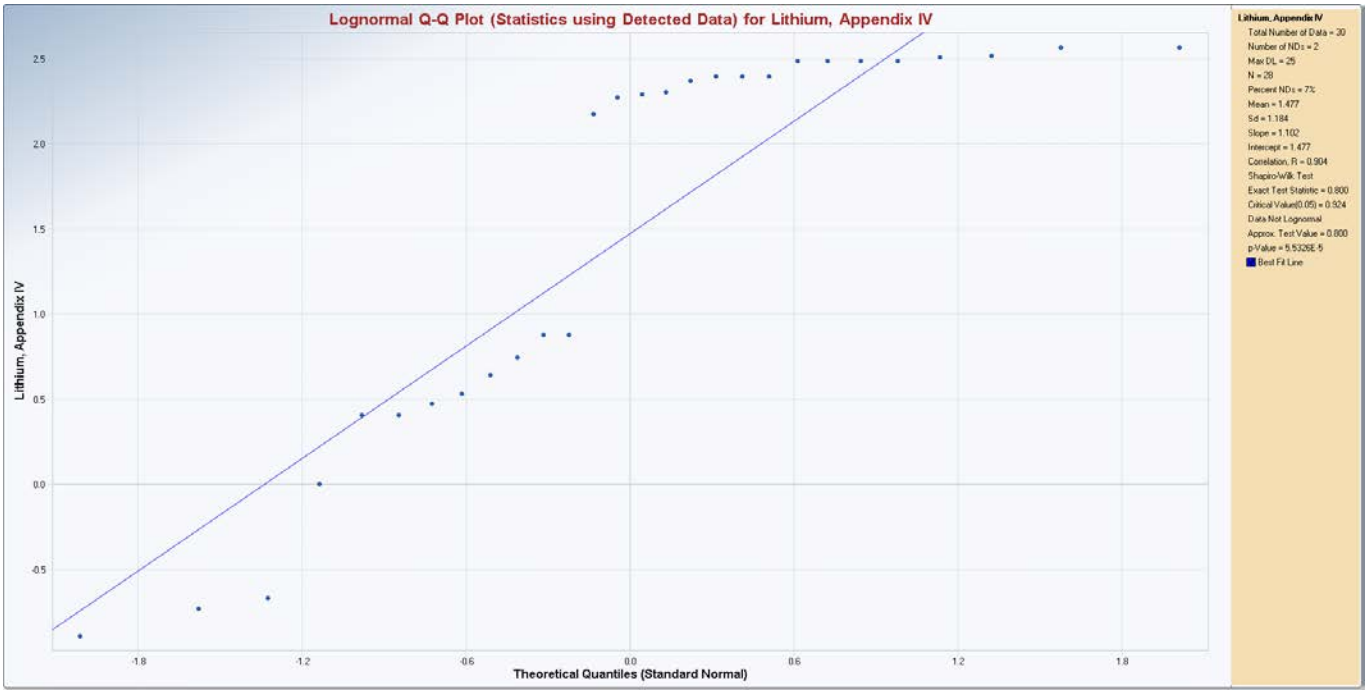
Tolerance Factor K (For UTL)	2.36	d2max (for USL)	2.745



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.786	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level



Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.8	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	30	95% UTL with95% Coverage	13
Approx, f used to compute achieved CC	1.579	Approximate Actual Confidence Coefficient achieved by UTL	0.785
Approximate Sample Size needed to achieve specified CC	59	95% UPL	18.4

General Statistics

Total Number of Observations	32		
Number of Distinct Observations	16		
Number of Detects	18	Number of Non-Detects	14
Number of Distinct Detects	15	Number of Distinct Non-Detects	2
Minimum Detect	0.58	Minimum Non-Detect	5
Maximum Detect	6.4	Maximum Non-Detect	10
Variance Detected	2.519	Percent Non-Detects	43.75%
Mean Detected	1.571	SD Detected	1.587
Mean of Detected Logged Data	0.161	SD of Detected Logged Data	0.7

Rosner's Outlier Test for 2 Outliers in Molybdenum, Appendix IV

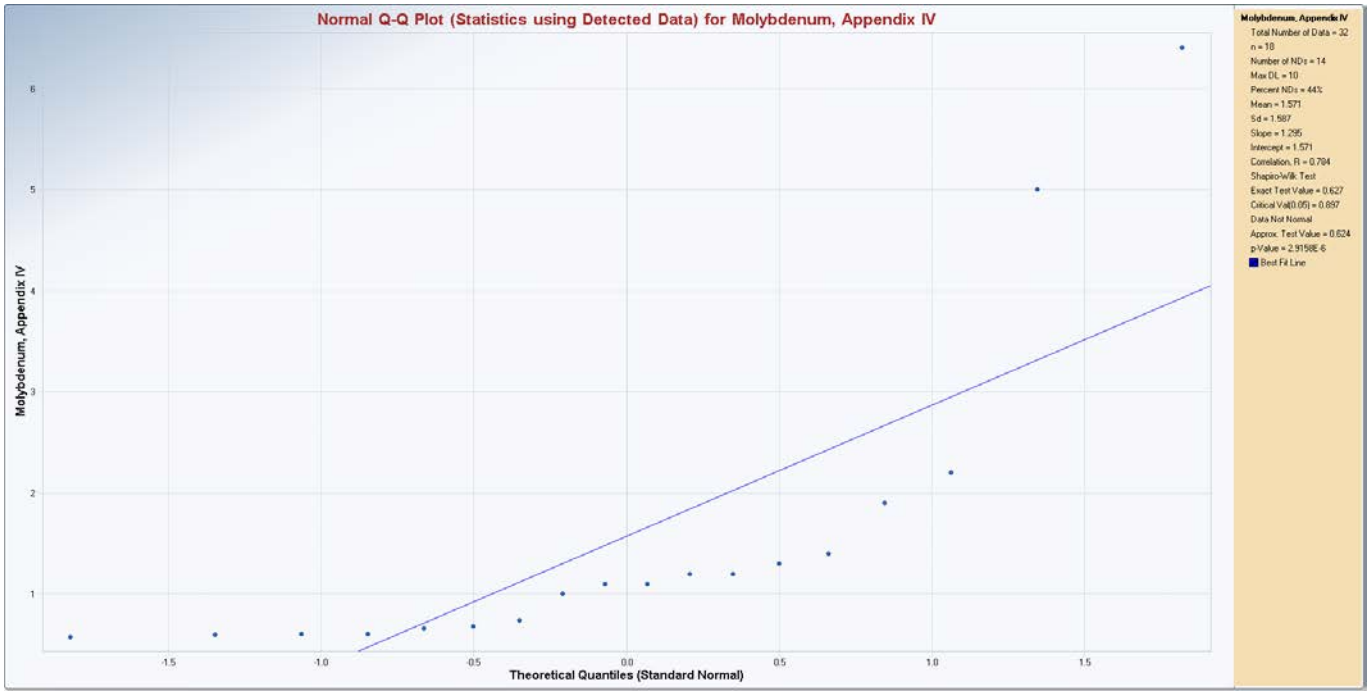
Total N	**32**
Number NDs	**14**
Number Detects	**32**
Mean with NDs=DL/2	**2.603**
SD with NDs=DL/2	**1.867**
Number of data	**32**
Number of suspected outliers	**2**
NDs replaced with half value.	

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	2.603	1.837	6.4	7	2.067	2.94	3.27
2	2.48	1.762	5	8	1.43	2.92	3.25

For 5% Significance Level, there are no Potential Outliers

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.198	d2max (for USL)	2.773

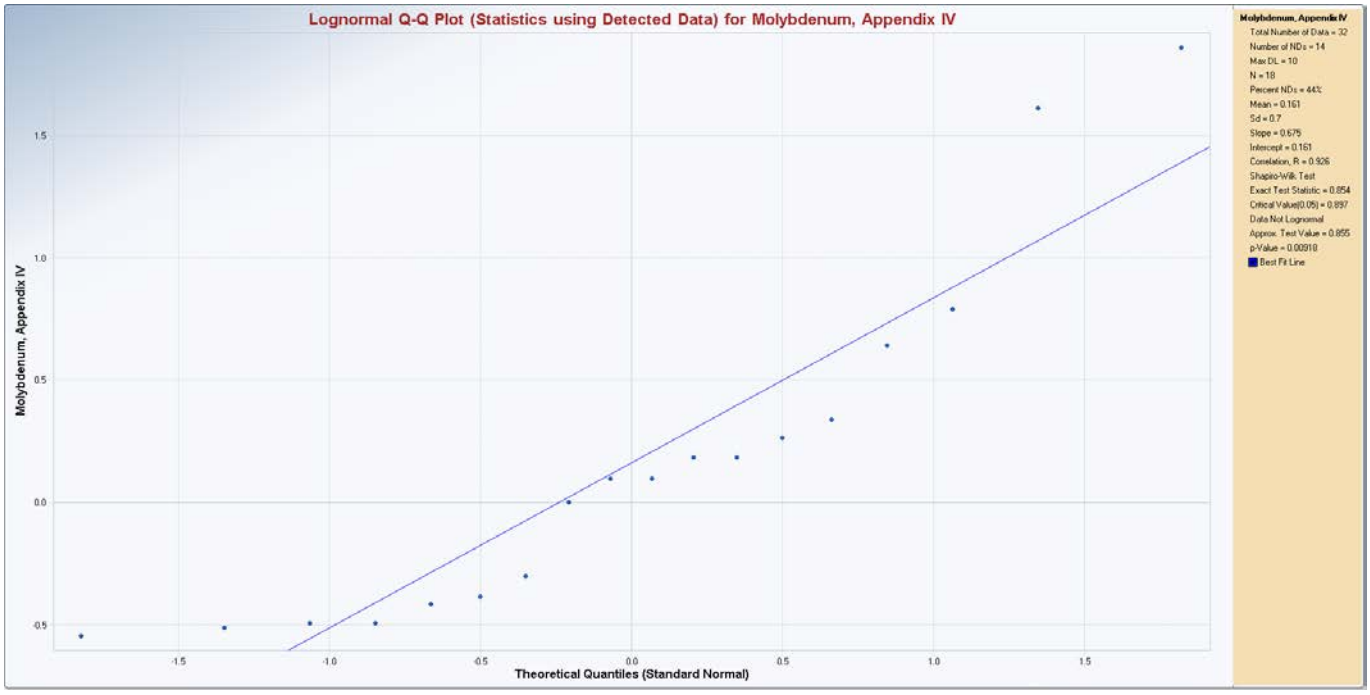


Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.627	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Molybdenum, Appendix IV



Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.854	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level	

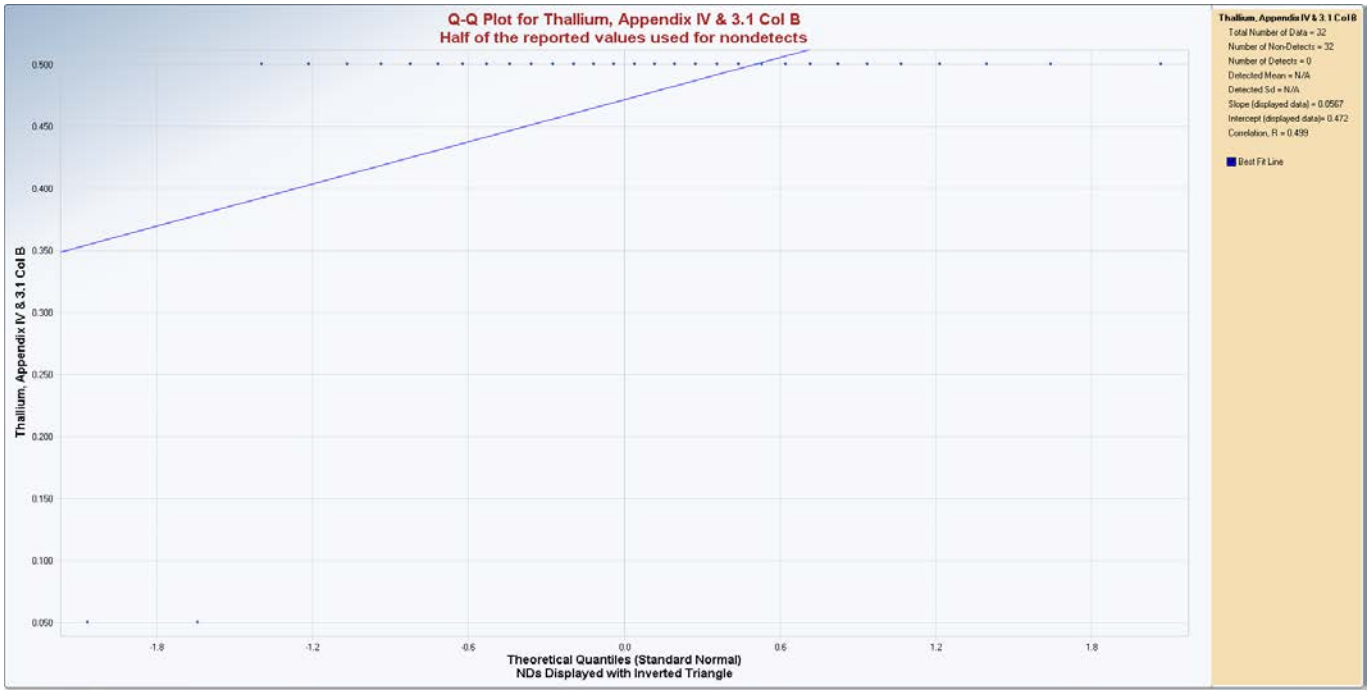
Data Not Lognormal at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	32	95% UTL with95% Coverage	6.4
Approx, f used to compute achieved CC	1.684	Approximate Actual Confidence Coefficient achieved by UTL	0.806
Approximate Sample Size needed to achieve specified CC	59	95% UPL	10
95% USL	10	95% KM Chebyshev UPL	7.525

General Statistics

Total Number of Observations	32		
Number of Distinct Observations	2		
Number of Detects	0	Number of Non-Detects	32
Number of Distinct Detects	0	Number of Distinct Non-Detects	2
Minimum Detect	N/A	Minimum Non-Detect	0.1
Maximum Detect	N/A	Maximum Non-Detect	1
Variance Detected	N/A	Percent Non-Detects	100%
Mean Detected	N/A	SD Detected	N/A
Mean of Detected Logged Data	N/A	SD of Detected Logged Data	N/A



General Statistics

Total Number of Observations	32		
Number of Distinct Observations	31		
Number of Detects	22	Number of Non-Detects	10
Number of Distinct Detects	21	Number of Distinct Non-Detects	10
Minimum Detect	0.358	Minimum Non-Detect	0.245
Maximum Detect	1.53	Maximum Non-Detect	1.26
Variance Detected	0.11	Percent Non-Detects	31.25%
Mean Detected	0.811	SD Detected	0.332
Mean of Detected Logged Data	-0.285	SD of Detected Logged Data	0.398

Rosner's Outlier Test for 1 Outliers in Total Radium

Total N	**32**
Number NDs	**10**
Number Detects	**32**
Mean with NDs=DL/2	**0.658**
SD with NDs=DL/2	**0.368**
Number of data	**32**
Number of suspected outliers	**1**
NDs replaced with half value.	

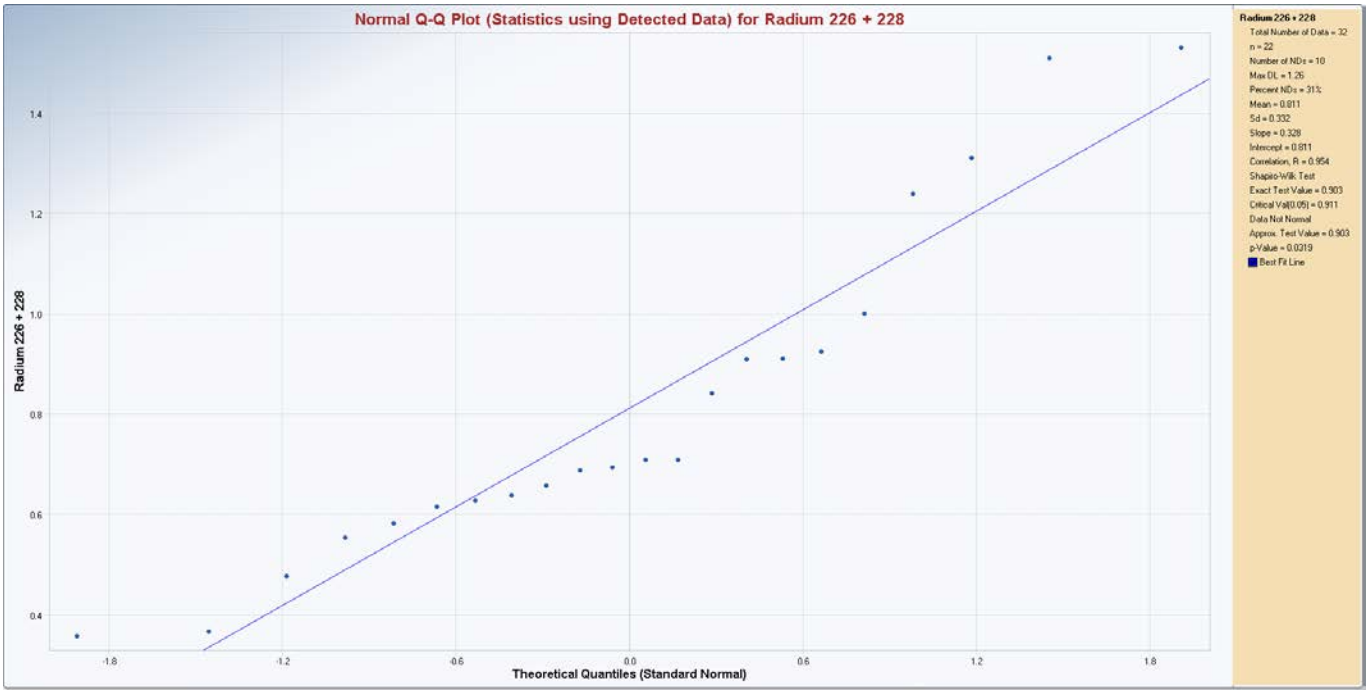
#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0.658	0.362	1.53	8	2.408	2.94	3.27

For 5% Significance Level, there are no Potential Outliers

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.198	d2max (for USL)	2.773

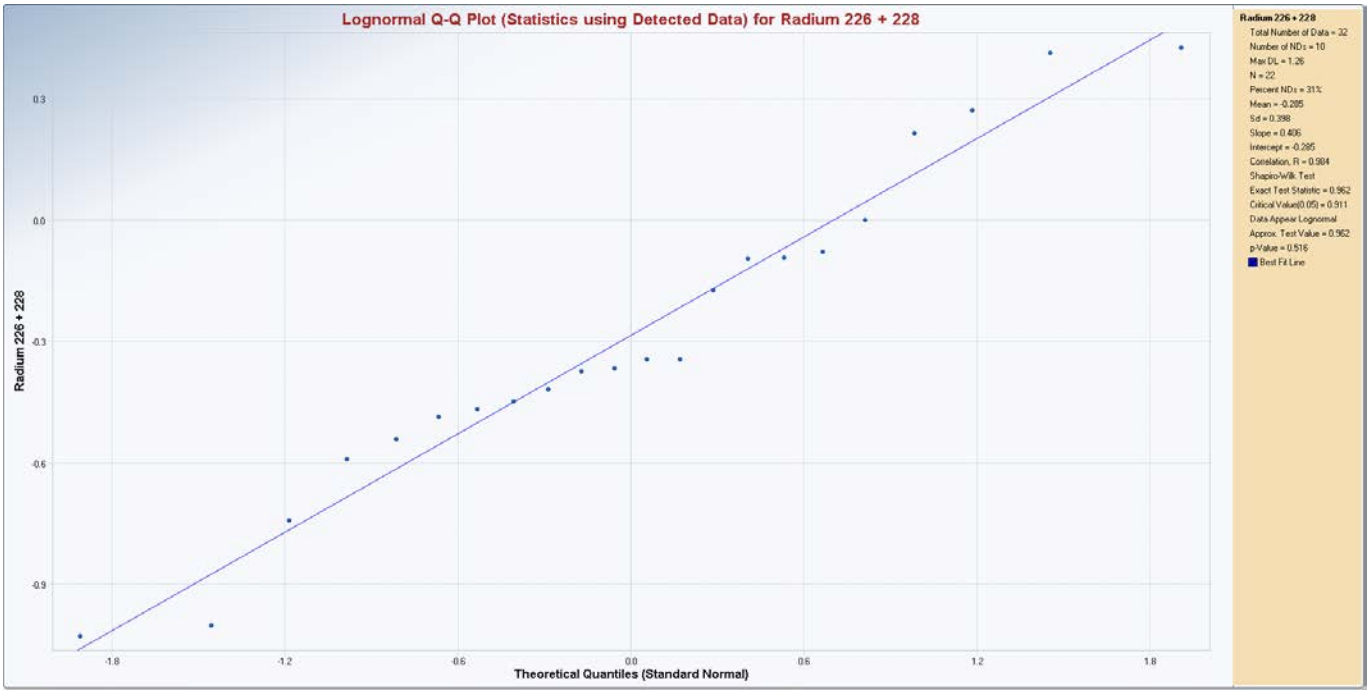
Total Radium, Appendix IV



Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.903	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level



Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Detected Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-0.514	95% KM UTL (Lognormal)95% Coverage	1.876
KM SD of Logged Data	0.523	95% KM UPL (Lognormal)	1.471
95% KM Percentile Lognormal (z)	1.413	95% KM USL (Lognormal)	2.55



golder.com